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NAS KEY WEST
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FIVE YEAR REVIEW REPORT WITH TRANSMITTAL LETTER NAS KEY WEST FL (PUBLIC DOCUMENT)
12/10/2004
TETRA TECH NUS

TETRA TECH NUS, INC.

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December 10, 2004

Project Number HK N5327 *via U.S. mail*

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Reference: CLEAN Contract No. N62467-94-D-0888
Contract Task Order No. 0300

Subject: Five Year Review Report, Rev. 0, Naval Air Station, Key West, Florida

Dear Ms. Martin:

I have enclosed a CD containing the PDF file for the Five Year Review Report, Rev. 0, Naval Air Station, Key West, Florida. The file is being distributed to the members of the NAS Key West Partnering Team via U.S. mail for their convenience. I am not expecting to receive comments on this document; however, I will be pleased to incorporate any comments received from the Partnering Team into a future revision.

Please call me at (803) 649-7963, extension 345, if you have any questions regarding the enclosed document.

Sincerely,

C. M. Bryan
Project Manager

CMB:spc

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Five Year Review Report

for

Naval Air Station
Key West, Florida

Southern Division
Naval Facilities Engineering Command

Contract Number N62467-94-D-0888

Contract Task Order 0300

December 2004

Rev. 0
12/10/04

FIVE YEAR REVIEW REPORT

FOR

NAVAL AIR STATION
KEY WEST, FLORIDA

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
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Naval Facilities Engineering Command
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CONTRACT NUMBER N62467-94-D-0888
CONTRACT TASK ORDER 0300

DECEMBER 2004

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LIST OF ACRONYMS AND ABBREVIATIONS

ABB	ABB Environmental Services, Inc.
AIMD	Aircraft Intermediate Maintenance Department
AOC	Area of Concern
APHIS	Animal and Plant Health Inspection Services
ARAR	Applicable or Relevant & Appropriate Requirements
AST	aboveground storage tank
BBL	Blasland, Bouck & Lee, Inc.
BEI	Bechtel Environmental, Inc.
BRA	baseline human health risk assessment
BRAC	Base Realignment and Closure
bls	below land surface
B&RE	Brown and Root Environmental, Inc.
BTEX	benzene, toluene, ethylbenzene, and xylenes
CAMP	Corrective Action Management Plan
CCI	CH2MHill Constructors, Inc.
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLEAN	Comprehensive Long-Term Environmental Action Navy
CMS	Corrective Measures Study
COC	chemical of concern
COE	U.S. Army Corps of Engineers
CTL	Cleanup Target Level
CTO	Contract Task Order
DCE	dichloroethene
DDD	4,4'-dichlorodiphenyl
DDE	4,4'-dichlorodiphenyl dichloroethane
DDT	4,4'-dichlorodiphenyl trichloroethane
DO	dissolved oxygen
DoD	Department of Defense
DPT	direct-push technology
EPA	U.S. Environmental Protection Agency
ER-M	Effects Range-Median
FAA	Federal Aviation Administration
FAC	Florida Administrative Code
FDEP	Florida Department of Environmental Protection
FDER	Florida Department of Environmental Regulation

FS	Feasibility Study
FWS	U.S. Fish and Wildlife Service
GCTL	Groundwater Cleanup Target Level
G&M	Geraghty & Miller
HRC®	Hydrogen Release Compound®
HSTAIC	Harry S. Truman Animal Import Center
HSWA	Hazardous and Solid Waste Amendments
IAS	Initial Assessment Study
IR	Installation Restoration
IRA	Interim Remedial Action
IT	IT Corporation, Inc.
JP	jet propellant
LNAPL	light non-aqueous phase liquid
LUC	Land-Use Control
LUCIP	Land-Use Control Implementation Plan
µg/kg	micrograms per kilogram
mg/kg	milligrams per kilogram
µg/L	micrograms per liter
MIP	membrane interface probe
mph	miles per hour
NACIP	Naval Assessment and Control Installation Pollutants Program
NAS	Naval Air Station
NAVFAC EFD SOUTH	Naval Facilities Engineering Command Field Division South
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NFA	no further action
NOV	Notice of Violation
OES	Omega Environmental Services
ORC®	Oxygen Release Compound®
ORP	oxidation/reduction potential
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
PEL	Probable Effects Level
PVC	Polyvinyl Chloride
RAC	Remedial Action Contract
RCRA	Resource Conservation and Recovery Act
REA	REA Remedial Solutions, Inc.
RFA	RCRA Facility Assessment

RFI	RCRA Facility Investigation
RI	Remedial Investigation
SAL	Screening Action Level
SI	Site Inspection
SOP	Standard Operating Procedure
SSI	Supplemental Site Inspection
SVOC	semi-volatile organic compound
SWMU	Solid Waste Management Unit
TAL	Target Analyte List
TCE	trichloroethene
TCL	Target Compound List
TEL	Threshold Effects Level
TF	trichlorotrifluoromethane
TRPH	total recoverable petroleum hydrocarbons
TtNUS	Tetra Tech NUS, Inc.
USDA	U.S. Department of Agriculture
UST	underground storage tank
VOC	volatile organic compound
VSI	Visual Site Inspection

1.0 INTRODUCTION

Tetra Tech NUS, Inc. (TtNUS) (formerly known as Brown and Root Environmental [B&RE]) has been contracted by the Department of the Navy, Naval Facilities Engineering Field Division South (NAVFAC EFD SOUTH) to perform a five-year review for 13 sites at Naval Air Station (NAS) Key West, Florida. This Five-Year Review Report has been prepared under the Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract Number 62467-94-D-0888, Contract Task Order (CTO) Number 0300.

The purpose of the five-year review is to determine whether the remedies at the 13 Installation Restoration (IR) sites are protective of human health and the environment. The methods, findings, and conclusions of the reviews are documented in this report. In addition, this report identifies issues found during the review, if any, and presents recommendations to address them.

This is the first five-year review for the NAS Key West IR sites. Five-year reviews are required by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) when hazardous substances, pollutants, and contaminants remain in the environment that do not allow for unlimited use and unrestricted exposure. Six of the NAS Key West sites are regulated under CERCLA. The seven Solid Waste Management Units (SWMUs) at NAS Key West are regulated under the Resource Conservation and Recovery Act (RCRA). However, the NAS Key West Partnering Team decided that five-year reviews were appropriate for these sites, as well as the CERCLA sites. The triggering action for the five-year reviews was the Hazardous and Solid Waste Amendments (HSWA) permit modification for SWMUs 1 through 4 on May 31, 1999.

Sections 2.0 through 14.0 contain the five-year reviews for SWMU 1, SWMU 2, SWMU 3, SWMU 4, SWMU 5, SWMU 7, SWMU 9, Area of Concern (AOC) B, IR 1, IR 3, IR 7, IR 8, and IR 21, at NAS Key West. Each section includes the site chronology, background, summary of the selected remedy, and the five-year review findings, assessment, deficiency list, recommendations, and protectiveness statements.

Section 15.0 provides a general summary, conclusions, and protectiveness statement for the NAS Key West sites. Appendix A contains response to any comments received. Appendix B contains the Background Tissue Report. Appendix C contains the action level selection process, along with the Applicable or Relevant and Appropriate Requirements (ARARs) and the media-specific action levels.

1.1 OVERVIEW OF NAS KEY WEST

NAS Key West is in southern Monroe County, Florida. Key West, one of the two westernmost major islands of Florida Keys, is approximately 150 miles southwest of Miami. Key West is connected to the mainland by the Overseas Highway (U.S. Highway No. 1). Several installations in various parts of the lower Florida Keys comprise what is known as the Naval Complex at Key West. Most of these are on Key West and Boca Chica Key (Figure 1-1). Other parts of the complex include Sigsbee Key (formerly Dredgers Key), Fleming Key, Demolition Key, and Big Coppitt Key. The entire complex encompasses approximately 5,675 acres (B&RE, 1997).

At present, NAS Key West maintains aviation operations, a research laboratory, communications intelligence, counter-narcotics air surveillance operations, a weather service, and several other activities. In addition to the Naval activities and units, other Department of Defense (DoD) and Federal agencies at NAS Key West include U.S. Coast Guard, U.S. Army Special Forces Underwater Training School, and Joint Interagency Task Force South.

Several investigations have been performed at NAS Key West since the mid-1980s to confirm or characterize contamination. As part of the Naval Assessment and Control Installation Pollutants Program (NACIP), an Initial Assessment Study (IAS) was performed by Envirodyne Engineers, Inc. at NAS Key West in 1985 (Envirodyne, 1985). The verification phase of the NACIP confirmation study was performed by Geraghty and Miller (G&M) in 1986. This study verified the presence or absence of shallow groundwater and soil contamination at various sites, and recommended sites that need further site-specific investigations during the characterization phase of the confirmation study (G&M, 1987).

In April 1988, a visual site inspection (VSI) was conducted by the U.S. Environmental Protection Agency (EPA) as part of the RCRA Facility Assessment (RFA) process (EPA, 1988). A preliminary remedial investigation (RI) report was prepared by IT Corporation (IT, 1991) and followed by a full RCRA Facility Investigation (RFI)/RI (IT, 1994). B&RE subsequently performed the Supplemental RFI/RI for High Priority Sites (B&RE, 1997) and the Supplemental RFI/RI for Eight Sites (B&RE, 1998a), which recommended remedies for the 13 IR sites at NAS Key West. Corrective Measures Studies (CMSs) were performed for several of the SWMUs to select the final remedy for the site. Remedies are documented in either Statements of Basis for the RCRA sites or Decision Documents for the CERCLA sites.

1.2 ARAR AND SITE-SPECIFIC ACTION LEVEL CHANGES

The five-year review is being conducted for two purposes:

- To determine if the remedial actions are being implemented as specified in the Statements of Basis or Decision Documents and if these actions remain protective of human health and the environment.

- To determine if there have been changes in the ARARs or site-specific action levels that call into question the protectiveness of the remedy.

The ARARs identified in the Supplemental RFI/RIs and the CMSs were reviewed to determine if they had been updated. This section describes the new or changed ARARs that address the risk posed to human health or the environment.

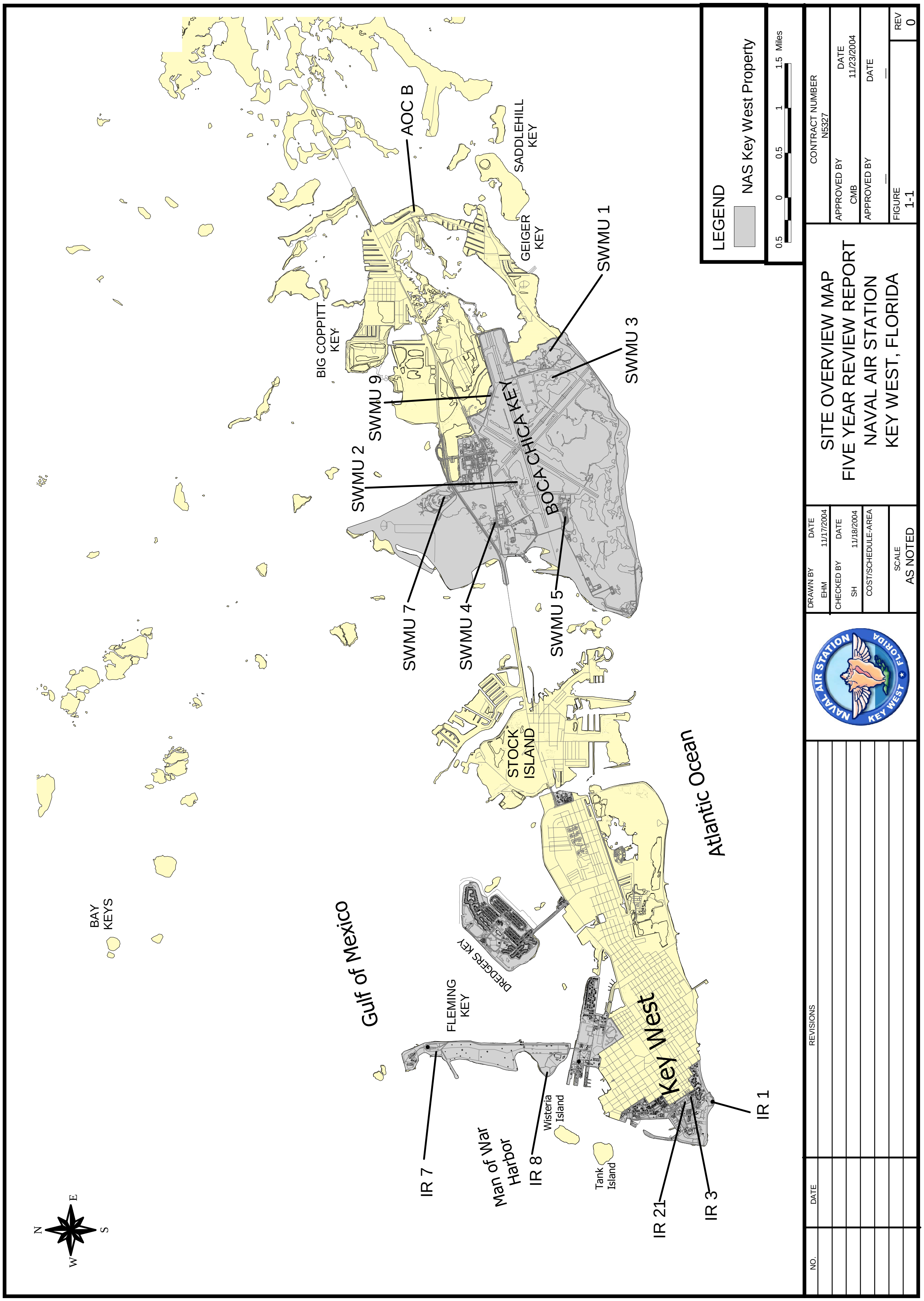
The most significant change in the ARARs that has occurred in the past five years is related to changes in the state of Florida regulations and guidance. Florida promulgated the Chapter 62-777, Florida Administrative Code (FAC) in August 1999. This regulation developed risk-based cleanup target levels (CTLs) for soil, groundwater, and surface water.

Following production of the Supplemental RFI/RIs in 1997 and 1998, the NAS Key West Partnering Team developed an action level selection process, as documented in the Site Investigation Work Plan for Ten Base Realignment and Closure (BRAC) Properties (B&RE, 1998b). The list of ARARs and the selection process is presented in Appendix C, along with selected media-specific action levels and the source of these action levels.

The general result of the new regulations, guidance, and action level selection process is an increase in the allowed contaminant concentrations. The action levels used in the Supplemental RFI/RIs were selected based on the most conservative values available at that time. However, action levels for some chemicals are more stringent than in Supplemental RFI/RIs because the regulatory levels for some chemicals have decreased in recent years. Specific action level information is provided in Sections 2.0 through 14.0.

1.3 2004 ANNUAL PERFORMANCE MONITORING DATA

In January 2004, REA Remedial Solutions, Inc. (REA) performed the annual performance monitoring event (REA, 2004) at some NAS Key West sites where monitoring was included as part of the final remedy. However, after review of the data produced, the Navy determined that the data was not usable because data completeness objectives were not met, a significant portion of the sample data was rejected, and because Florida Standard Operating Procedures (SOPs) were not followed during the sample collection process. Therefore, the 2004 Annual Performance Monitoring data is not presented or discussed in this document.



K:\FIVE YEAR REVIEW.APR LAYOUT: FIGURE 1-1 SITE LOCATION MAP 11/19/2004 BY: EHM

2.0 SWMU 1- BOCA CHICA OPEN DISPOSAL AREA

This section describes the five-year review for SWMU 1, the Boca Chica Open Disposal Area.

2.1 HISTORY AND SITE CHRONOLOGY

A list of important SWMU 1 historical events and relevant dates in the site chronology is shown below. The identified events are intended to be illustrative, rather than comprehensive.

Investigation/Activity	Date
Site operations	1942 to mid-1960s
3 aboveground storage tanks (ASTs) removed (portion of one remained until 2002)	before 1985
IAS Report issued by Envirodyne Engineers, Inc.	May 1985
Verification Study Assessment issued by G&M	March 1987
VSI conducted by EPA as documented in the RFA Report	April 1988
Preliminary RI Report issued by IT	January 1991
RFI/RI Report issued by IT	June 1994
Delineation Sampling Report produced by Bechtel Environmental, Inc. (BEI)	November 1995
Interim Remedial Action (IRA) excavation completed by BEI	April 1996
Supplemental RFI/RI Report for High-Priority Sites issued by B&RE	July 1997
CMS Report for SWMU 1 issued by B&RE	March 1998
Statement of Basis issued by TtNUS	July 1998
First year of Quarterly Performance Monitoring implemented by TtNUS	April 2000
Delineation sampling completed by CH2MHill Constructors, Inc. (CCI)	March 2001
Annual Performance Monitoring conducted by TtNUS	January 2002
Excavation of petroleum contaminated soil completed by CCI	March 2003
Annual Performance Monitoring conducted by TtNUS	January 2003
RCRA Corrective Action Management Plan (CAMP), Rev. 4 issued by TtNUS	July 2003
Annual Performance Monitoring conducted by REA	January 2004

2.2 BACKGROUND

2.2.1 <u>Site Description</u>

SWMU 1, the Boca Chica Open Disposal Area, is located in the southeastern portion of Boca Chica Key, between Stone Road and the mangrove swamp along Geiger Creek and the Atlantic Ocean (Figure 2-1). Boca Chica Key is the location of an active military airstrip and the facilities that support the airstrip.

SWMU 1 was the location of an open disposal and burning area for general refuse and waste associated with aircraft maintenance activities from 1942 to the mid-1960s. The site received general refuse and waste associated with the operation and maintenance of aircraft operated by the squadrons and Aircraft Intermediate Maintenance Department (AIMD). An estimated 2,600 tons of waste were disposed or burned at this site each year (G&M, 1987). It is estimated that these wastes included 60,000 tons of general refuse; 50,000 gallons of waste oils and fuels; 40,000 gallons of solvents (including methyl ethyl ketone, toluene, and xylene); 1,000 gallons of waste paints; and 3,000 gallons of waste paint thinners.

The area of waste disposal and burning (approximately 4 acres) was indicated by debris present near the eastern edge of the site. Most of the debris area lies beneath a dense canopy of mangrove trees. The mangrove-covered area is protected by state and federal dredge and fill regulations, since it is classified as a wetland (IT, 1994).

2.2.2 <u>Summary of Sampling Results</u>

Sampling at SWMU 1 was conducted to characterize contamination. Sampling was performed in 1986, 1990, 1993, 1995, and 1996 during a series of field investigations. Metals, semi-volatile organic compounds (SVOCs), and pesticides were found in the soil and sediment in excess of the action levels derived from the most restrictive ARARs and Screening Action Levels (SALs). The metals found in soil included lead, chromium, copper, manganese, and mercury. Polynuclear aromatic hydrocarbons (PAHs), which are common constituents and byproducts of asphalt, vehicle exhaust, and burning, were found in excess of action levels. The pesticide 4,4'-dichlorodiphenyl trichloroethane (DDT), and its close structural analogs 4,4-dichlorodiphenyl dichloroethane (DDD) and 4,4'-dichlorodiphenyl dichloroethylene (DDE), were detected in soil and sediment. For convenience, 4,4’-DDT, 4,4’-DDD, and 4,4’-DDE will be referred to as DDT, DDD, and DDE, respectively.

2.2.3 1996 IRA

Based on delineation sampling results, the Navy coordinated with EPA and Florida Department of Environmental Protection (FDEP) during discussions held on October 24-30, 1995, to determine the boundaries for excavating contaminated soil and sediment in an IRA. The estimated quantity of soil to be removed was increased from the budgeted 2,500 cubic yards to 5,740 cubic yards (BEI, 1995a) based on the sampling results and discussions with the regulatory agencies. Under the Navy's Remedial Action Contract (RAC), BEI completed the contaminated soil and sediment IRA in April 1996. The actual quantity of soil removed was 5,916 cubic yards. Approximately 71 tons of soil and sediment were excavated and treated/disposed off-site as hazardous waste based on lead concentrations. Approximately 7,400 tons of contaminated soil and sediment were excavated and disposed off-site as nonhazardous waste. Approximately 5,800 tons of clean backfill were placed in the excavation. Pursuant to a wetlands permit requirement, BEI sloped the backfill material at SWMU 1 to promote natural mangrove revegetation in the excavated area (BEI, 1998).

2.2.4 Summary of Risk

A baseline human health risk assessment (BRA) and an ecological risk assessment were performed as part of the Supplemental RFI/RI (B&RE, 1997). The BRA identified a carcinogenic (i.e., cancer) risk for the hypothetical future resident from aroclor-1260 in surface soil, and benzo(a)pyrene and arsenic in surface soil and sediment. Benzo(a)pyrene was the principal chemical of concern (COC) contributing to the cancer risk. The BRA identified a non-carcinogenic risk for the hypothetical future resident from metals, primarily iron and manganese in surface soil.

The ecological risk assessment (B&RE, 1997) concluded that ecological risks were marginal, but metals, PAHs, and DDT and its metabolites might pose risks to some receptors.

2.3 REMEDIAL ACTIONS

2.3.1 Remedy Selection

The CMS determined that the appropriate remedy for SWMU 1 was Institutional Controls, consisting of land-use controls (LUCs) with monitoring (B&RE, 1998c). The LUCs are designed to eliminate or reduce exposure pathways by limiting site access. Additional information regarding the selection of LUCs with monitoring as a remedy for SWMU 1 is provided in the CMS and summarized in the Statement of Basis for SWMU 1 (TtNUS, 1998a).

2.3.2 Remedy implementation

2.3.2.1 Land-Use Controls with Monitoring

SWMU 1 is near an active air strip on an active military base with no planned change in site usage for the foreseeable future. The IRA conducted in spring 1996 removed the majority of the contaminated soil and sediment. Other alternatives considered would have required the destruction of significant areas of uncontaminated mangrove swamp to gain access to the remaining contaminated soil and sediment. Additionally, considering that the IRA was conducted at a significant cost to remove the majority of the contamination, the costs associated with other alternatives were considered by the NAS Key West Partnering Team as cost prohibitive when compared to the overall protectiveness of human health and the environment to be gained (B&RE, 1998c).

LUCs were developed through Land Use Control Implementation Plans (LUCIPs). These controls were designed to ensure protection of human health and the environment by restricting future site use and accessibility, educating NAS personnel, and maintaining records of contamination. The LUCs documented in the NAS Master Plan prevent future residential use at this site. The LUCIP for SWMU 1 includes the placement and maintenance of signs around the site perimeter, which state that trespassing and dumping are not permitted at the site. Personnel from the NAS Key West Public Works Department are required to visually inspect SWMU 1 at least once every three months to ensure that all LUCs are being implemented and properly maintained. The NAS Key West Public Works Department submits an annual report to FDEP describing the results of the quarterly inspections.

To implement the monitoring program for this corrective measure, groundwater, surface water, and sediment samples were collected quarterly for the first year and annually thereafter. The quarterly monitoring began in April 2000 and was completed in January 2001 (TtNUS, 2001a). Additional annual events were performed in January 2002 and 2003 (TtNUS; 2002a, 2003a). Monitoring of ecological receptors was performed in October 2000 and January 2003, and involved the analysis of fish, crab, and vegetation tissue for pesticides and metals (TtNUS; 2001b, 2003a).

2.3.2.2 Additional Remediation

During the first quarterly monitoring event at SWMU 1 as part of the selected remedy, TtNUS personnel discovered a free-phase petroleum-based product in one monitoring well at SWMU 1. The monitoring well was located within the previously remediated area. This product resembled the tar-like substance discovered by BEI during the 1996 IRA. In addition, a sheen was observed on surface water near the monitoring well (TtNUS, 2001a).

In response to this discovery, the Navy tasked its RAC (CCI) to conduct delineation activities at SWMU 1 to evaluate the vertical and horizontal extent of the material identified during previous sampling activities. Following delineation, CCI performed source removal activities at SWMU 1 from March to June 2002. A total of 8,450 tons of petroleum-contaminated soil was excavated from the SWMU 1 area. The nonhazardous soil was transported to Waste Management's Central Landfill located in Pompano Beach, Florida and disposed. Approximately 500 gallons of free product/decontamination water were recovered by a vacuum truck, transported and disposed at the Cliff Berry, Inc. facility in Fort Lauderdale, Florida. The free product/water was classified as nonhazardous waste using the excavated soil waste profile and analytical results. Backfilling began in June 2002 and was completed in February 2003. Site restoration was completed in March 2003 by placing a layer of topsoil (approximately 1 foot) over the backfilled source area excavation (CCI, 2003).

Following restoration, Oxygen Release Compound® (ORC®), a bio-enhancement reagent, was injected to remediate any residual petroleum contamination. Originally, the method of ORC® placement specified in the work plan was to mix ORC® with clean sand during backfilling of the excavation. Due to the residual petroleum product sinking to the bottom of the excavation and the increased size of the excavation, ORC® was injected into the backfill material in the saturated zone after it was placed. This allowed a more precise placement of the ORC® at the excavation bottom where the highest potential petroleum contamination would be present (CCI, 2003). A monitoring well was placed in the center of the remediation area and sampled in August 2003 (TtNUS, 2003b).

2.3.3 System Operations and Maintenance

Seven sampling events involving the monitoring of groundwater, surface water, and sediment have been conducted since April 2000. Four sampling events were conducted quarterly during the first year (TtNUS, 2001a). Subsequent annual events were conducted in January 2002 and 2003 (TtNUS; 2002a, 2003a). Biological monitoring was performed twice since the remedy was implemented, in October 2000 (TtNUS, 2001b) and January 2003 (TtNUS, 2003a).

The estimated cost for excavation and removal of the source area during the 2002 IRA was $250,000 to $350,000 (CCI, 2001). According to cost estimates obtained from the NAS Key West Public Works Environmental Department, the approximate annual cost for the long term monitoring and LUCs associated with the remedy at SWMU 1 is $6,200.

2.4 FIVE YEAR REVIEW PROCESS

2.4.1 Document Review

Reports and data from investigations conducted from 1985 through 2003 were reviewed for this five-year review, as discussed in Section 2.2.

2.4.2 Data Review

Concentrations of media-specific COCs identified in the Supplemental RFI/RI and the CMS were plotted to identify and evaluate trends across various investigations. For COCs that were monitored in groundwater, surface water, and sediment, the plots show concentrations over time at each monitoring location. Surface soil sampling was not included in the long-term monitoring plan, so the surface soil plots do not show concentrations over time. Instead, the soil plots simply show data for individual samples typically collected only once at a particular sampling location. The plots for groundwater, surface water, sediment, and surface soil also show the media-specific action level for each COC. The action levels are concentrations that have been selected by the NAS Key West Partnering Team as representing concentrations below which there is no potential for unacceptable risk to human health or the environment. The action levels were selected from several sources, and are included in Appendix C.

As explained above, concentrations of COCs identified in the Supplemental RFI/RI and the CMS were plotted to evaluate trends. Chemicals that were not identified as COCs in the Supplemental RFI/RI and/or the CMS were not plotted in this report, but were evaluated and are discussed in their respective media-specific sections.

The plots of biological tissue data show data for all detected chemicals that were COCs in surface water, sediment, or surface soil. COCs in vegetation and fish tissue are plotted over time, although tissue data were monitored in fewer sampling events than abiotic media. Another difference between the plots of abiotic samples compared to the biological samples is that the biological samples typically represent a larger area than the abiotic samples. For example, a sediment sample can be collected in the same location in successive sampling events, but fish are mobile. Thus, the biological data plots are set up differently than the abiotic data plots. The plots of groundwater, surface water, and sediment show data for discrete sampling locations over time, but the tissue plots show average concentrations of all tissue samples collected during a specific sampling event.

2.4.2.1 Groundwater Monitoring

Concentrations of COCs over time for groundwater are shown in Figures 2-2 through 2-8. All detected concentrations of beryllium, copper, manganese, vanadium, and pyrene in groundwater have been less than action levels since 1986. Cadmium concentrations in some groundwater samples have exceeded its action level of 5 micrograms per liter (µg/L), but the exceedances have been slight, with maximum cadmium concentrations of 8 µg/L (Figure 2-3). Mercury concentrations have exceeded the 2 µg/L action level in only one sampling event since 1986; concentrations in two samples were 6 µg/L in the April 2000 quarterly monitoring event (Figure 2-6).

Concentrations of analytes that were not previously identified as COCs (hereafter referred to as "non-COCs") in groundwater have tended to be less than action levels, and as a result, the NAS Key West Partnering Team has reduced the number of chemicals for which analyses are conducted in Performance Monitoring of groundwater (TtNUS, 2001a; 2002a; 2003a).

2.4.2.2 Surface Water Monitoring

Concentrations of copper and lead have exceeded their action levels in most samples, and were especially elevated at S1SW-1 during the April 2000 quarterly monitoring event (Figures 2-9 and 2-10). Mercury concentrations have typically been less than its action level since 1991 (Figure 2-11). Surface water concentrations of other metals have exceeded action levels in some samples; most commonly aluminum, iron, manganese, and zinc (TtNUS, 2001a; 2002a; 2003a). Surface water samples were not filtered, and thus, the data reflect total (unfiltered) concentrations of metals instead of dissolved concentrations. Elevated concentrations of metals in some surface water samples might be due to high turbidity, especially when samples were collected from shallow water, as was the case with some samples at SWMU 1. The sporadic high concentrations, therefore, might be at least partially due to field sampling techniques.

Surface water toxicity tests conducted in support of the Supplemental RFI/RI (B&RE, 1997) indicated low potential risk to aquatic organisms, so concentrations equal to or less than those evaluated in the Supplemental RFI/RI do not appear to pose ecological risks. Potential risks posed by COC concentrations that exceed the data evaluated in 1997 cannot be ruled out. However, such elevated concentrations have been sporadic rather than consistent, which reduces the potential risk posed by these COCs.

2.4.2.3 Sediment Monitoring

Arsenic concentrations have typically tended to be less than its action level, with the notable exception of sample location S1SD-04 during two sampling events in 2000 and 2001 (Figure 2-12). Lead concentrations have typically exceeded the action level, and have been especially elevated at sample locations S1SD-02 and S1SD-03 (Figure 2-13). Concentrations of benzo(a)pyrene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene have exceeded their action levels in most samples, and have been especially elevated at sample location S1SD-01 (Figures 2-14 through 2-16).

Sediment concentrations of other metals have exceeded action levels in several samples; most commonly aluminum, cobalt, copper, iron, manganese, vanadium, zinc, and pesticides (TtNUS, 2001a; 2002a; 2003a).

Sediment toxicity tests conducted in support of the Supplemental RFI/RI (B&RE, 1997) indicated low potential risk to benthic (sediment-dwelling) organisms, so concentrations equal to or less than those evaluated in the Supplemental RFI/RI do not appear to pose ecological risks. Potential risks posed by COC concentrations that exceed the data evaluated in 1997 cannot be ruled out. However, such elevated concentrations have been sporadic rather than consistent, which reduces the potential risk posed by these COCs.

2.4.2.4 Soil Samples

The remedial actions conducted at SWMU 1 did not include the removal of surface debris near the eastern edge of the site. Most of the visible debris lies beneath a canopy of mangrove trees, and consists primarily of corroding metal. This debris may undoubtedly be a continuing source of soil contamination for metals and possibly for other long-lived contaminants such as organochlorine pesticides, and may be for many years to come. The long-term monitoring at SWMU 1 did not include the sampling and analysis of soil samples. Thus, soil data are available only for samples collected in 1996 or earlier. The soil data were evaluated in the Supplemental RFI/RI, and were not re-evaluated in this five-year review. Plots showing the soil data are included as Figures 2-17 through 2-22.

2.4.2.5 Biota Monitoring

Minnow samples were initially collected at SWMU 1 in January 1996 for evaluation in the Supplemental RFI/RI. Minnow-sized fish, mud fiddler crabs, and sea oxeye daisy (a small terrestrial plant) were collected for laboratory analysis in October 2000. Mud fiddler crabs were not present in sufficient numbers for analysis in January 2003, so biological samples in January 2003 were limited to minnows and sea oxeye daisy.

Chromium, copper, lead, and mercury in minnow samples varied very little over time (Figure 2-23). Concentrations of DDD and DDE in minnow samples were more variable over time than concentrations of DDT, and average concentrations of DDD and DDE in minnow samples from SWMU 1 (Figure 2-24) were greater than average concentrations in background minnows (Appendix B, Table B-2). The minnow tissue data were used to estimate risks to piscivorous (fish eating) birds represented by the little blue heron. Food chain modeling indicated COCs pose minimal risk to piscivorous birds that forage on minnows from SWMU 1 (TtNUS, 2003a).

Concentrations of inorganic COCs in sea oxeye daisy tissue were similar between the two sampling events (Figure 2-25). Concentrations of DDD and DDT in sea oxeye daisy appeared to be slightly less in 2003 than in 2000 (Figure 2-26). It should be noted, however, that DDD and DDT were not detected in sea oxeye daisy samples in 2000; the concentrations shown in Figure 2-26 for the 2000 sampling event represent one-half the detection limit (17 micrograms per kilogram [µg/kg]). Detection limits were lower in 2003 samples (1.7 µg/kg). Concentrations of COCs in sea oxeye daisy samples from SWMU 1 are similar to background values (Appendix B, Table B-4). The sea oxeye tissue data were used to estimate risks to herbivorous mammals represented by the endangered Lower Keys marsh rabbit. Food chain modeling indicated no risk to herbivorous mammals from COCs through consumption of sea oxeye daisy vegetation (TtNUS, 2003a).

Mud fiddler crab tissue data were not plotted and are not presented in this report, since this species was collected in only one sampling event.

2.4.3 Site Inspection

The site has been inspected on numerous occasions during routine monitoring events by NAS Key West personnel and Navy contractors. No significant issues have been identified at any time regarding the site. Since access to the base is restricted, access by trespassers is minimal. In addition, warning signs are in place around the site perimeter, notifying base personnel that trespassing is not permitted at SWMU 1.

2.5 TECHNICAL ASSESSMENT

The Comprehensive Five-Year Review Guidance (EPA, 2001) states that the technical assessment section should answer three primary questions, each of which is presented below.

2.5.1 Question A

Is the remedy functioning as intended by the decision documents?

The remedy to protect human health and the environment is functioning as intended. SWMU 1 is located on an active military base, and access to the base is restricted. NAS Key West personnel perform quarterly monitoring to ensure adherence to LUCs, and an annual report is submitted to FDEP describing the results of the quarterly monitoring. In addition, warning signs are in place around the site perimeter, reducing the chance of trespassing and potential exposure to base personnel. There is no planned change in site usage for the foreseeable future.

Overall, the existing remedy is protective of ecological receptors. Tissue concentrations of COCs pose negligible risk to receptors that consume minnows and plants. Since the surface water at SWMU 1 is too saline to be used as drinking water by wildlife species, risks from drinking are not applicable. Concentrations of arsenic, lead, and PAHs in some surface water and sediment samples indicate potential risk to ecological receptors (primarily aquatic and benthic invertebrates), but elevated concentrations have been sporadic.

2.5.2 Question B

Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of the remedy selection still valid?

There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. There has been no change to the standardized risk assessment methodology or toxicity data that could affect the protectiveness of the remedy. However, following conclusions presented in the Supplemental RFI/RI Report, the action level selection process was revised by the NAS Key West Partnering Team as presented in the Site Investigation Work Plan for Ten BRAC Parcels (B&RE, 1998b). The current ARARs are included in Appendix C, along with the dates of the latest revisions and method of selection for each medium. Values evaluated for each medium are listed in tables, along with the selected action level.

Updated action levels were compared to COCs for surface water, sediment, and soil identified in the Supplemental RFI/RI Report and COCs for groundwater from the CMS for SWMU 1. These comparisons resulted in several chemicals that were previously identified as COCs that now do not exceed current action levels. Groundwater COCs that no longer exhibit any exceedances of the selected action level include copper, manganese, vanadium, and pyrene. Likewise, beryllium, cadmium, chromium, copper, iron, manganese, mercury, DDD, DDE, DDT, aroclor-1260, benzo(a)anthracene, and indeno(1,2,3-cd)pyrene no longer exceed action levels in soil. Concentrations of metals in surface water and sediment, however, as well as concentrations of pesticides in sediment, have exceeded action levels in several samples collected during long term monitoring.

2.5.3 Question C

Has any other information come to light that could call into question the protectiveness of the remedy?

No new ecological receptors or human usage of the site were identified during long-term monitoring or during the five-year review. No weather related events have affected the protectiveness of the remedy. Hurricane Georges passed directly over the Key West area in September 1998, with maximum sustained winds near 100 miles per hour (mph) on Boca Chica Key, but no erosion or other effects were visible at SWMU 1 as a result of the storm. The only information that could possibly call into question the protectiveness of the remedy is the surface debris remaining at the eastern edge of the site. This debris, consisting primarily of corroding metal, is presumably a source of soil contamination, and possibly surface water and sediment contamination.

2.5.4 Technical Assessment Summary

Based on the data reviewed and the site inspections, the remedy is functioning as intended by the HSWA Permit. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. There have been no changes to the standardized risk assessment methodology that could affect the protectiveness of the remedy. With the possible exception of surface debris remaining on site, there is no other information that calls into question the protectiveness of the remedy.

2.6 ISSUES

There are no unresolved issues that could impact the remedy.

2.7 RECOMMENDATIONS AND FOLLOW UP ACTIONS

The remaining surface debris should be considered for removal. It might be possible to remove most of this material without significant disturbance of the nearby mangrove wetland.

The collection of additional biological samples as part of long-term monitoring should be discontinued for the following reasons:

- Concentrations of COCs in sea-oxeye daisy samples from SWMU 1 were similar to background values and pose no risk to herbivorous mammals.

- Concentrations of inorganic COCs in SWMU 1 minnow samples were similar to background values and pose no risk to piscivorous birds.

- Concentrations of DDD and DDE in some SWMU 1 minnow samples were greater than average concentrations in background minnows, but pose minimal risk to piscivorous birds.

- The presence of mud fiddler crabs, which were collected in the first biennial sampling event, depends largely on hydrological conditions.

Mud fiddler crabs feed on detritus at the edge of water bodies, and live in burrows that typically extend down to the water level. Site conditions were extremely dry during the second biennial sampling event, and mud fiddler crabs were not present in sufficient numbers for collection and analysis. In addition, the mud fiddler crabs, when present, are found primarily within the mangrove-covered area that has not been remediated. Many of the minnow samples were also collected in this area, from two small borrow-pit ponds. Since this area has not been remediated, and since metallic debris is visible in this area, the presence of metals in fish and crab tissue is expected. Similarly, organochlorine pesticides such as DDD and DDE are long-lived in the environment, and their presence in tissue in a waste-disposal area is not surprising. Because metals, DDD, and DDE are expected to remain in SWMU 1 media for the foreseeable future, and since existing tissue data show negligible risk to ecological receptors, the collection of additional biological samples as part of long-term monitoring is not considered to be necessary. It is recommended that the collection of additional biological samples as part of long-term monitoring be discontinued. If concentrations of COCs in abiotic media substantially increase, then tissue monitoring could be re-established.

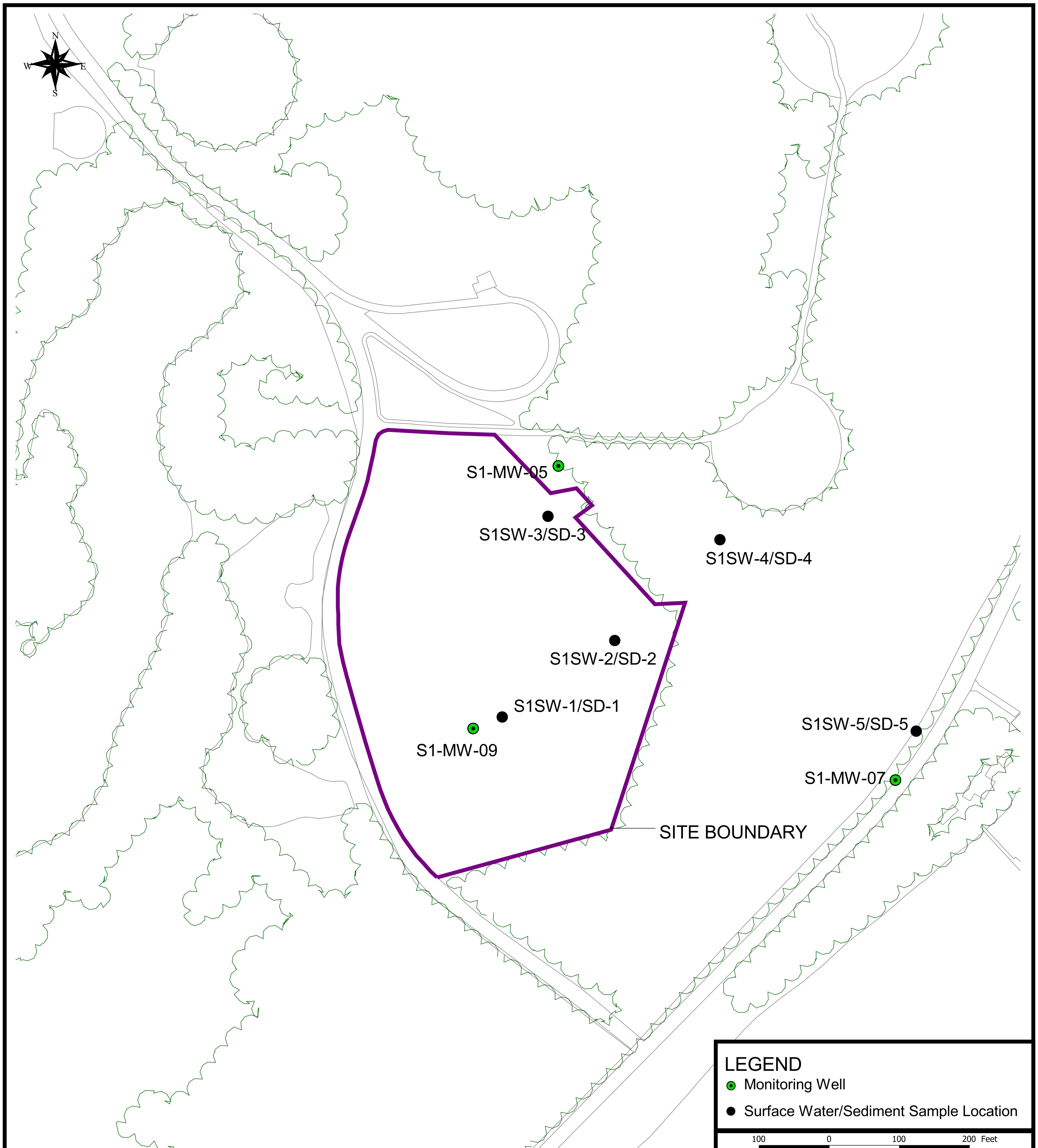
The LUCs and LUCIPs associated with the selected remedy should be continued.

2.8 PROTECTIVENESS STATEMENT

The remedy is expected to continue to be protective of human health and the environment.

2.9 NEXT REVIEW

The next five-year review for SWMU 1 is required by May 2009.



NO.	DATE	REVISIONS

DRAWN BY: EHM, DATE: 11/17/2004
CHECKED BY: SH, DATE: 11/18/2004
COST/SCHED-AREA
SCALE: AS NOTED

SWMU 1 SITE LAYOUT
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

CONTRACT NO. 5327
APPROVED BY: CMB, DATE: 11/23/2004
APPROVED BY: —, DATE: —
FIGURE NO. 2-1
REV. 0

FILE: K:\FIVE YEAR REVIEW.APR LAYOUT: FIGURE 2-1 SWMU 1 SITE LAYOUT DATE: 11/17/2004 BY: EHM

FIGURE 2-2

BERYLLIUM IN GROUNDWATER
SWMU 1
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

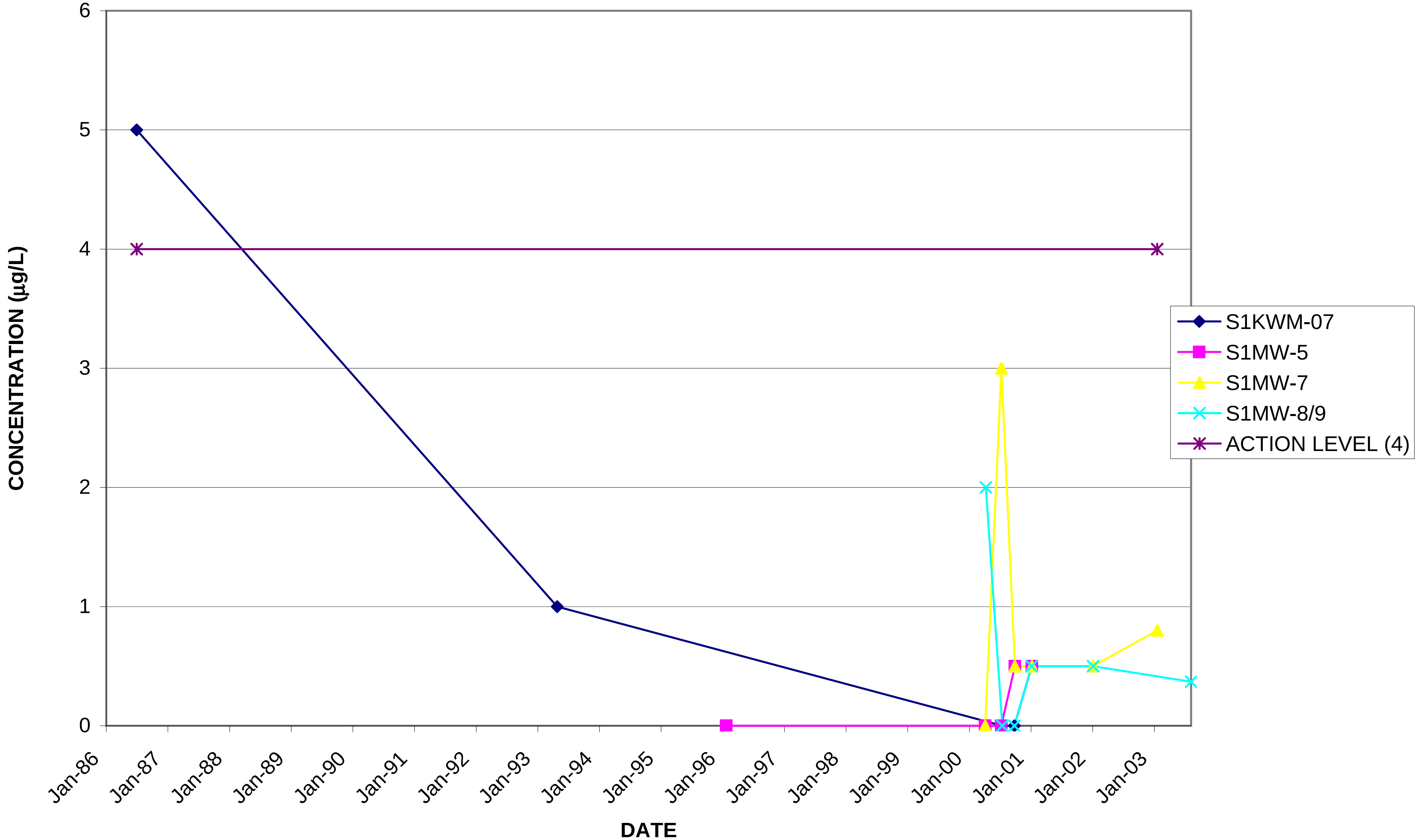


FIGURE 2-3

CADMIUM IN GROUNDWATER
SWMU 1
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

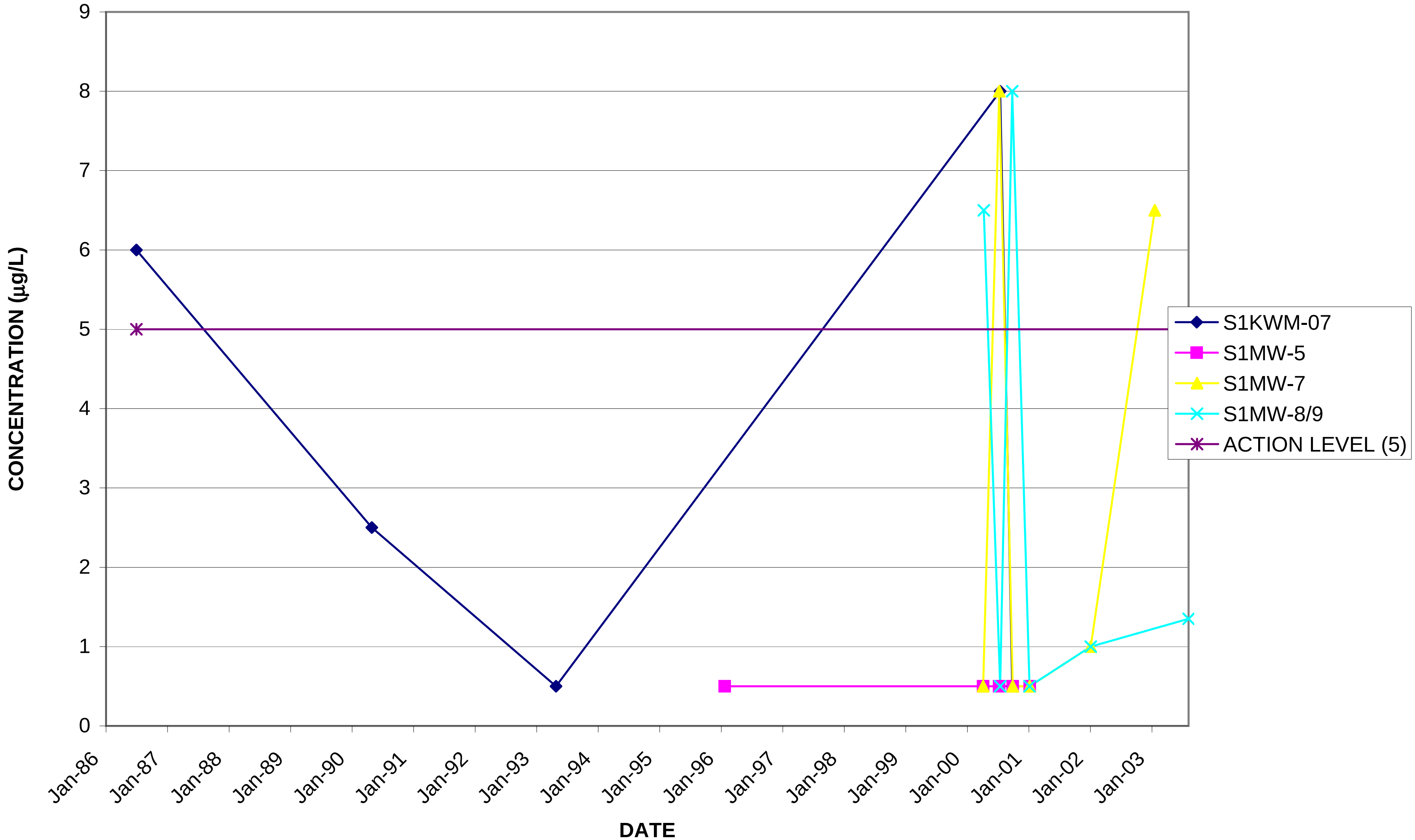
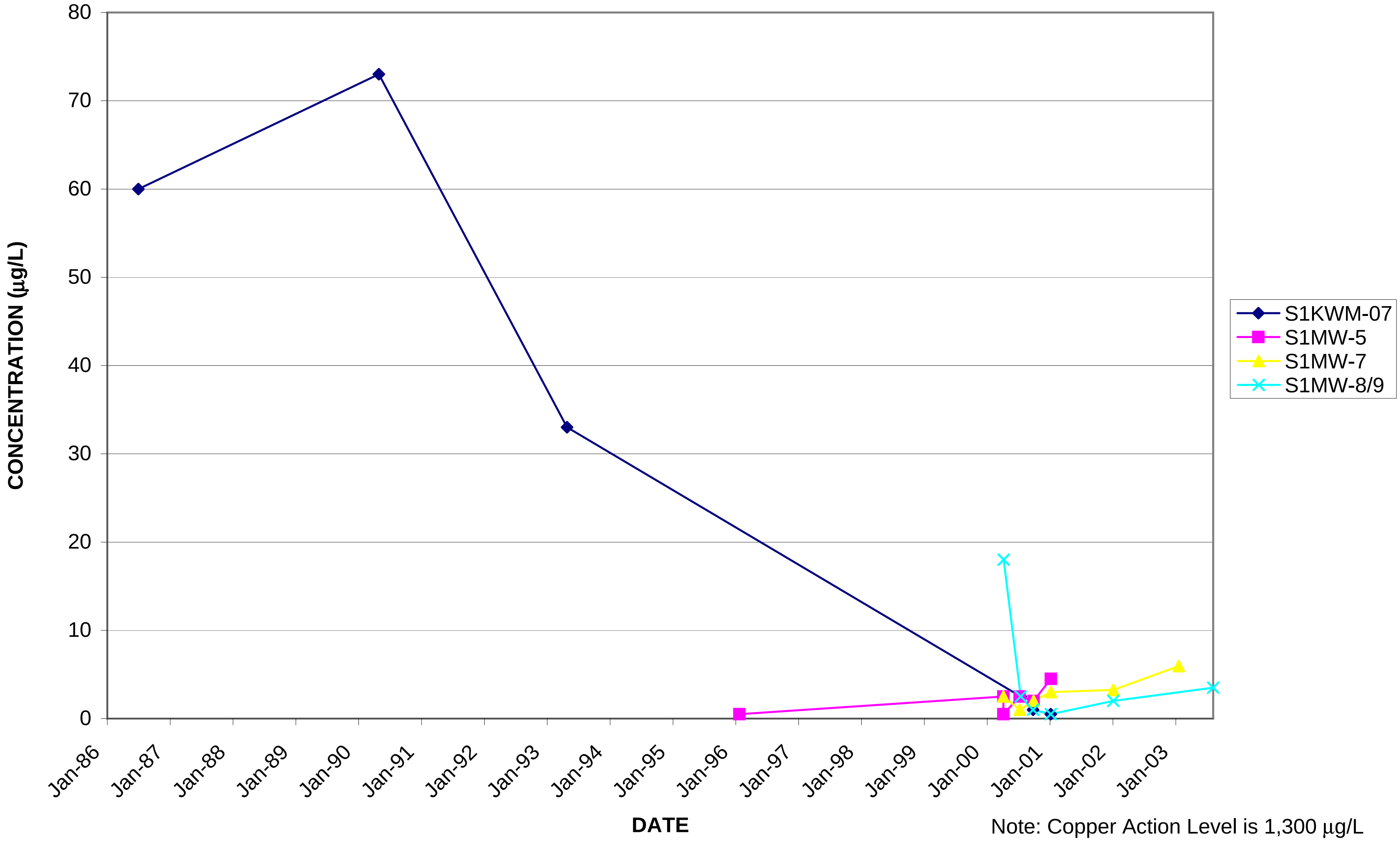


FIGURE 2-4

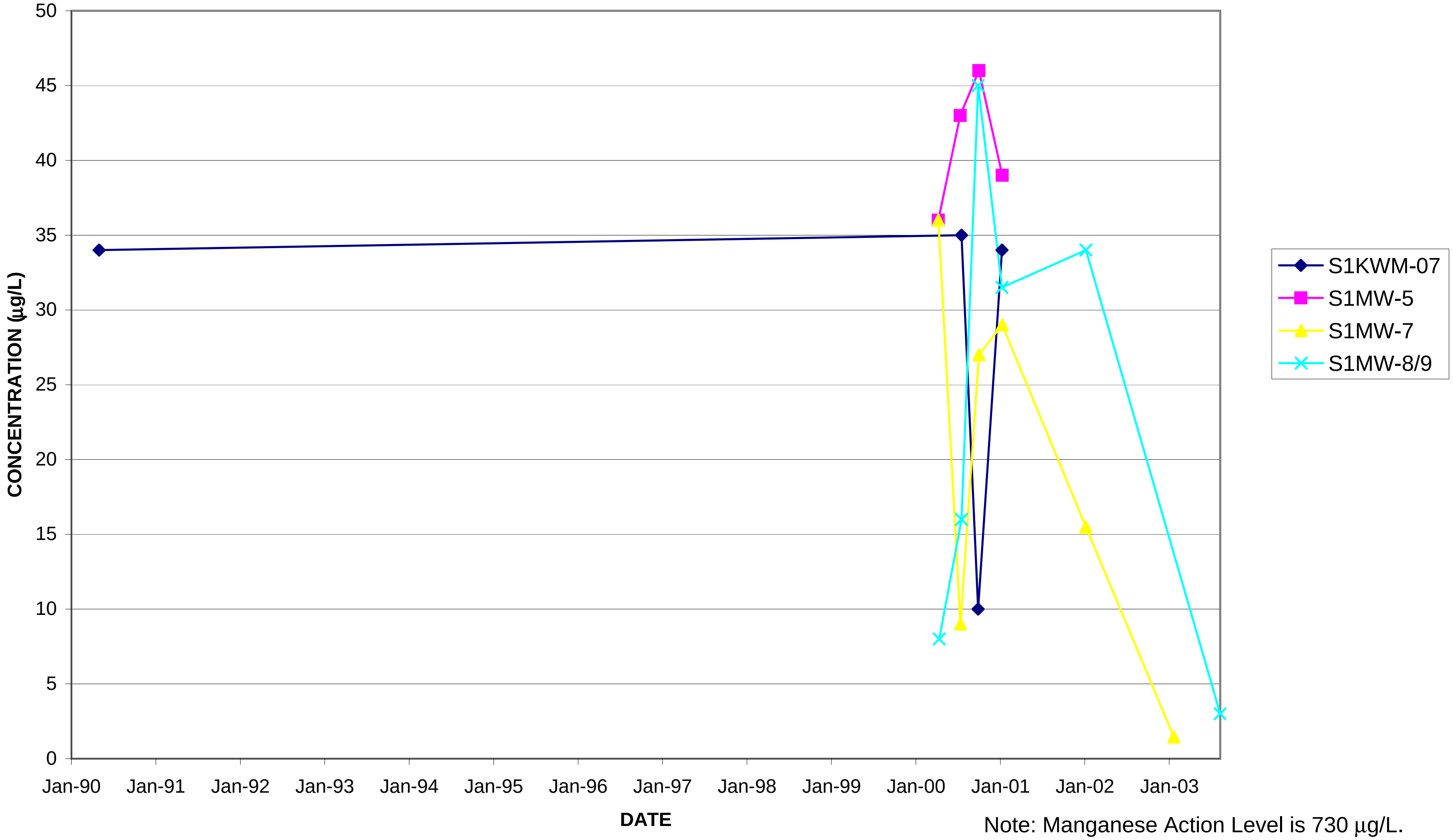
COPPER IN GROUNDWATER
SWMU 1
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA



Note: Copper Action Level is 1,300 µg/L

FIGURE 2-5

MANGANESE IN GROUNDWATER
SWMU 1
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA



Note: Manganese Action Level is 730 µg/L.

FIGURE 2-6

MERCURY IN GROUNDWATER
SWMU 1
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

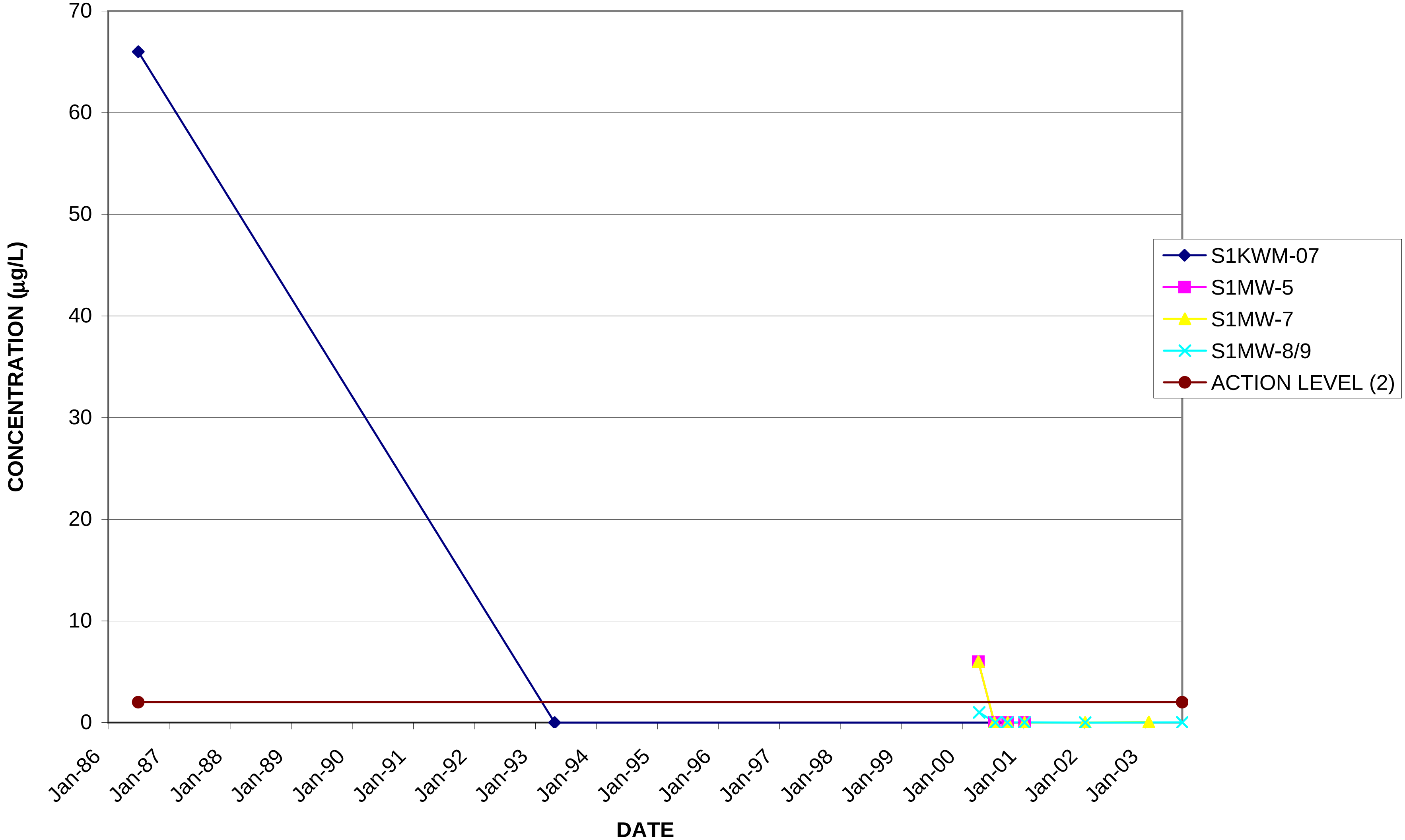
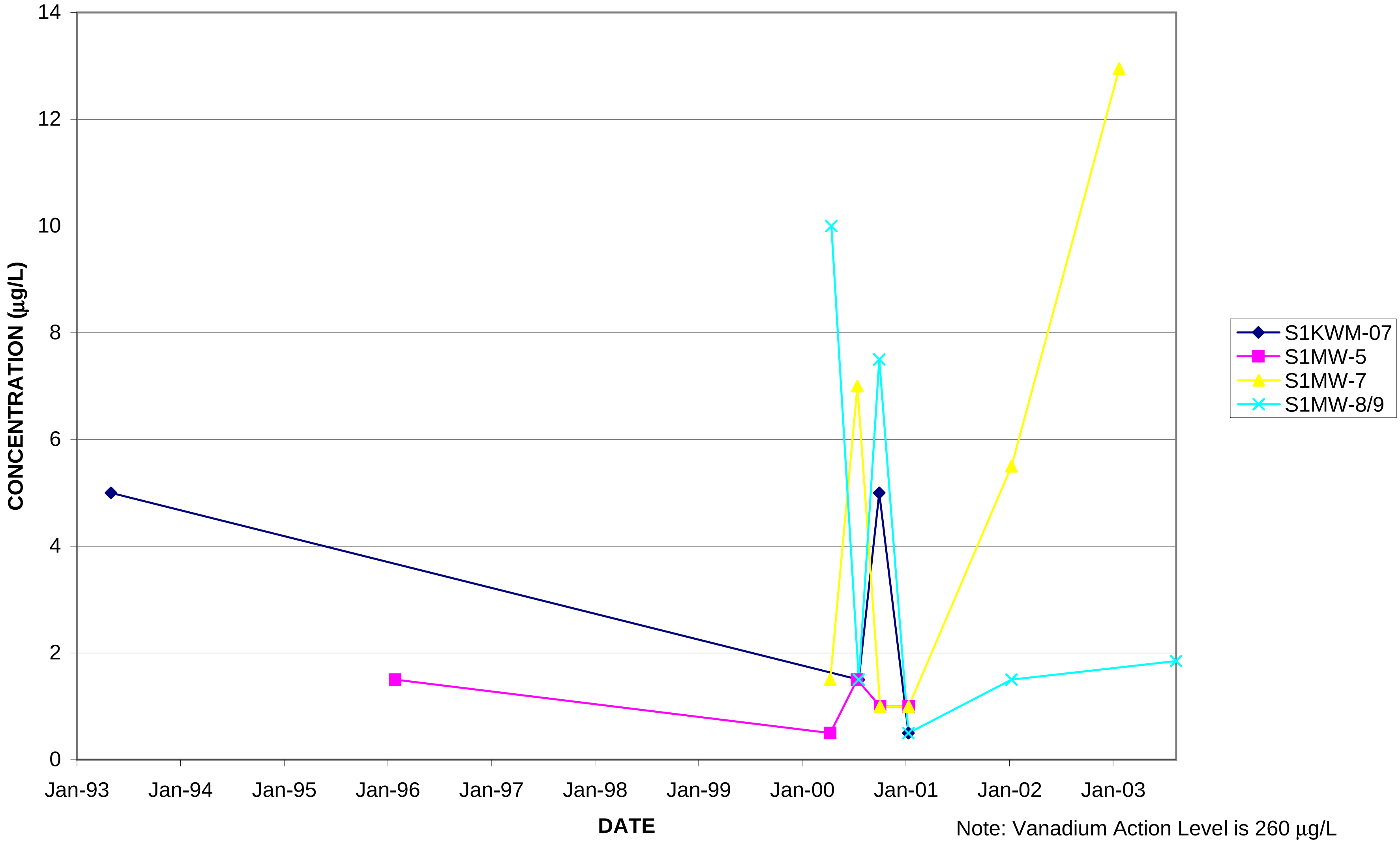


FIGURE 2-7

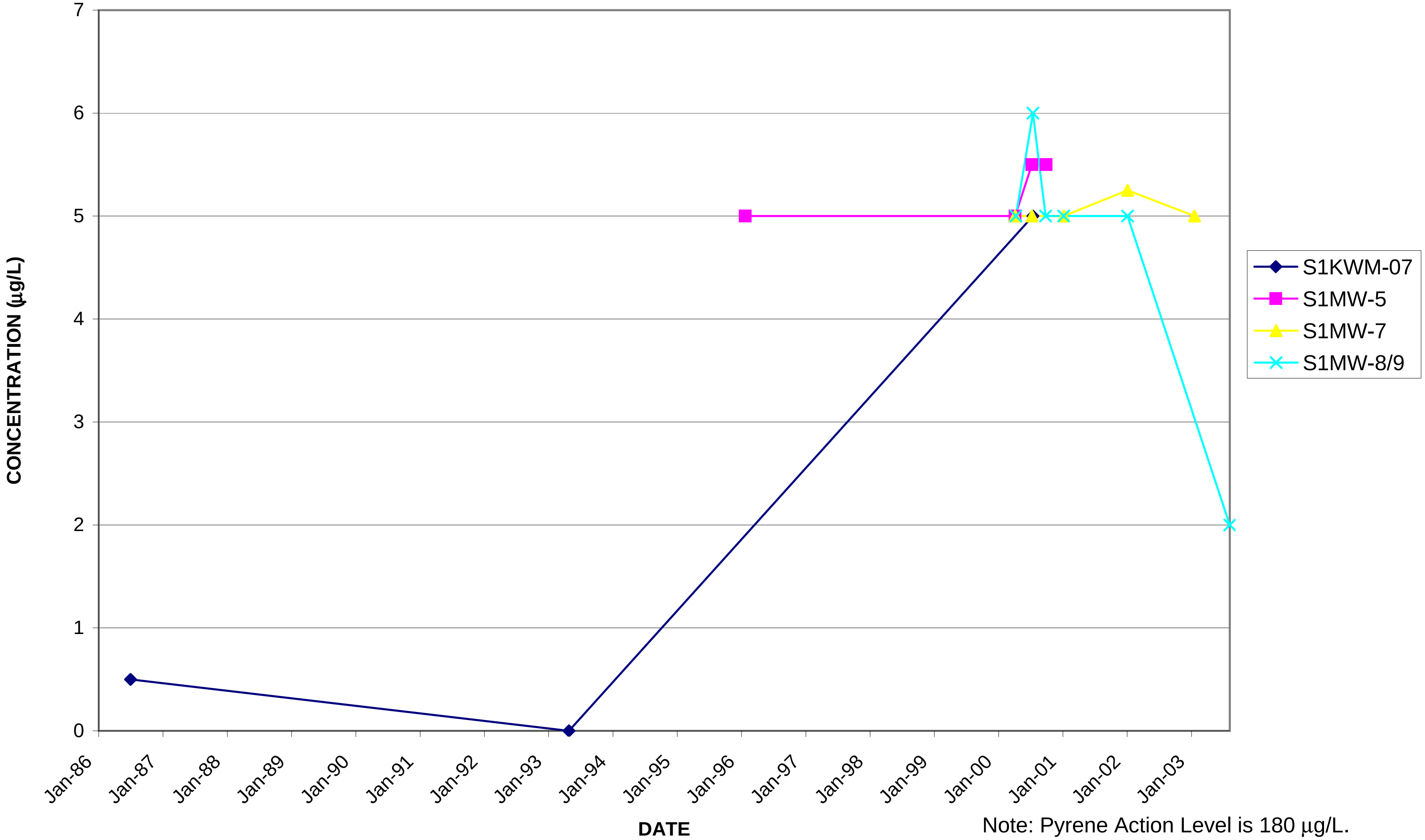
VANADIUM IN GROUNDWATER
SWMU 1
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA



Note: Vanadium Action Level is 260 µg/L

FIGURE 2-8

PYRENE IN GROUNDWATER
SWMU 1
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA



Note: Pyrene Action Level is 180 µg/L.

FIGURE 2-9

COPPER IN SURFACE WATER
SWMU 1
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

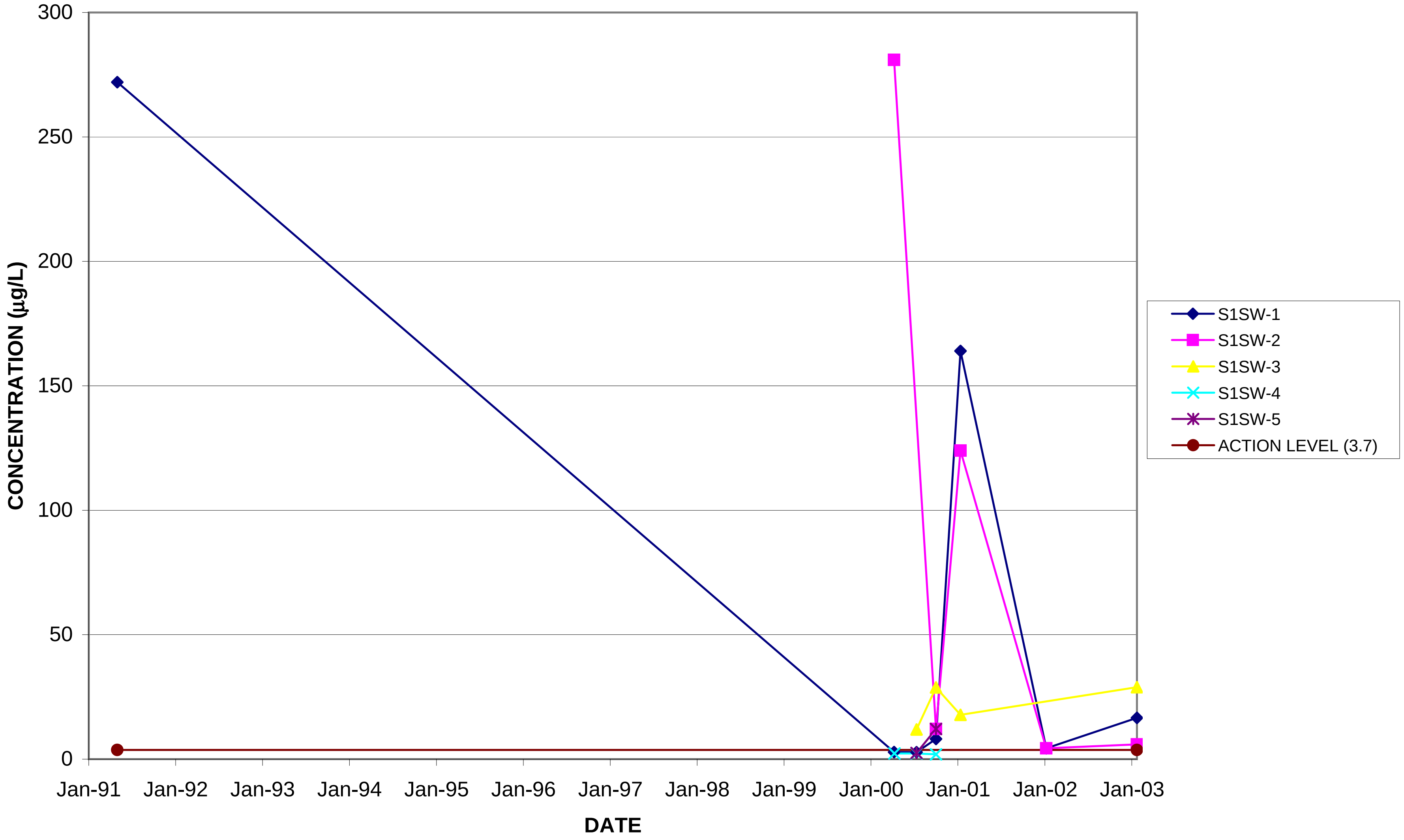


FIGURE 2-10

LEAD IN SURFACE WATER
SWMU 1
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

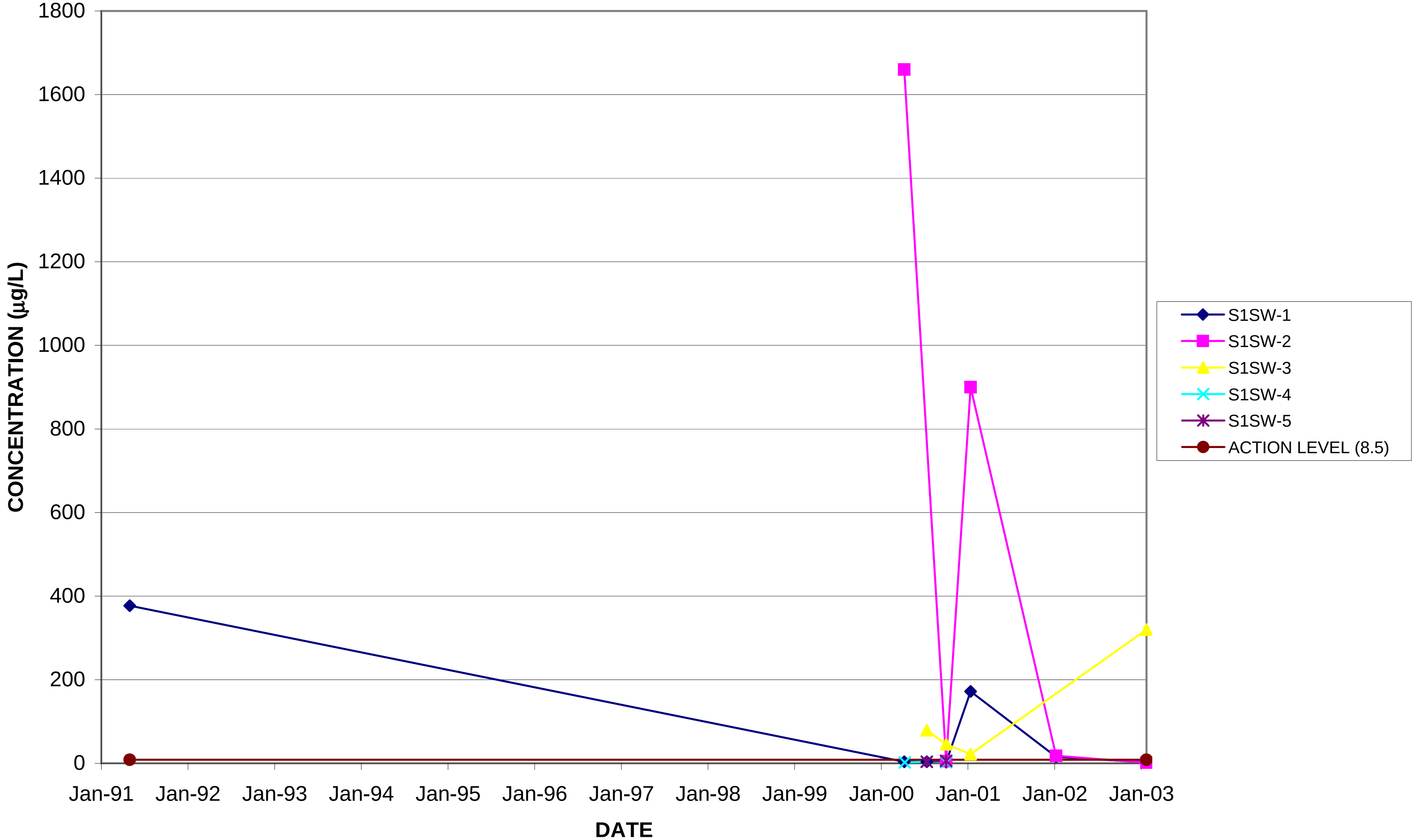


FIGURE 2-11

MERCURY IN SURFACE WATER
SWMU 1
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

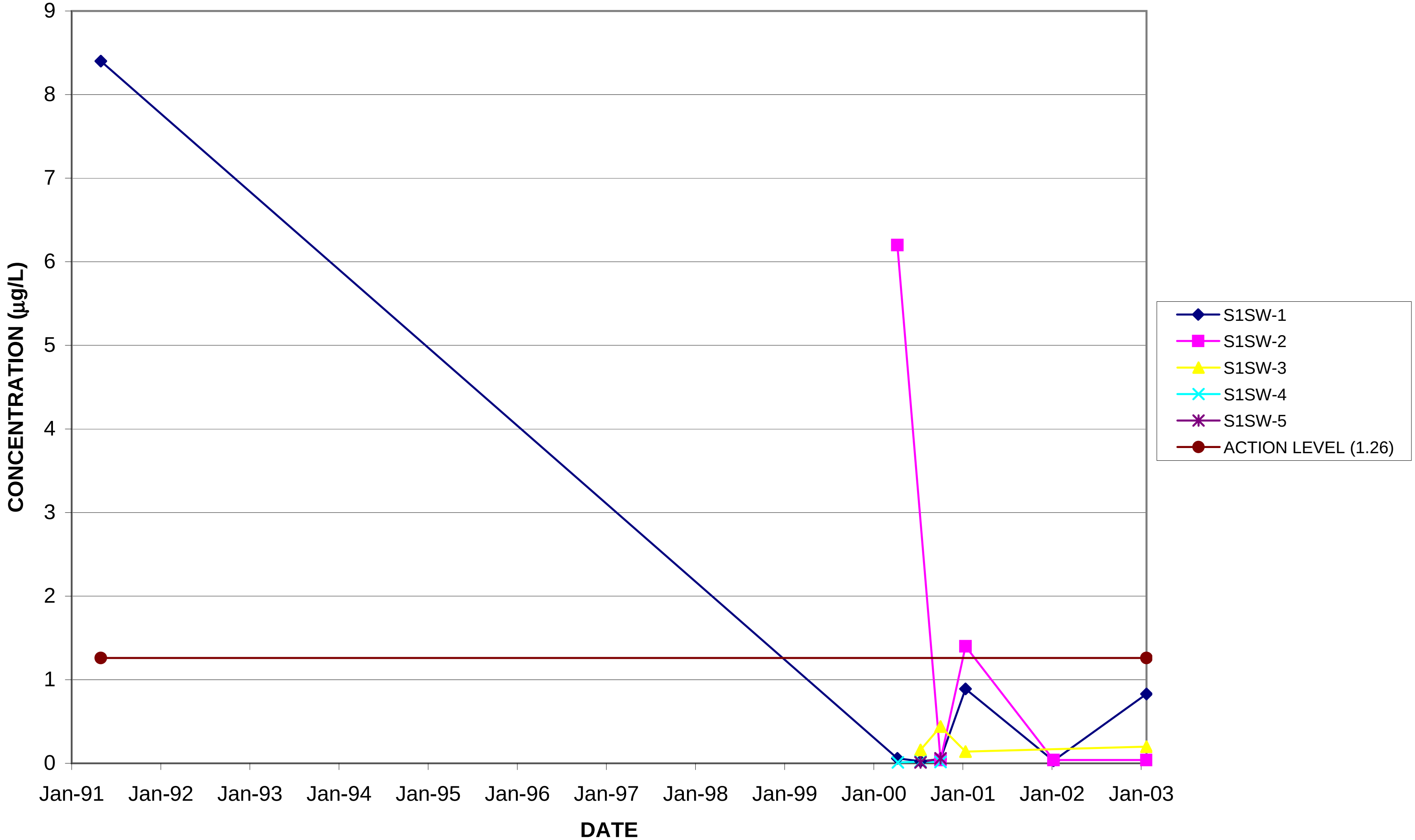


FIGURE 2-12

ARSENIC IN SEDIMENT
SWMU 1
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

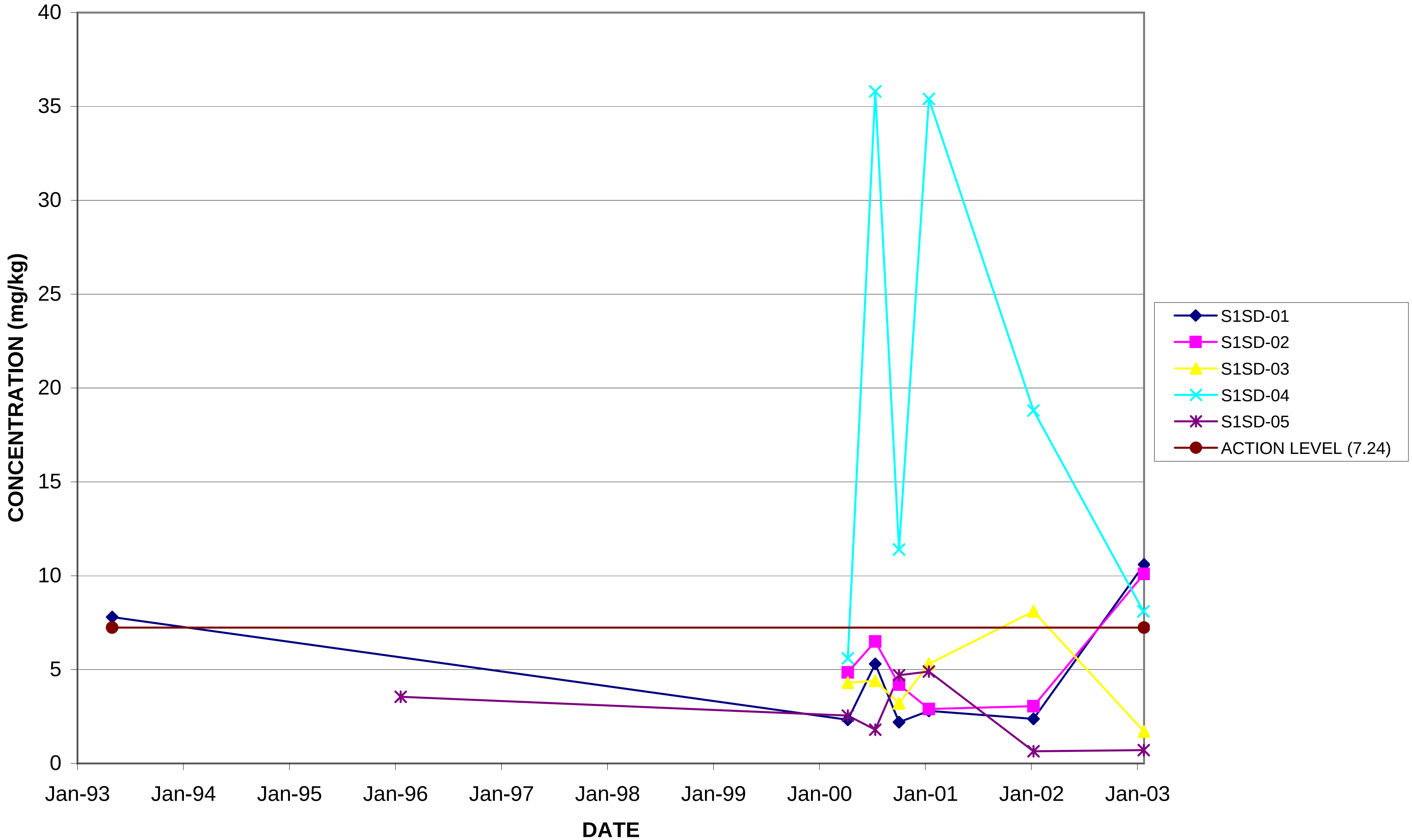


FIGURE 2-13

LEAD IN SEDIMENT
SWMU 1
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

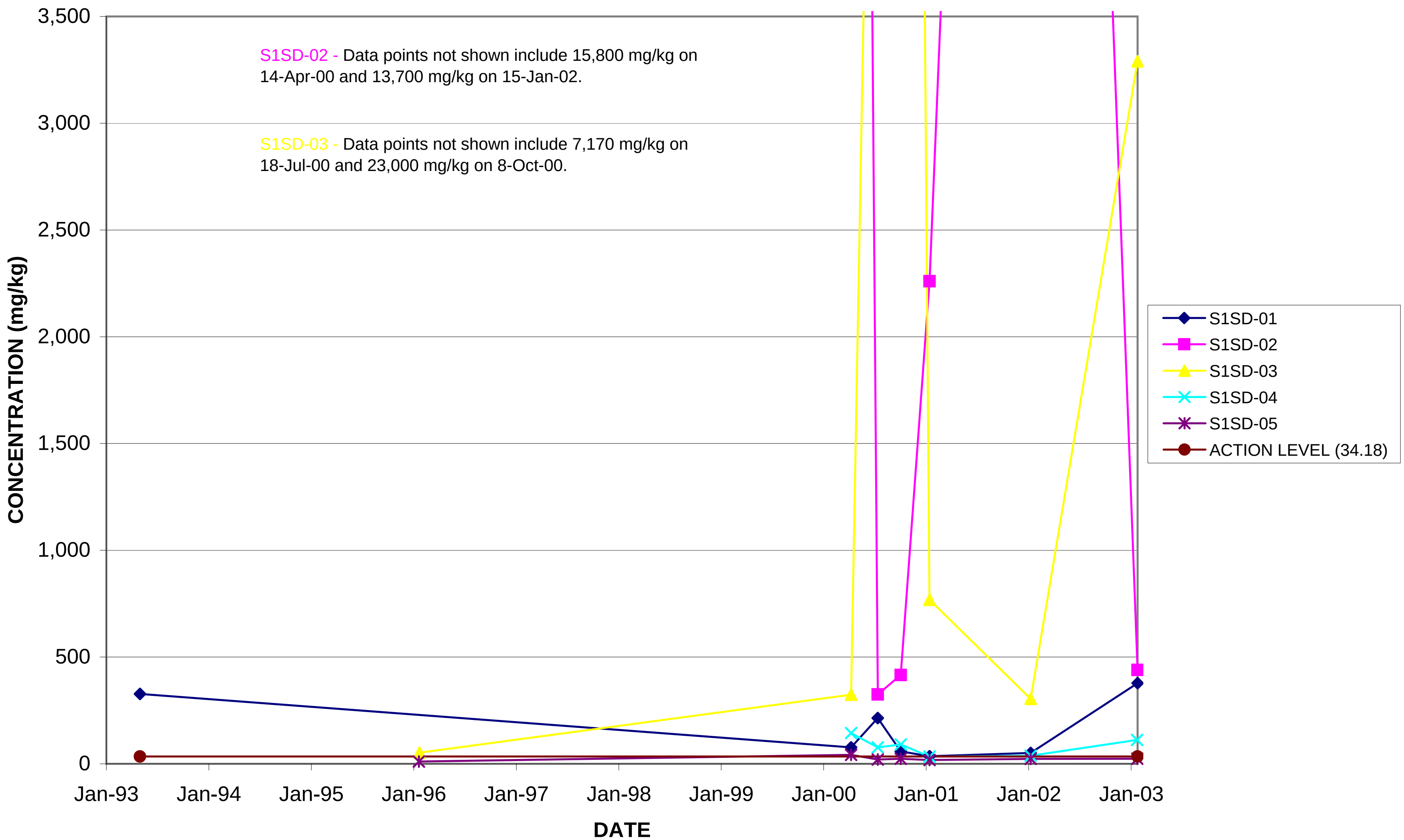


FIGURE 2-14

BENZO(A)PYRENE IN SEDIMENT
SWMU 1
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

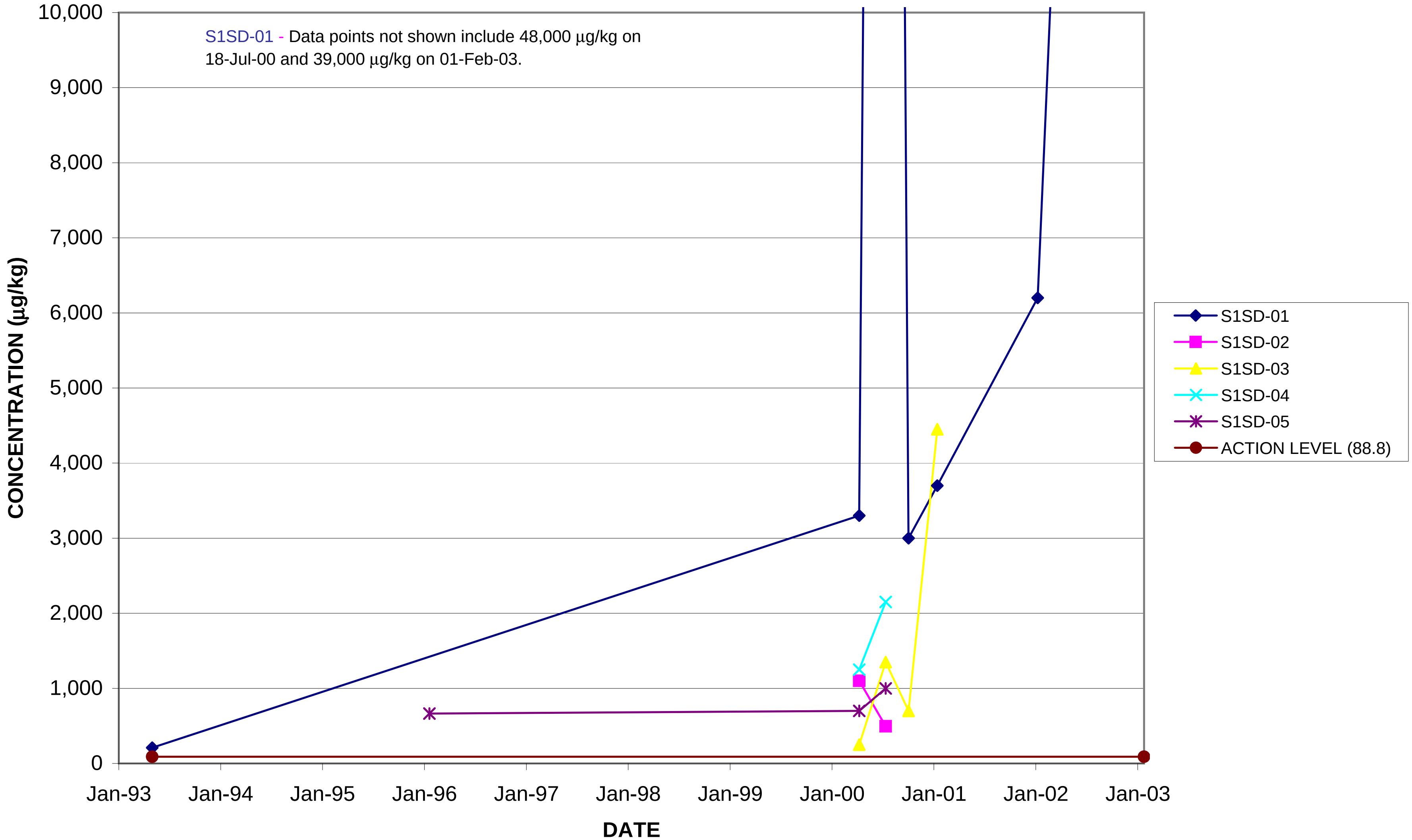


FIGURE 2-15

DIBENZO(A,H)ANTHRACENE IN SEDIMENT
SWMU 1
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

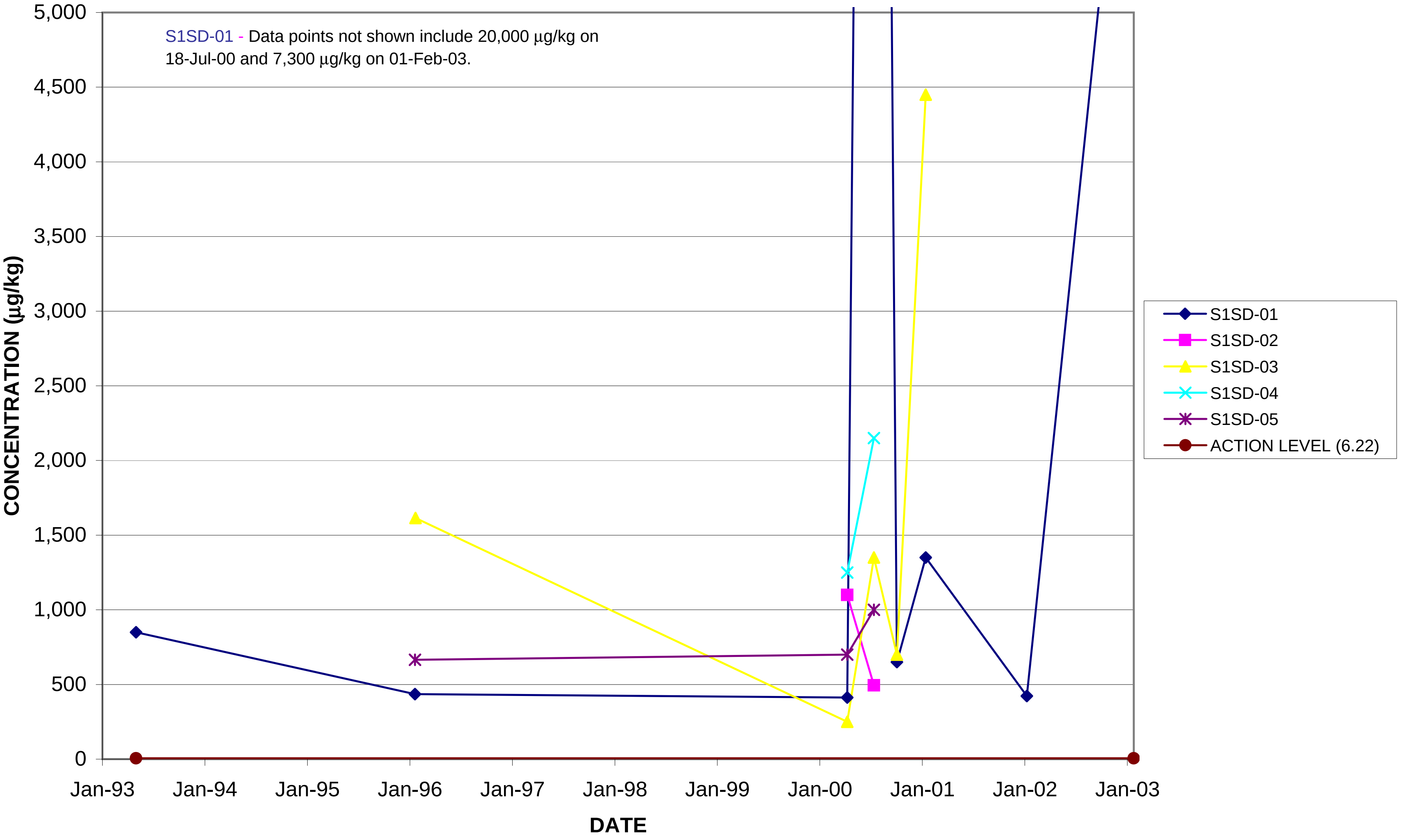


FIGURE 2-16

INDENO(1,2,3-CD)PYRENE IN SEDIMENT
SWMU 1
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

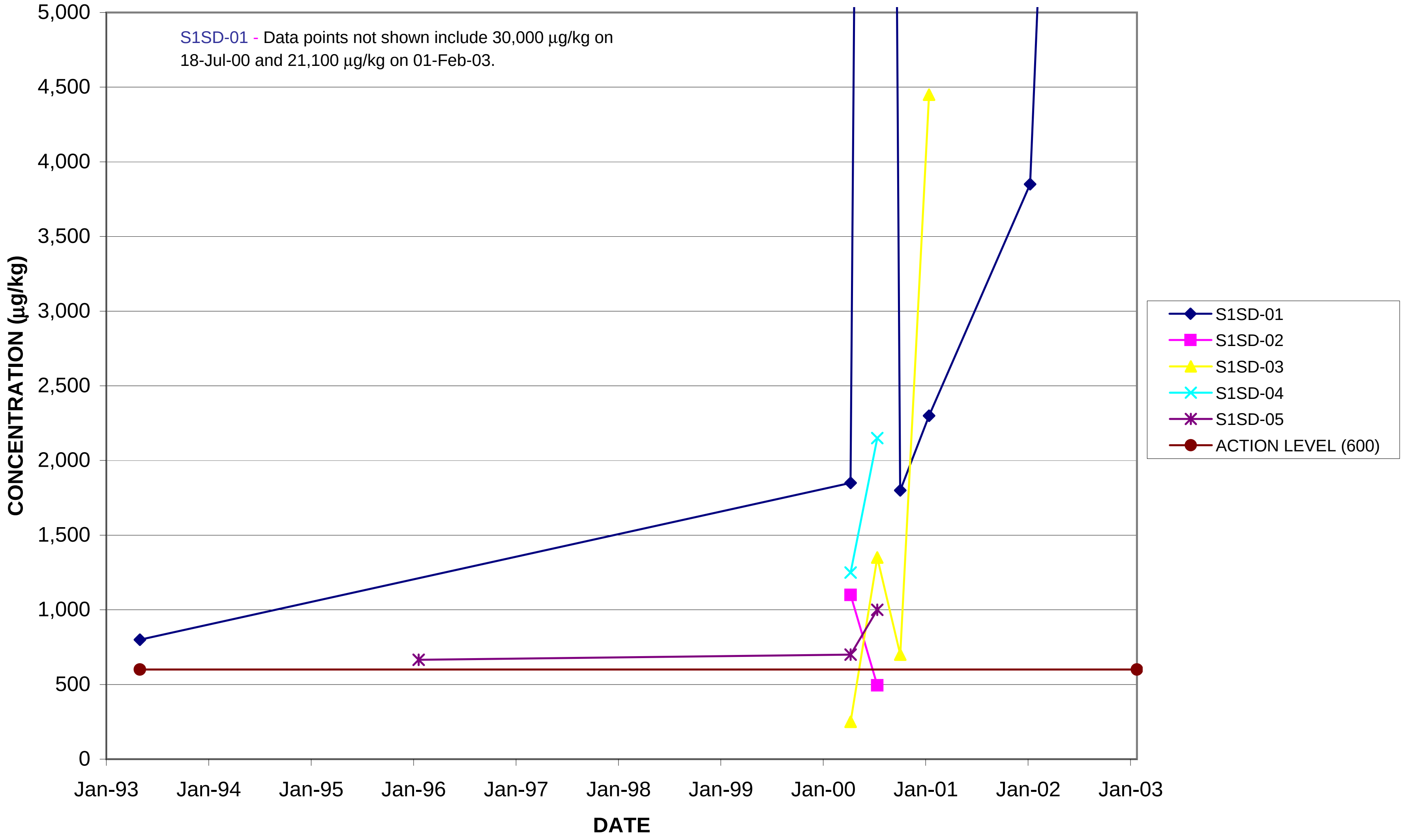
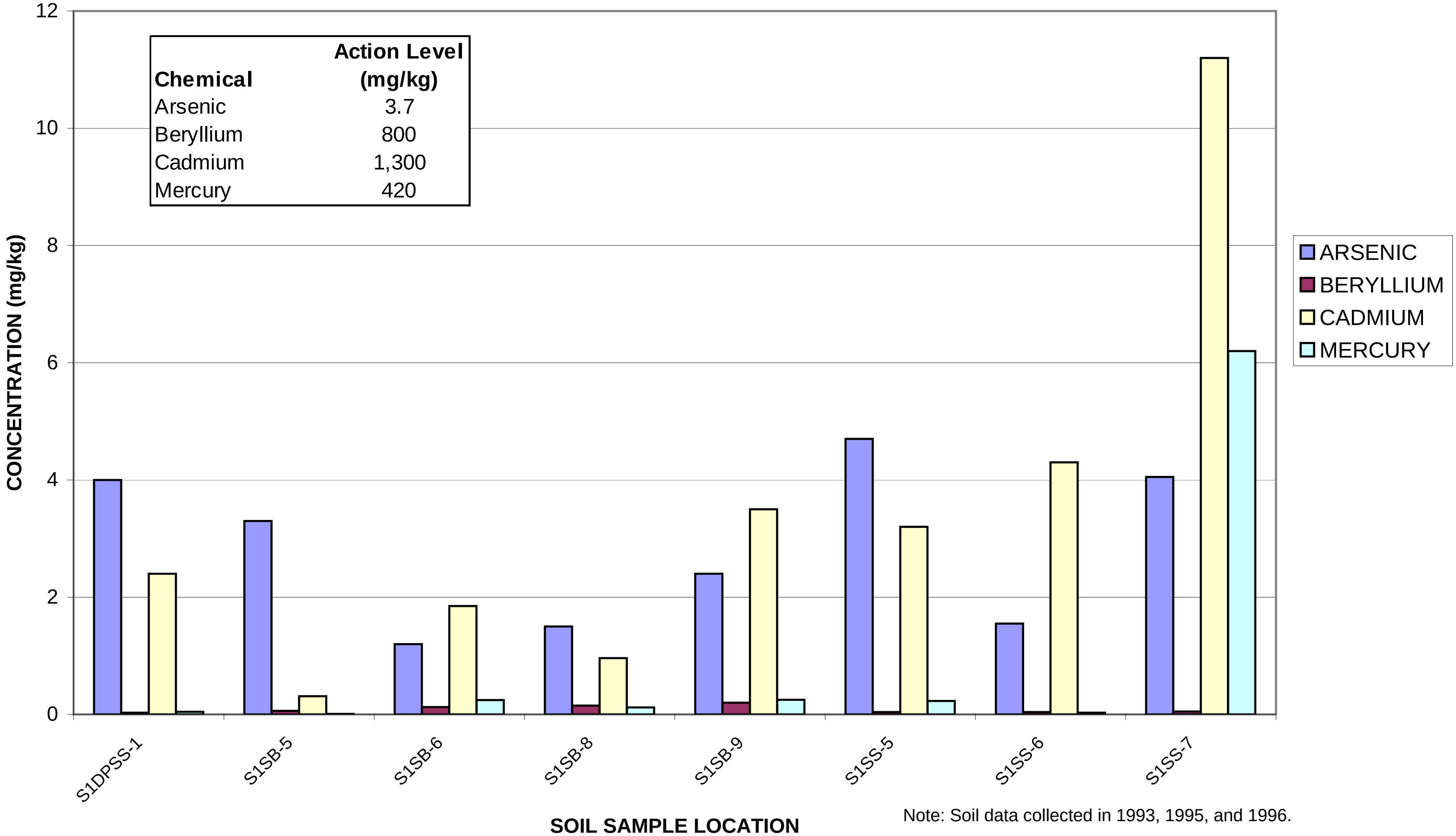


FIGURE 2-17

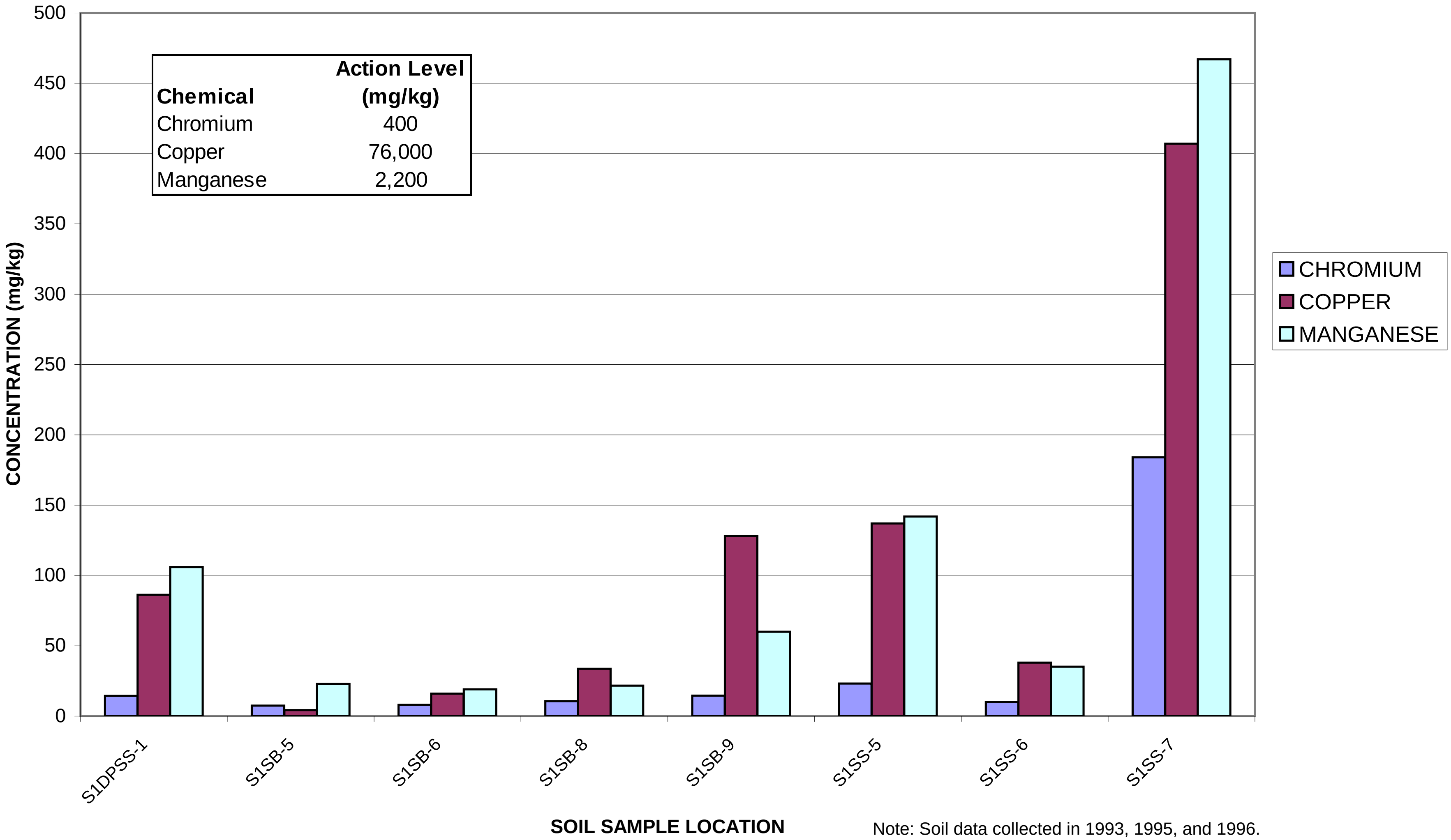
INORGANIC COCS IN SOIL
SWMU 1
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA



Note: Soil data collected in 1993, 1995, and 1996.

FIGURE 2-18

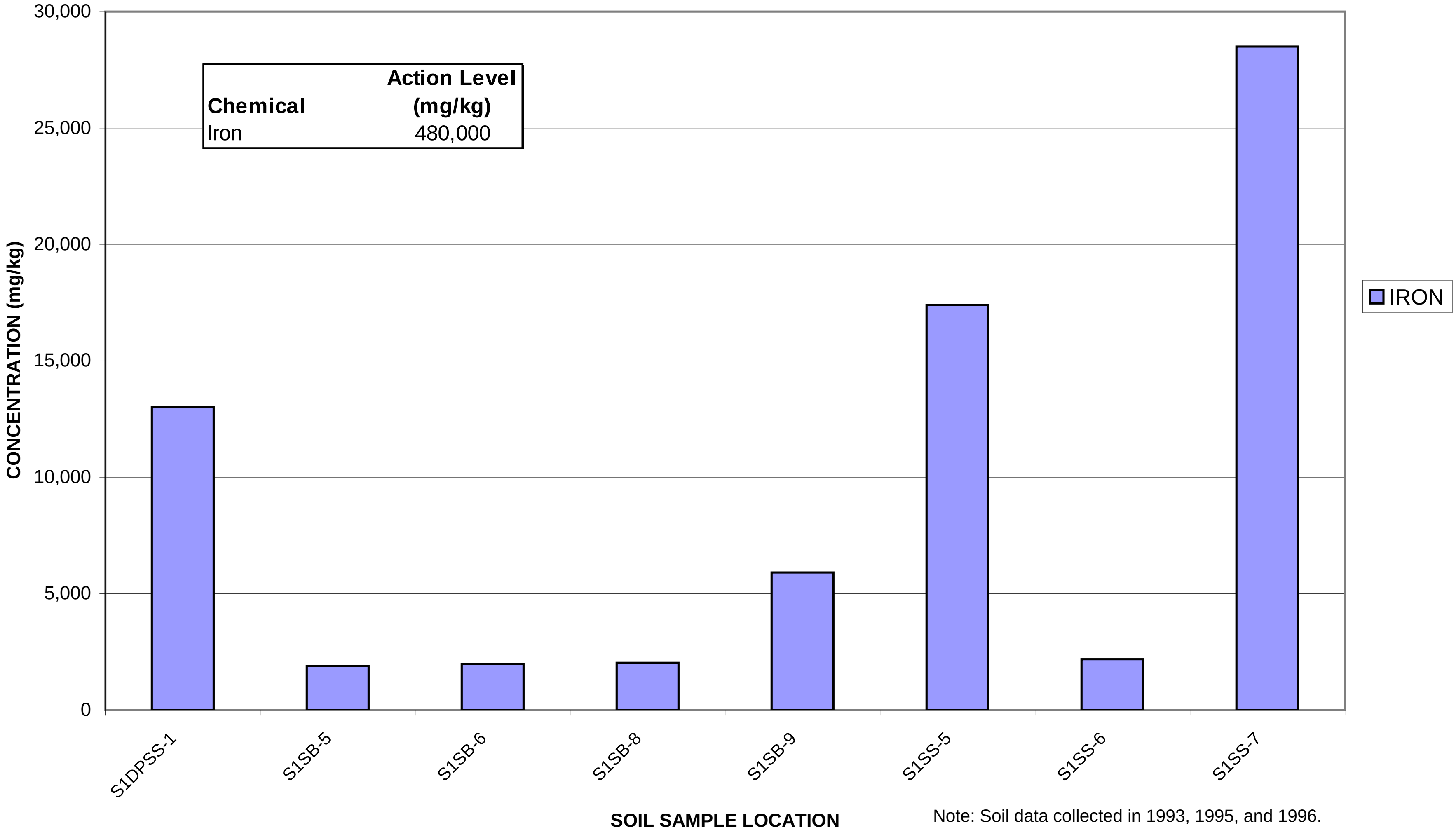
INORGANIC COCS IN SOIL
SWMU 1
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA



Note: Soil data collected in 1993, 1995, and 1996.

FIGURE 2-19

IRON IN SOIL
SWMU 1
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA



Note: Soil data collected in 1993, 1995, and 1996.

FIGURE 2-20

LEAD IN SOIL
SWMU 1
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

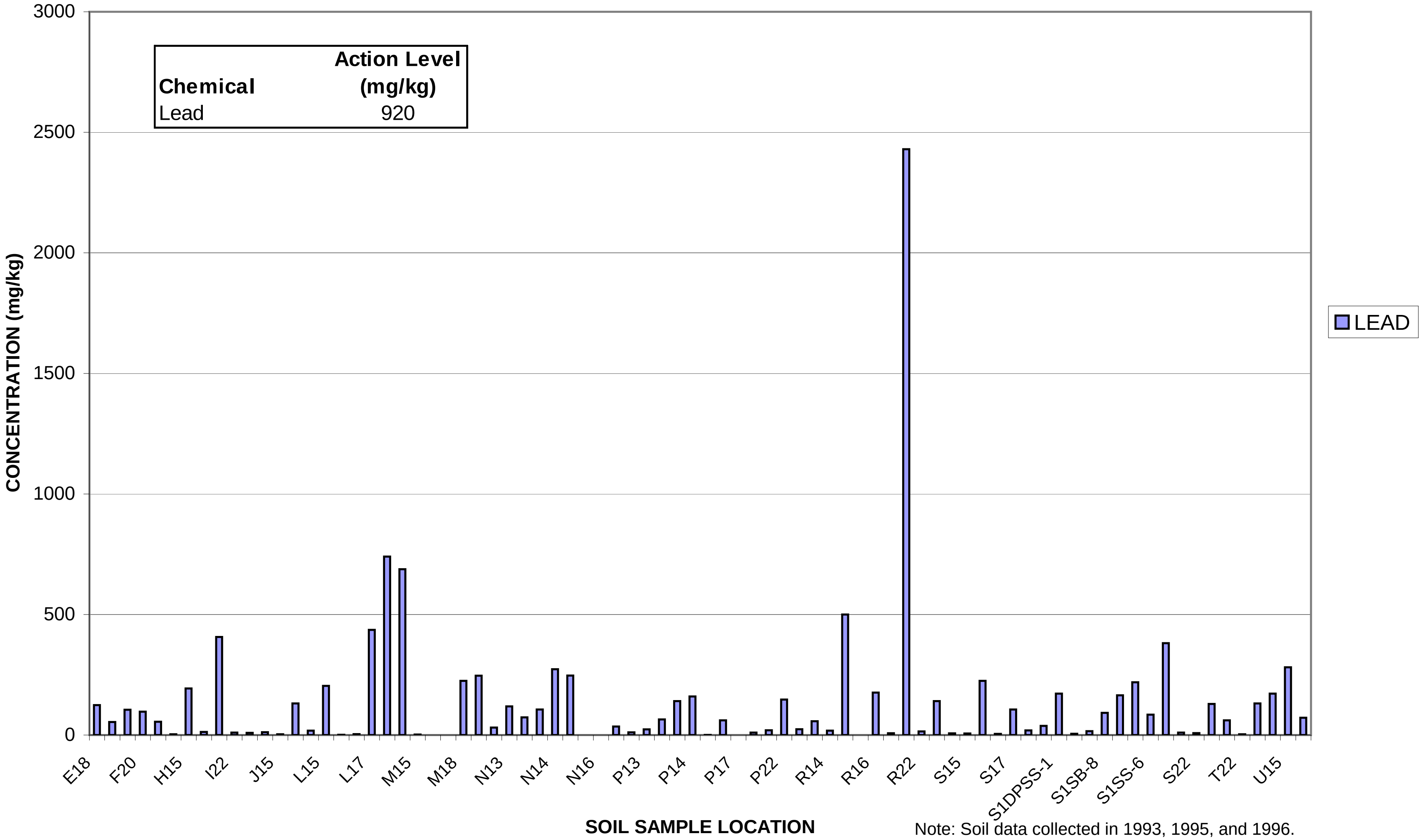
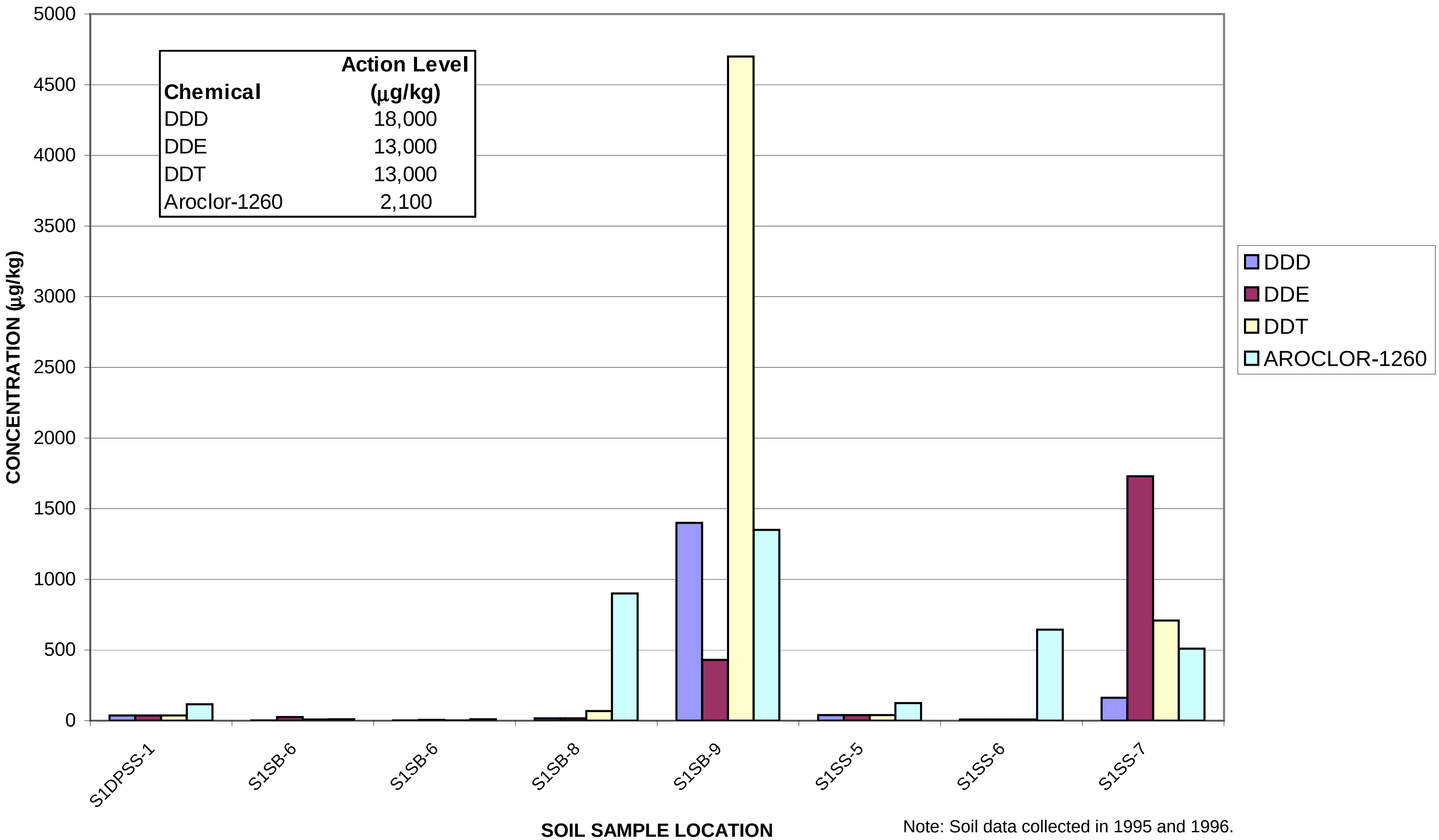


FIGURE 2-21

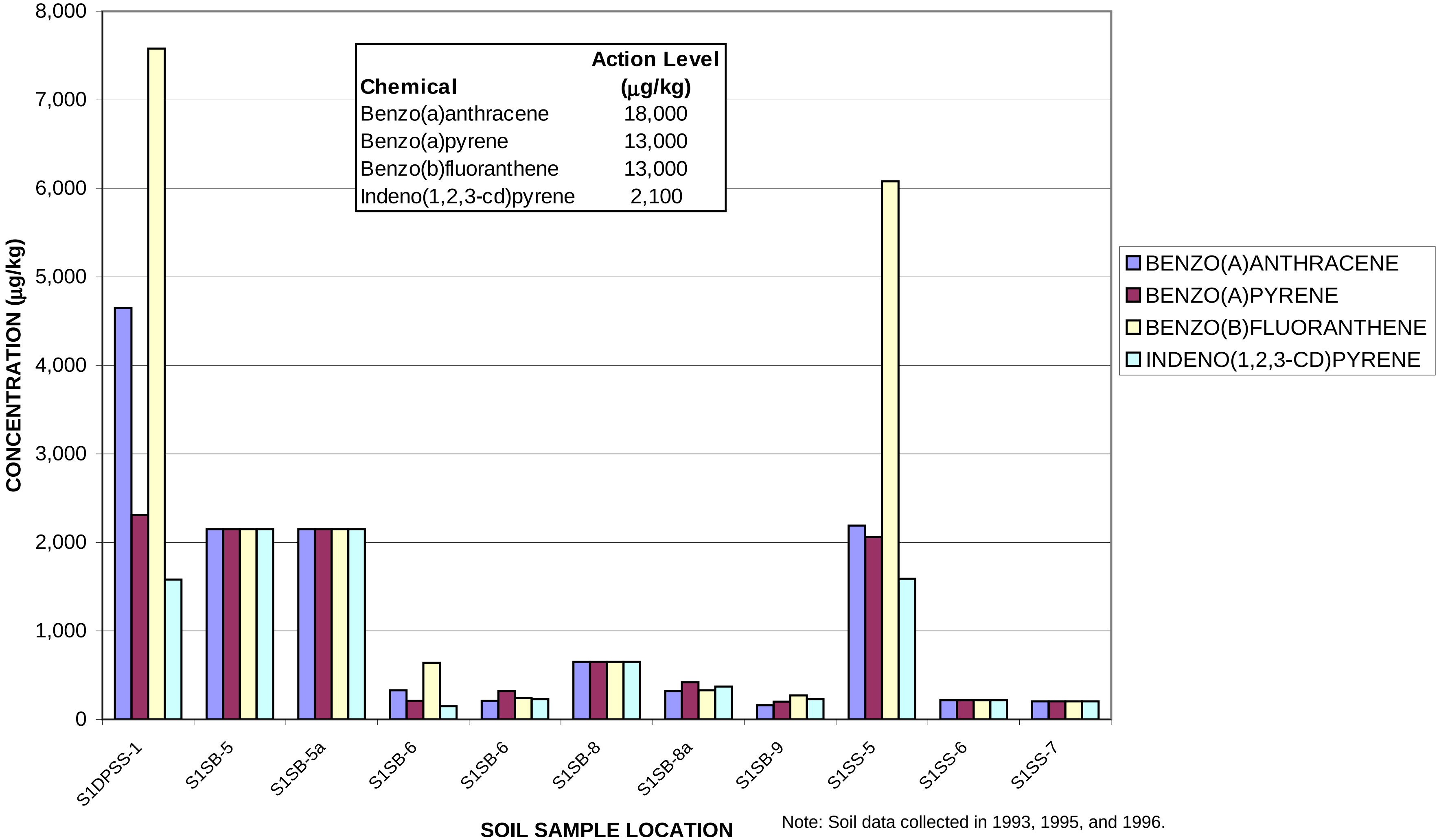
PESTICIDES AND PCBS IN SOIL
SWMU 1
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA



Note: Soil data collected in 1995 and 1996.

FIGURE 2-22

SVOCs IN SOIL
SWMU 1
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA



Chemical	Action Level (µg/kg)
Benzo(a)anthracene	18,000
Benzo(a)pyrene	13,000
Benzo(b)fluoranthene	13,000
Indeno(1,2,3-cd)pyrene	2,100

Note: Soil data collected in 1993, 1995, and 1996.

FIGURE 2-23

INORGANIC COCS IN MINNOWS
SWMU 1
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

FIGURE 2-24

ORGANIC COCS IN MINNOWS
SWMU 1
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

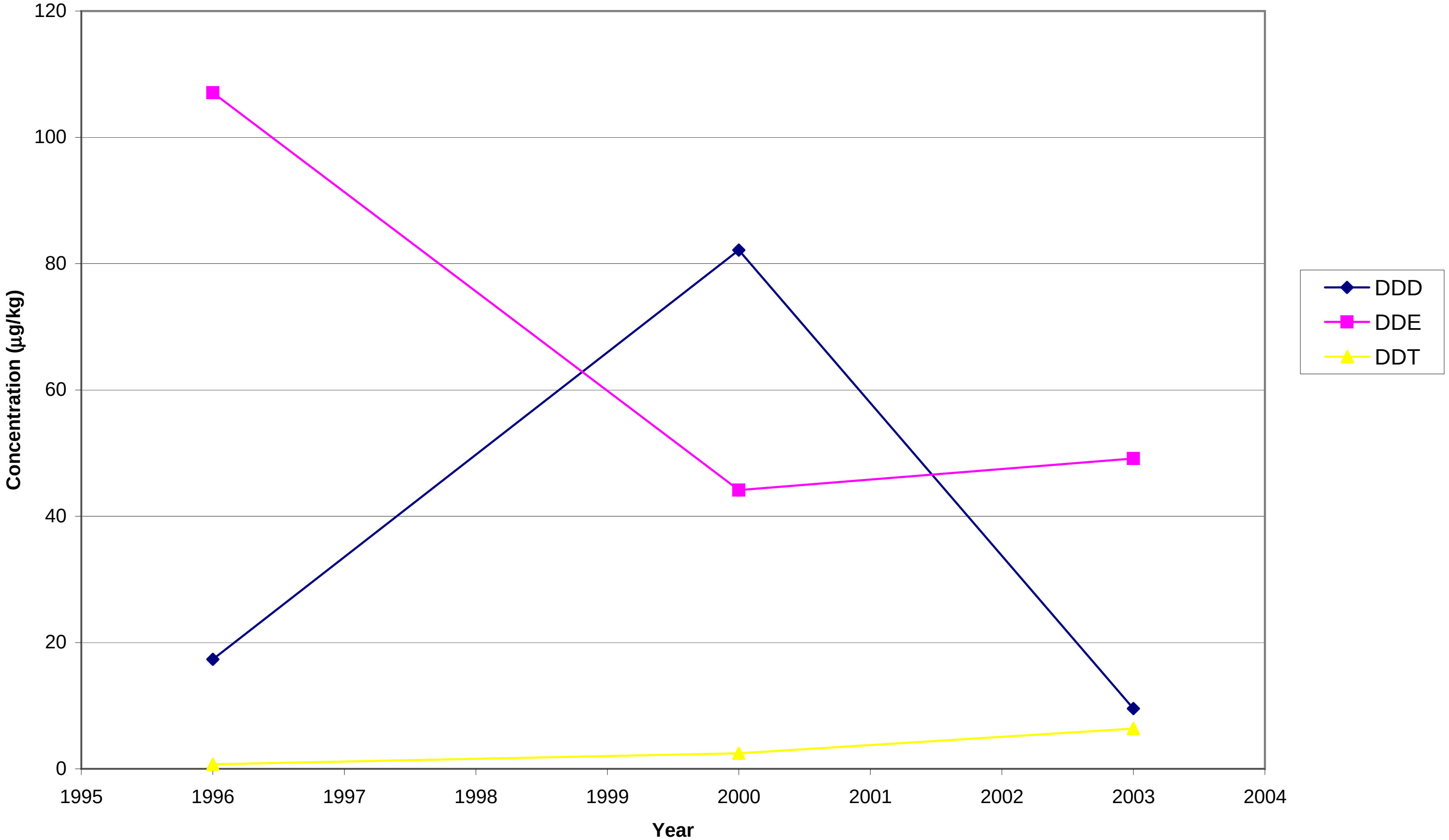


FIGURE 2-25

INORGANIC COCS IN SEA OXEYE DAISY
SWMU 1
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

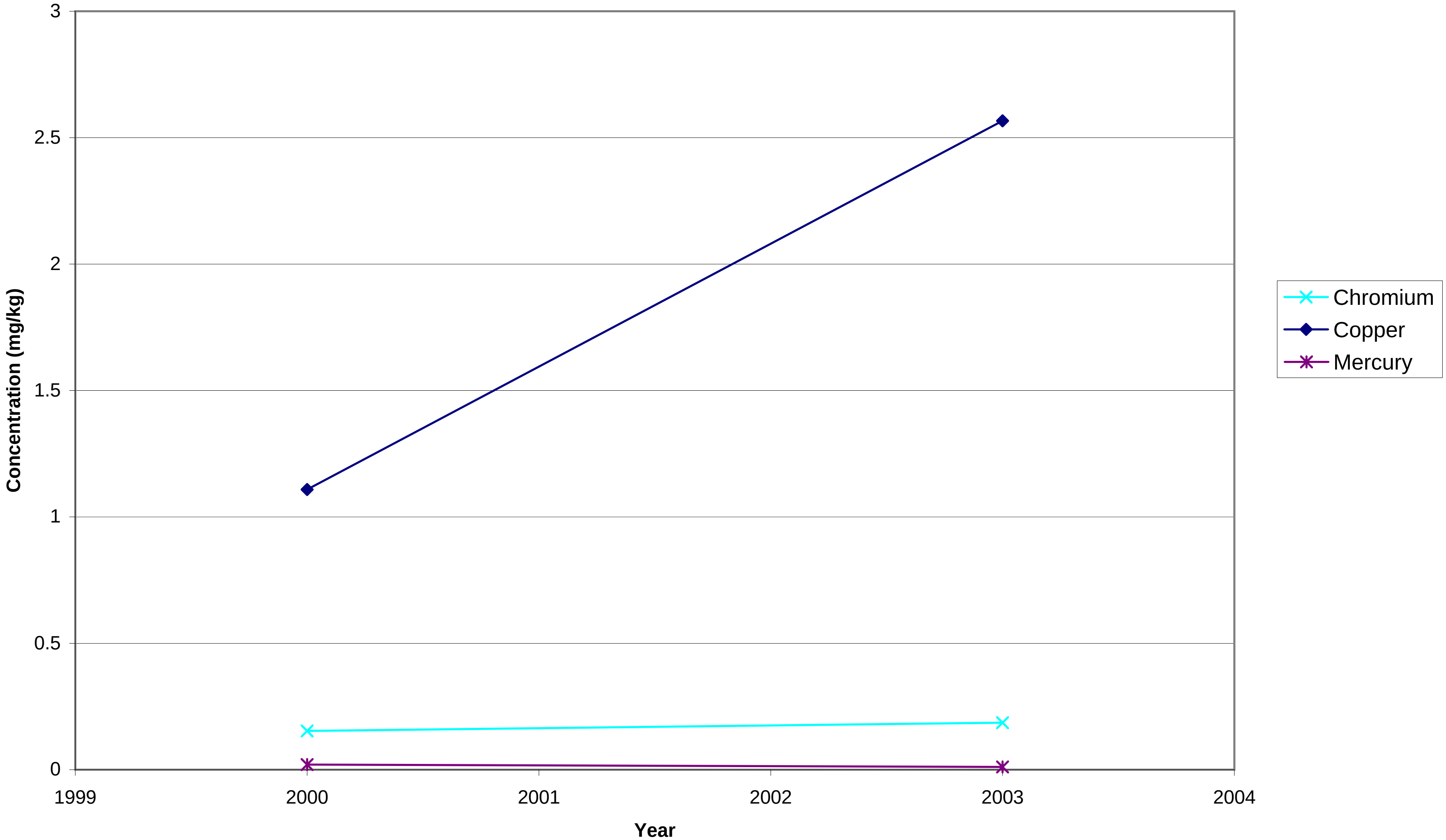
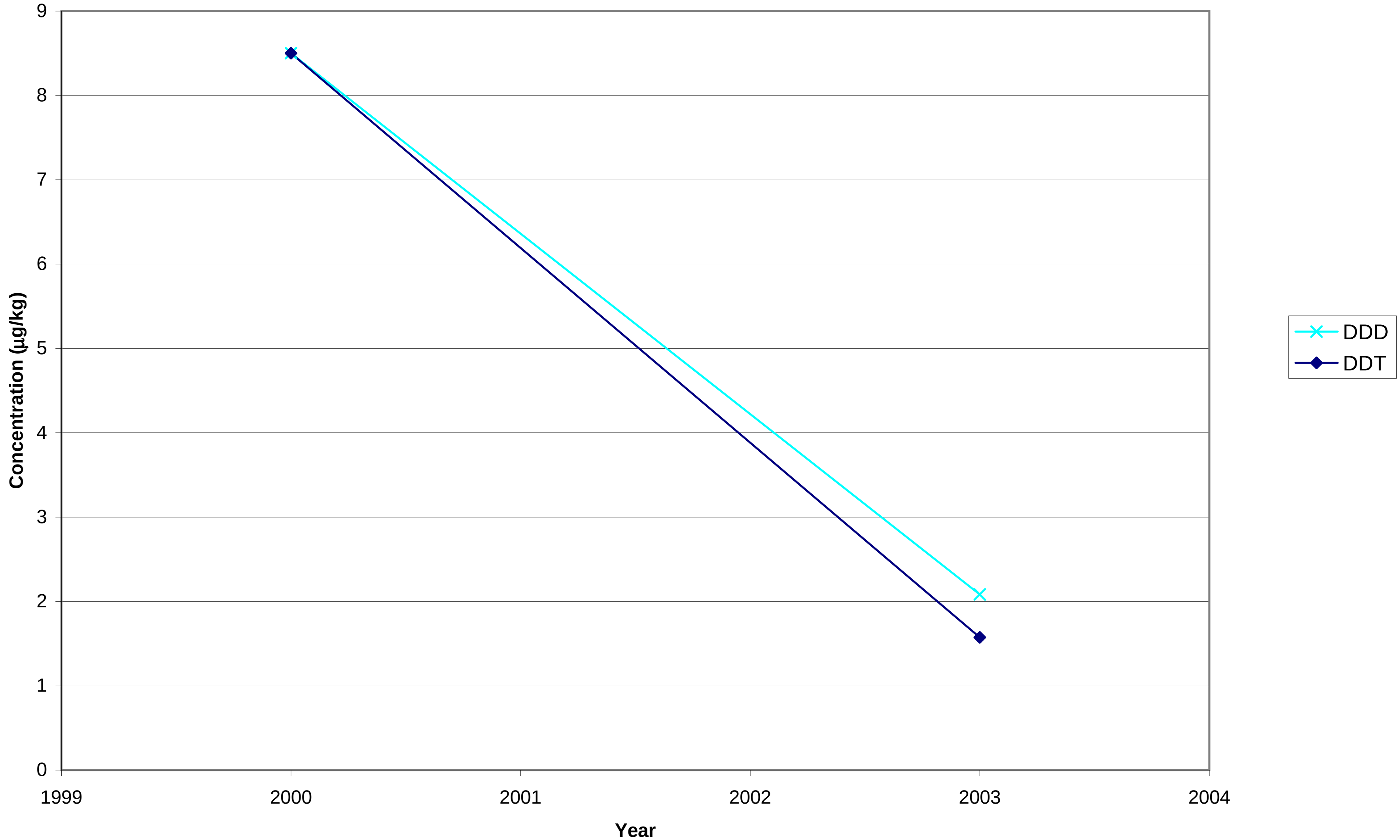


FIGURE 2-26

ORGANIC COCS IN SEA OXEYE DAISY
SWMU 1
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA



3.0 SWMU 2 – BOCA CHICA DDT MIXING AREA

This section describes the five-year review for SWMU 2, the Boca Chica DDT Mixing Area.

3.1 HISTORY AND SITE CHRONOLOGY

A list of important SWMU 2 historical events and relevant dates in the site chronology is shown below. The identified events are intended to be illustrative, rather than comprehensive.

Investigation/Activity	Date
Site operation	1940s to early 1970s
DDT Mixing Building 915 demolished	1982
AST removal, spillage occurred	?
IAS Report produced by Envirodyne Engineers, Inc.	May 1985
Verification Study Assessment issued by G&M	March 1987
VSI performed by the EPA as documented in the RFA Report	April 1988
Preliminary RI Report issued by IT	January 1991
RFI/RI Report issued by IT	June 1994
Delineation Sampling Report for IRA issued by BEI	November 1995
IRA excavation completed by BEI	April 1996
Supplemental RFI/RI Report for High-Priority Sites produced by B&RE	July 1997
CMS Report issued by TtNUS	March 1998
Statement of Basis issued by TtNUS	July 1998
First year of Quarterly Performance Monitoring implemented by TtNUS	April 2000
Annual Performance Monitoring conducted by TtNUS	January 2002
Annual Performance Monitoring conducted by TtNUS	January 2003
RCRA CAMP (Rev. 4) conducted by TtNUS	July 2003
Annual Performance Monitoring conducted by REA	January 2004

3.2 BACKGROUND

3.2.1 <u>Site Description</u>

SWMU 2, the former Boca Chica DDT Mixing Area, is located in the central portion of Boca Chica Key along the southeast side of a taxiway (Figure 3-1). The unit is within an active airstrip and is completely surrounded by runways and taxiways. SWMU 2 consists of the former location of Building 915 and its surrounding area, which was used for the storage and mixing of pesticides from the mid-1940s to the early 1970s. Building 915 was demolished in 1982. The site covers approximately 0.25 acre and contains a manmade ditch that receives surface water runoff from SWMU 2 and the area north of the site. Surface water in the ditch at the site is not used for recreation, but does support aquatic life. The ditch flows into a 15-acre lagoon, which also supports aquatic life and a variety of birds. There are no surface water connections from the ditch and lagoon to nearby marine waters (B&RE, 1997).

Two ASTs (a 500-gallon mixing tank and a 1,000-gallon storage tank) on concrete foundations were located to the west of Building 915. DDT contamination at the site reportedly occurred during the removal of the ASTs, when some spillage occurred (G&M, 1987). Contamination may also have occurred when pesticides were mixed with waste fuel oil to allow the pesticides to float on the surface of any standing water in order to help destroy insect larvae (IT, 1994).

3.2.2 Summary of Sampling Results

Media sampling at SWMU 2 was conducted to characterize constituent types and distributions. Sampling was performed in 1986, 1990, 1993, and 1995 during a series of remedial investigations. Pesticide contamination was identified in all media and the RFI/RI recommended further sampling and analysis to adequately delineate this contamination. In addition, the report recommended an IRA to prevent further migration of soil contamination to surrounding water bodies (IT, 1994).

The primary COCs were identified as DDT, DDE, and DDD. DDT and its metabolites, DDD and DDE, are listed RCRA wastes when these products have been spilled and have contaminated soil or debris. Soil contaminated with these chemicals is classified as hazardous waste (RCRA waste codes U060 and U061). A secondary concern was lead in sediment (BEI, 1998).

3.2.3 1996 IRA

The Remediation Work Plan for the contaminated soil and sediment removal was prepared by BEI in 1995 (BEI, 1995b). Delineation sampling was performed to establish cleanup boundaries, nearly doubling the size of the planned soil excavation. The remedial action consisted of blocking water flow into the ditch with water-filled cofferdams, suction-dredging all sediments from the ditch, and excavating the contaminated soil around the ditch. Approximately 1,950 cubic yards of contaminated soil were removed from the excavated area and disposed. The majority of the contaminated sediment was removed with an excavator. The remaining sediment was vacuumed from the site using a trash pump. The water in the ditch was cleaned by repeated filtration until the DDT concentration was less than

1.0 μg/L. Confirmation sampling of soil and surface water was performed before the area was backfilled to determine the effectiveness of the removal. IRA activities were completed in April 1996 (BEI, 1998).

3.2.4 Summary of Risk

A BRA and an ecological risk assessment were performed as part of the Supplemental RFI/RI (B&RE, 1997). The BRA identified a carcinogenic risk of between 1E-04 and 1E-06 for the hypothetical future resident, the trespasser adult scenario, and the trespasser adolescent scenario in the borderline area.

The ecological risk assessment, which was based on samples collected in January 1996, concluded that sediment concentrations of DDT and its metabolites DDD and DDE posed potential risk to benthic (sediment dwelling) and piscivorous (fish-eating) receptors (B&RE, 1997). The ecological risk assessment also stated that the extent to which the IRA (conducted in spring 1996) would reduce potential ecological risks was unknown.

3.3 REMEDIAL ACTIONS

3.3.1 Remedy Selection

A CMS was performed to determine the appropriate remedy for the site based on post-remediation sample data (B&RE, 1997). Institutional Controls, consisting of LUCs with monitoring, were chosen as the remedy for SWMU 2. This remedy is summarized in the Statement of Basis for SWMU 2 (TtNUS, 1998b).

3.3.2 Remedial Implementation

3.3.2.1 LUCs With Long-Term Monitoring

The CMS recommended that the selected remedy for SWMU 2 be Limited Action: Institutional Controls with Long-Term Monitoring (B&RE, 1998d). Details of the remedy are documented in the Statement of Basis for SWMU 2 (TtNUS, 1998b). LUCs were developed through LUCIPs. These LUCs were designed to ensure protection of human health and the environment by restricting future site use and accessibility, educating NAS personnel, and maintaining records of contamination. The LUCs documented in the NAS Key West Master Plan prevent future residential use at this site. The LUCIP for SWMU 2 includes the placement and maintenance of signs around the site perimeter which state that trespassing and dumping are not permitted at the site. Personnel from the NAS Key West Public Works Department are required to visually inspect SWMU 2 at least once every three months to ensure that all LUCs are being implemented and properly maintained. The NAS Key West Public Works Department submits an annual report to FDEP describing the results of the quarterly inspections.

To implement the monitoring program for this corrective measure, groundwater, surface water, and sediment samples were collected quarterly for the first year and annually thereafter. The quarterly monitoring began in April 2000 and was completed in January 2001 (TtNUS, 2001a). Additional annual events were performed in January 2002 and 2003 (TtNUS; 2002a, 2003a). Monitoring of ecological receptors was performed in October 2000 and January 2003 and involved pesticide and metals analysis of fish and vegetation (TtNUS; 2001b, 2003a).

3.3.3 System Operations and Maintenance

Seven sampling events monitoring groundwater, surface water, and sediment have been conducted since April 2000. Four sampling events were conducted quarterly during the first year (TtNUS, 2001a). Subsequent annual events were conducted in January 2002 and 2003 (TtNUS; 2002a, 2003a). Biological monitoring has been performed twice since the remedy was implemented, in October 2000 (TtNUS, 2001b) and January 2003 (TtNUS, 2003a). According to cost estimates obtained from the NAS Key West Public Works Environmental Department, the approximate annual cost for the long term monitoring and LUCs associated with the remedy at SWMU 2 is $5,980.

3.4 FIVE YEAR REVIEW PROCESS

3.4.1 Document Review

Reports and data from investigations conducted from 1985 through 2003 were reviewed for this five-year review, as discussed in Section 3.2.

3.4.2 Data Review and Evaluation

Concentrations of media-specific COCs identified in the Supplemental RFI/RI for High-Priority Sites and the CMS were plotted to identify and evaluate trends across various investigations. For COCs that were monitored in groundwater, surface water, and sediment, the plots show concentrations over time at each monitoring location. Surface soil sampling and analysis were not included in the long-term monitoring plan, so the surface soil plots do not show concentrations over time. Instead, the soil plots simply show data for individual samples typically collected only once at a particular location. The plots for groundwater, surface water, sediment, and surface soil also show the media-specific action level for each COC. The action levels are concentrations that have been selected by the NAS Key West Partnering

Team as representing concentrations below which there is no potential for unacceptable risk to human health or the environment. The action levels were selected from several sources, and are included in Appendix C.

The plots of biological tissue data show for all detected chemicals that were COCs in surface water, sediment, and surface soil. COCs in vegetation and fish tissue are plotted over time, although tissue data were monitored in fewer sampling events than abiotic media. Another difference between the plots of abiotic samples compared to the biological samples is that the biological samples typically represent a larger area than the abiotic samples. For example, a sediment sample can be collected in the same location in successive sampling events, but fish are mobile. Thus, the plots of groundwater, surface water, and sediment show data for discrete sampling locations over time, but the tissue plots show average concentrations of all tissue samples collected during a specific sampling event.

Chemicals that were detected in groundwater, surface water, and sediment during long term monitoring but were not identified as COCs in the Supplemental RFI/RI and/or the CMS were not plotted in this report, but were evaluated and are discussed below in Sections 3.4.2.1 (groundwater), 3.4.2.2 (surface water) and 3.4.2.3 (sediment).

3.4.2.1 Groundwater Monitoring

COCs in SWMU 2 groundwater include the pesticides DDD, DDE, and DDT. DDD has been consistently detected above its action level in one monitoring well (S2MW-5) at SWMU 2 since monitoring began in April 2000 (Figure 3-2). DDE and DDT have been below action levels in SWMU 2 groundwater since July 2000 (Figures 3-3 and 3-4).

During the first two quarters of performance monitoring, groundwater samples were analyzed for Appendix IX VOCs, SVOCs, pesticides, and Target Analyte List (TAL) metals. The first two quarters of data indicated that pesticides were the only groundwater analytes above action levels, and with the concurrence of the NAS Key West Partnering Team, the groundwater monitoring plan was revised such that subsequent groundwater samples were analyzed only for pesticides (TtNUS, 2001a). With the exception of DDT, DDD, and DDE, no pesticides have been detected in groundwater.

3.4.2.2 Surface Water Monitoring

Surface water COCs for SWMU 2 include DDD, DDE, DDT, aldrin, beta-BHC, and heptachlor. DDD is the only COC that has been detected in surface water since the performance monitoring program was implemented. DDD has not exceeded its action level in surface water since 1995 (Figure 3-5). However, monitoring of pesticides in surface water has continued because of elevated pesticide concentrations in sediment.

During the first two quarters of performance monitoring, surface water samples were analyzed for Appendix IX SVOCs, pesticides, and TAL metals. With the concurrence of the NAS Key West Partnering Team, the surface water monitoring plan was revised such that subsequent samples were analyzed only for pesticides and metals (TtNUS, 2001a). During the first year of monitoring, manganese in surface water exceeded its 10 µg/L action level in some samples, with a maximum concentration of 32.8 µg/L, and silver exceeded its 2.3 µg/L action level in one sample, at 4 µg/L (TtNUS, 2001a). During the second year of monitoring, nickel in surface water exceeded its 8.3 µg/L action level in one sample, at 10.2 µg/L (TtNUS, 2002a). No other metals or pesticides have been detected above action levels in surface water (TtNUS, 2001a; 2002a; 2003a).

3.4.2.3 Sediment Monitoring

Sediment COCs consist of DDD, DDE, and DDT. Contaminant trends are shown on Figures 3-6, 3-7, and 3-8. All three pesticides have consistently exceeded action levels in sediment at SWMU 2. In addition, concentrations in many samples exceeded guidelines that are indicative of probable risk to benthic receptors. Specifically, FDEP's probable effects levels (PELs) (MacDonald, 1994) are as follows for the pesticide COCs at SWMU 2: DDD= 7.81 µg/kg, DDE=374 µg/kg, DDT=4.77 µg/kg, and total DDT (the sum of DDE, DDD, and DDT) = 51.7 µg/kg. The effects range-median (ER-M) for DDE is 27 µg/kg and the ER-M for total DDT is 46.1 µg/kg (Long et al., 1995). As shown in Figures 3-6, 3-7, and 3-8, concentrations in some samples have greatly exceeded these values.

Other than DDT and its analogs DDD and DDE, gamma-chlordane has been the only pesticide detected in sediment during six performance monitoring events, and it was detected in only one sample during the third year of monitoring (TtNUS, 2001a; 2002a; 2003a). The NAS Key West Partnering Team has not developed an action level for gamma chlordane, but the single detected value (1,700 µg/kg) was well above the FDEP's PEL of 4.79 µg/kg for total chlordane (MacDonald, 1994). Sediment concentrations of several metals have exceeded action levels in various samples; most commonly aluminum, cobalt, copper, iron, lead, and zinc (TtNUS, 2001a; 2002a; 2003a).

3.4.2.4 Soil Samples

The long-term monitoring at SWMU 2 did not include the sampling and analysis of soil samples. Thus, soil data are available only for samples collected in 1996 or earlier. Figure 3-9 presents concentrations of soil COCs (DDD, DDE, and DDT) detected in 1993, 1995, and 1996. All concentrations of these pesticides were less than current industrial action levels in soil. Current residential CTLs for these pesticides in soil are 4,600 µg/kg (DDD) and 3,300 µg/kg (DDE and DDT) (Chapter 62-777, F.A.C., May 1999). All concentrations of DDD, DDE, and DDT (Figure 3-9) were less than their respective residential CTLs. A comparison of historical soil data (obtained from the Supplemental RFI/RI) to current residential CTLs indicates that concentrations of the following analytes exceed their respective residential CTLs: arsenic, beryllium, aldrin, alpha-BHC, beta-BHC, gamma-BHC (lindane), heptachlor epoxide, and toxaphene.

3.4.2.5 Biota Monitoring

Fish collected at SWMU 2 in January 1996 and in October 2000 included minnow-sized fish collected in minnow traps and larger fish (e.g. tarpon, mojarra, ladyfish) collected in gill nets. Concentrations of DDE and DDD in the gill-netted fish were less in 2000 than in 1996 (Figure 3-10), but were considerably greater than in background fish. Fish species such as tarpon, mojarra, and ladyfish have long life spans. Tarpon, for example, live as long as 50 years or more. Because organochlorine pesticides have long half-lives in fish tissue (decades), the NAS Key West Partnering Team determined that sampling of long-lived fish was not necessary at SWMU 2 during the January 2003 sampling event. Thus, Figure 3-10 shows data from two sampling events, and Figure 3-11 shows data from three sampling events. Fish samples collected in 2003 were limited to minnow-sized fish that are relatively short-lived (typically less than two years). Concentrations of DDD and DDE in minnows were much less in 2000 than in 1996, but concentrations increased in 2003 (Figure 3-11). DDD and DDE concentrations in SWMU 2 minnows during all three sampling events were greater than in background minnows. The fish tissue data were used to estimate risks to piscivorous birds represented by the little blue heron. Food chain modeling indicated risk to piscivorous if such birds foraged exclusively at SWMU 2 (TtNUS, 2003a).

Sea oxeye daisy, a terrestrial plant known to be a food item of the endangered Lower Keys marsh rabbit, was collected for analysis in October 2000 and January 2003. Pesticides were not detected in sea oxeye daisy samples in 2000, but DDD and DDT were detected near the detection limit in three of six samples collected in 2003. Figure 3-12 shows average concentrations of DDD and DDT in sea oxeye daisy samples, but the 2000 data in Figure 3-12 actually represent non-detected concentrations. The DDD and DDT concentrations in 2003 were similar to concentrations in background sea oxeye daisy samples. Food chain modeling indicates no potential pesticide-related risk to herbivorous mammals represented by the Lower Keys marsh rabbit from consumption of sea oxeye daisy vegetation at SWMU 2 (TtNUS, 2003a).

3.4.3 Site Inspection

The site has been inspected on numerous occasions during routine monitoring events. No significant issues have been identified at any time regarding the site. Since access to the base is restricted, access by trespassers is minimal. In addition, warning signs are in place around the site perimeter, notifying base personnel that access is restricted at SWMU 2.

3.5 TECHNICAL ASSESSMENT

The Comprehensive Five-Year Review Guidance (EPA, 2001) states that the technical assessment section should answer three primary questions, each of which is presented below.

3.5.1 Question A

Is the remedy functioning as intended by the decision documents?

The remedy to protect human health and the environment is functioning as intended. SWMU 2 is located on an active military base within active runways and taxiways, and access to the base is restricted. NAS Key West personnel perform quarterly monitoring to ensure adherence to LUCs, and an annual report is submitted to FDEP describing the results of the quarterly monitoring. Warning signs are in place around the site perimeter, reducing the chance of trespassing and potential exposure to base personnel. In addition, fishing is not allowed by base personnel at SWMU 2 or in the nearby lagoon, thus eliminating risks to human health from consumption of potentially contaminated fish. Any changes in site usage would need to address the contaminants that remain at SWMU 2.

The existing remedy does not appear to be protective of benthic receptors in the ditch at SWMU 2. As explained in Section 3.4.2.3, sediment concentrations of DDD, DDE, and DDT in several samples collected from the ditch have exceeded ER-M and PEL values, indicating probable risk to benthic receptors. Sediment toxicity tests conducted in support of the Supplemental RFI/RI (B&RE, 1997) indicated poor survival of test organisms, and sediment concentrations of pesticides are still elevated, with concentrations in some samples greater than those measured prior to the IRA.

Sediment samples have not been collected from the 15-acre lagoon located immediately east of SWMU 2, and potential risks to ecological receptors in the lagoon were not addressed in the original ecological risk assessment (IT, 1994) nor in the ecological risk assessment conducted during the Supplemental RFI/RI (B&RE, 1997). In the absence of sediment data from the lagoon, conclusions regarding risk to benthic receptors in the lagoon are uncertain. Presumably, site-related pesticide concentrations in sediment would not be greater in the lagoon than in the ditch at SWMU 2, since the former DDT Mixing Area was adjacent to the ditch, but 350 feet from the lagoon. Assuming that pesticide concentrations in lagoon sediments are similar to those in the ditch, then such concentrations pose risk to benthic receptors in the lagoon.

The existing remedy appears to be protective of other receptors (i.e., non-benthic organisms). Concentrations of pesticides in sea oxeye daisy tissue were negligible, and food chain modeling indicates no risk to herbivorous mammals such as the Lower Keys marsh rabbit from consumption of vegetation at SWMU 2. The surface water at SWMU 2 is too saline to be used as drinking water by wildlife, so risks from drinking are not applicable.

Concentrations of DDD, DDE, and DDT in fish tissue pose risks to birds that forage exclusively at SWMU 2, but risks posed by these pesticides are mitigated by conditions at the site. Wading birds such as herons and egrets and raptors such as ospreys and bald eagles forage over large areas, typically hundreds of acres. The ditch at SWMU 2 from which fish were collected is approximately 20 feet wide and 400 feet long, and much of the ditch is covered by a thick overstory of red mangroves. The overstory reduces foraging opportunities by most piscivorous bird species. TtNUS biologists have visited SWMU 2 on numerous occasions and have never observed ospreys or bald eagles in the vicinity, in spite of the known presence of these species at NAS Key West. Herons and egrets have been observed only in the portion of the ditch where trees were removed during the 1996 IRA. The extent to which site-related pesticides pose potential risk to piscivorous birds in the lagoon east of SWMU 2 is uncertain for two reasons: (1) food items (e.g. fish) have not been collected from the lagoon, and (2) the extent to which piscivorous receptors forage in the lagoon is uncertain. This uncertainty is partially mitigated by the fact that (as stated above) the foraging areas of piscivorous birds are typically hundreds of acres, so the prey items obtained from the lagoon plus the ditch at SWMU 2 would comprise a small portion of a bird's total intake. In addition, the lagoon is adjacent to an active runway and taxiway, where aircraft-related noise and disturbance would reduce the lagoon's apparent attractiveness as a foraging area, at least to some extent. Although the precise extent of foraging cannot be determined, site conditions and the large foraging areas of piscivorous birds (hundreds of acres) compared to the small area comprised by the ditch (0.2 acre) plus the lagoon (15 acres) result in a situation such that fish from SWMU 2 and the lagoon comprise only a small portion of the diet of any piscivorous bird, and therefore, site-related risk to piscivorous birds is minimal.

In summary, the remedy is protective of human health, and is probably protective of piscivorous birds, but the remedy does not appear to be protective of benthic (sediment dwelling) invertebrate receptors in the ditch (and possibly in the lagoon) at SWMU 2. At the time of the remedy selection, the IRA was expected to result in minimal residual sediment contamination. Subsequent sampling results, however, have shown that pesticides are still elevated, and measured concentrations in some samples have been greater than those measured prior to the IRA. Concentrations of DDD, DDE, and DDT have exceeded ER-M and PEL values. However, the ditch and lagoon to the east of SWMU 2 are land-locked, and thus, there is no contaminant migration pathway from the ditch and lagoon into other surface water bodies. Therefore, sediment contamination in the ditch at SWMU 2 and in the nearby lagoon does not pose risk to marine resources in other surface water bodies.

3.5.2 Question B

Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of the remedy selection still valid?

There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. There have been no significant changes to the standardized risk assessment methodology or toxicity data that could affect the protectiveness of the remedy. However, following conclusions presented in the Supplemental RFI/RI Report for High-Priority Sites, the action level selection process was revised by the NAS Key West Partnering Team as presented in the Site Investigation Work Plan for Ten BRAC Parcels (B&RE, 1998b). The current ARARs are included in Appendix C, along with the dates of the latest revisions and method of selection for each medium. Values evaluated for each medium are listed in tables, along with the selected action level.

Updated action levels were compared to COCs for surface water, sediment, and soil identified in the Supplemental RFI/RI Report for High-Priority Sites (B&RE, 1997) and COCs for groundwater from the CMS for SWMU 2 (B&RE, 1998d). The soil COCs identified in the Supplemental RFI/RI (DDD, DDE, and DDT) are less than current action levels and less than residential CTLs. However, concentrations of several PAHs, metals, and one PCB (aroclor-1260) exceed residential CTLs in one or more historical soil samples. In addition, DDT and/or its metabolites DDD and DDE have exceeded action levels in performance monitoring samples of groundwater, surface water, and sediment, and sediment concentrations of several metals and pesticides have exceeded action levels.

3.5.3 Question C

Has any other information come to light that could call into question the protectiveness of the remedy?

No new ecological receptors or human usage of the site were identified during long-term monitoring or during the five-year review. No weather related events have affected the protectiveness of the remedy.

Hurricane Georges passed directly over the Key West area in September 1998, with maximum sustained winds near 100 mph on Boca Chica Key, but no erosion or other effects were visible at SWMU 2 as a result of the storm. The only information that could call into question the protectiveness of the remedy is the elevated concentrations of DDD, DDE, and DDT in sediment; this was discussed under Question A (Section 3.5.1) and below in Section 3.5.4.

3.5.4 Technical Assessment Summary

Based on the data reviewed and the site inspections, the remedy is functioning as intended by the HSWA Permit. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. There have been no changes to the standardized risk assessment methodology that could affect the protectiveness of the remedy. Existing pesticide contamination in sediment poses risk to benthic invertebrates, but risk is limited to a relatively small isolated water body.

3.6 ISSUES

There are no unresolved issues that could impact the remedy.

3.7 RECOMMENDATIONS AND FOLLOW UP ACTIONS

LUCs should remain in place at the site. Sediment at SWMU 2 should continue to be monitored annually for metals and pesticides. Surface water should also be sampled annually to monitor cross-contamination at the site. Groundwater should continue to be monitored annually for pesticides.

The collection of additional biological samples as part of long-term monitoring should be discontinued for the following reasons:

- Concentrations of COCs in sea oxeye daisy samples from SWMU 2 were similar to background values and pose no risk to herbivorous mammals.

- Organochlorine pesticides such as DDT, DDD, and DDE are long-lived in the environment, and these pesticides are expected to remain in sediment and fish for the foreseeable future.

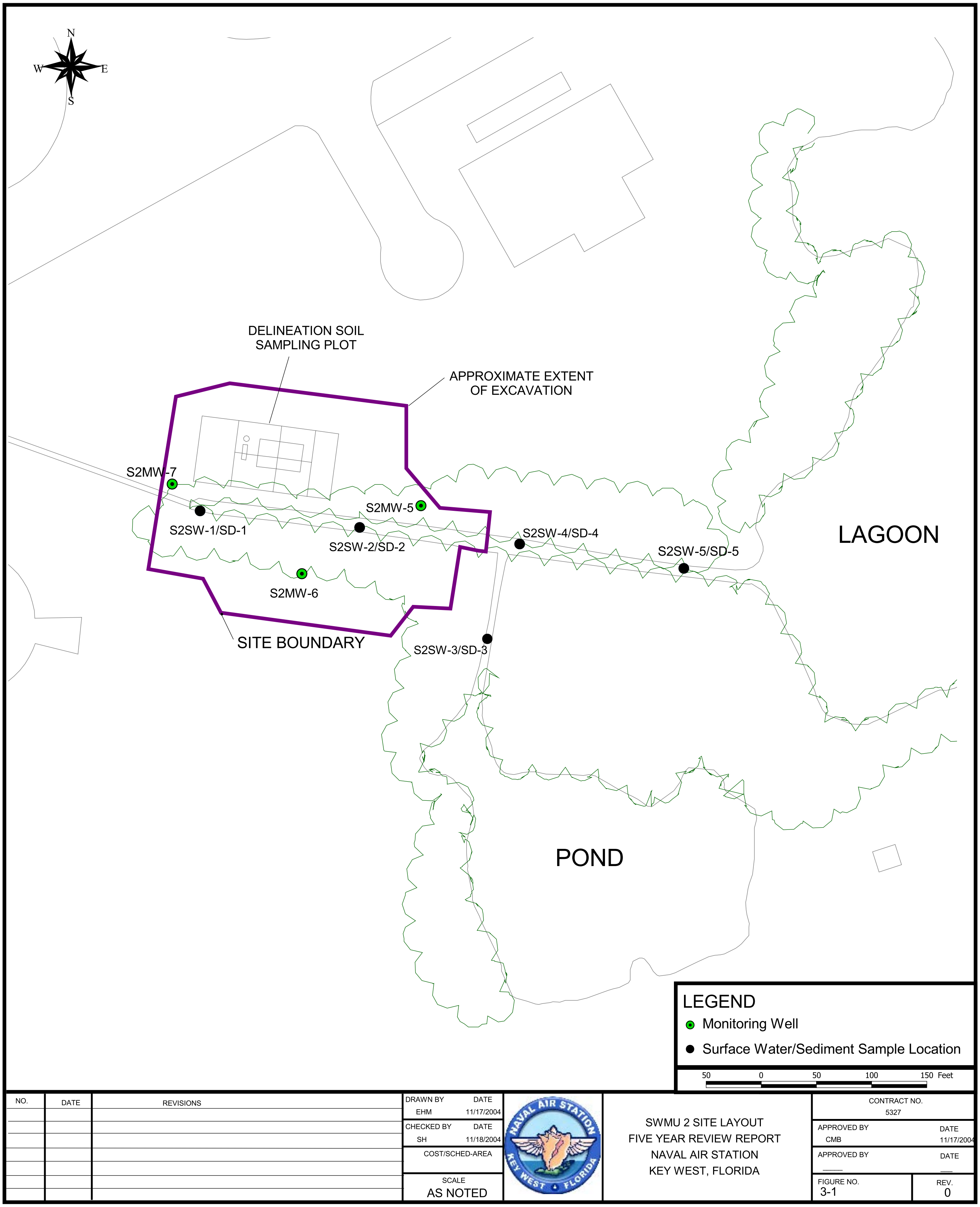
The results of future analyses of surface water and sediment samples should be evaluated by the NAS Key West Partnering Team in order to determine if and when biota sampling should be resumed.

3.8 PROTECTIVENESS STATEMENT

The remedy is expected to continue to be protective of human health and the environment. Existing pesticide contamination in sediment does pose risk to benthic invertebrates, but risk is limited to an isolated water body.

3.9 NEXT REVIEW

The next five-year review for SWMU 2 is required by May 2009.



FILE: K:\FIVE YEAR REVIEW.APR LAYOUT: FIGURE 3-1 SWMU 2 SITE LAYOUT DATE: 11/18/2004 BY: EHM

FIGURE 3-2

DDD IN GROUNDWATER
SWMU 2
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

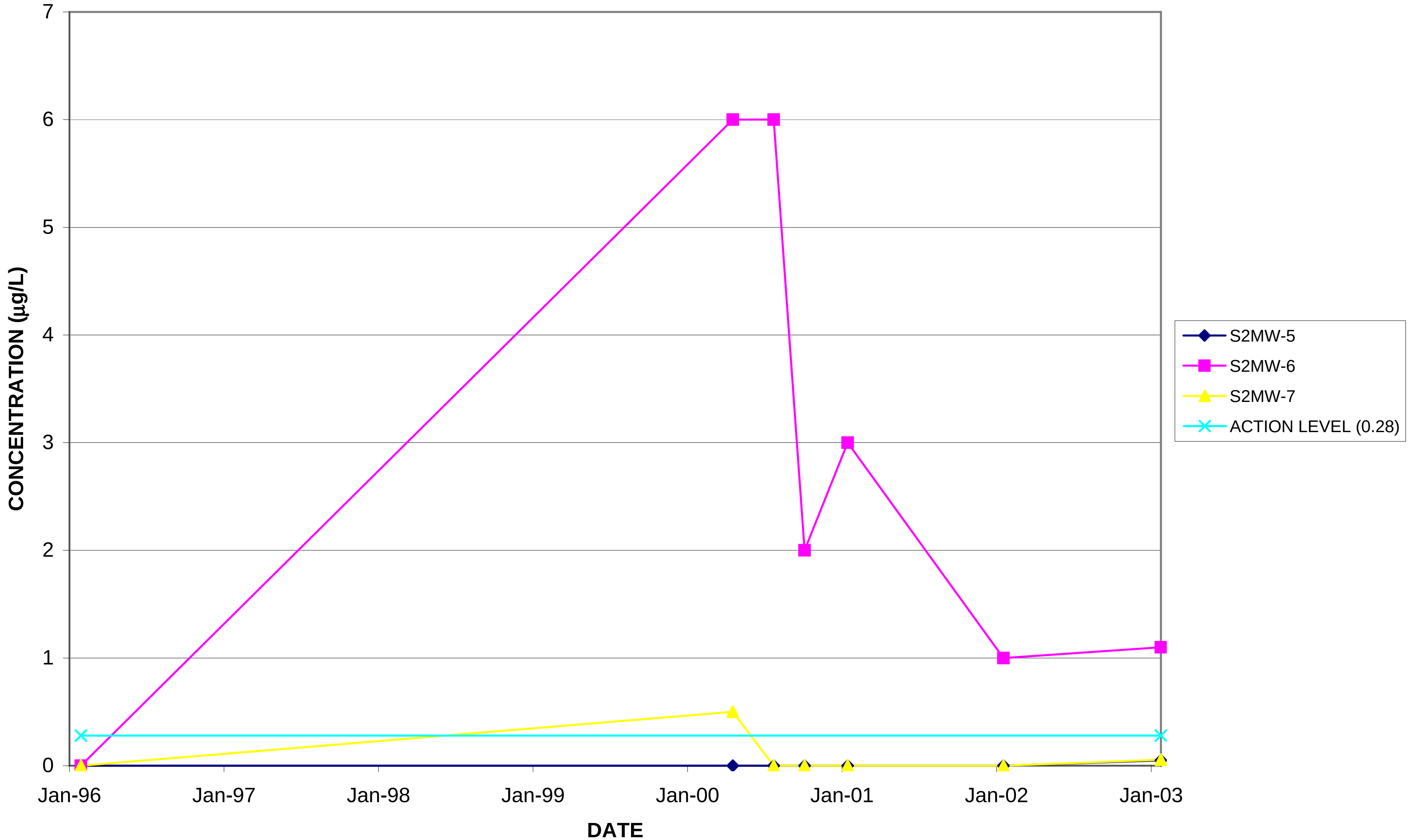


FIGURE 3-3

DDE IN GROUNDWATER
SWMU 2
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

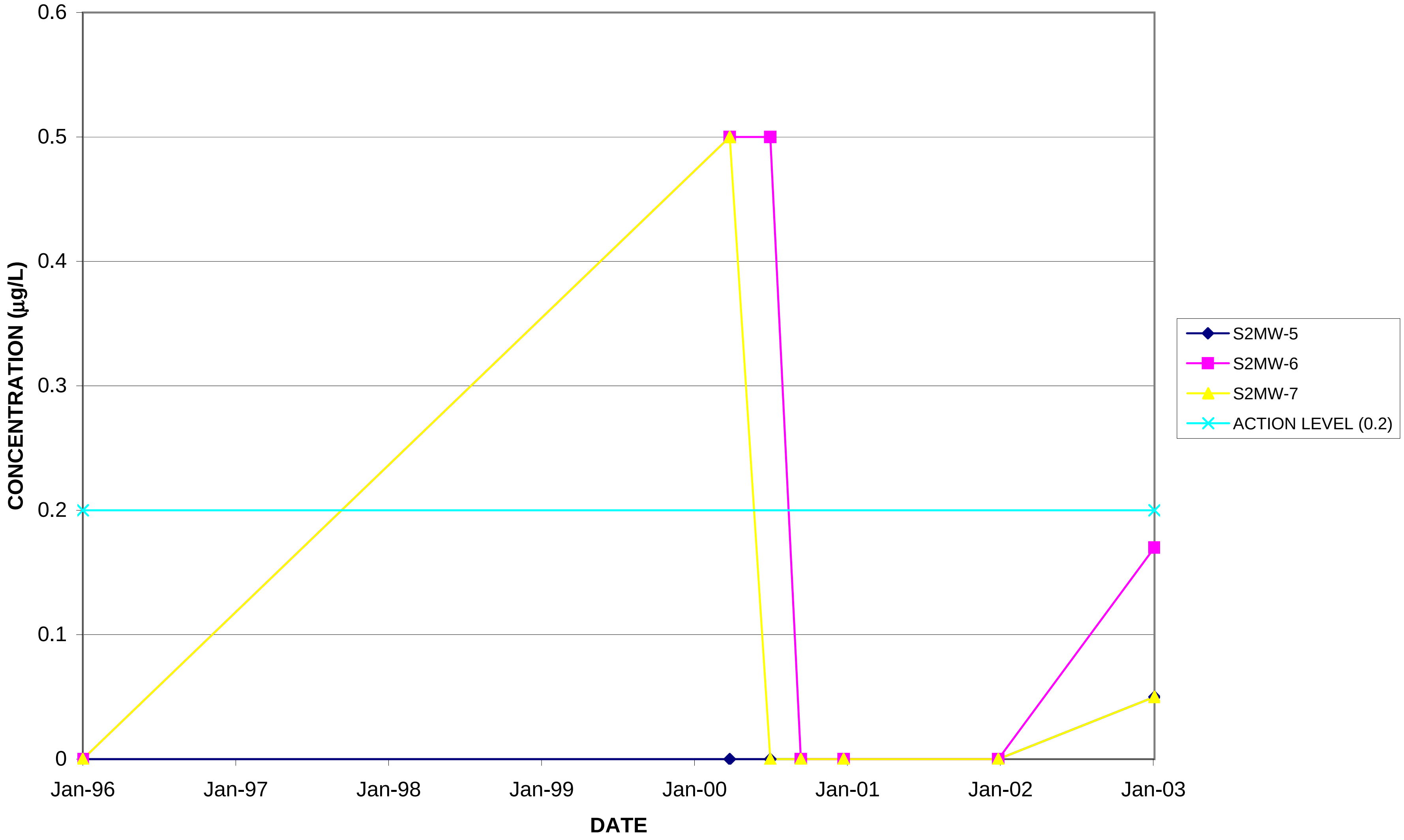


FIGURE 3-4

DDT IN GROUNDWATER
SWMU 2
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

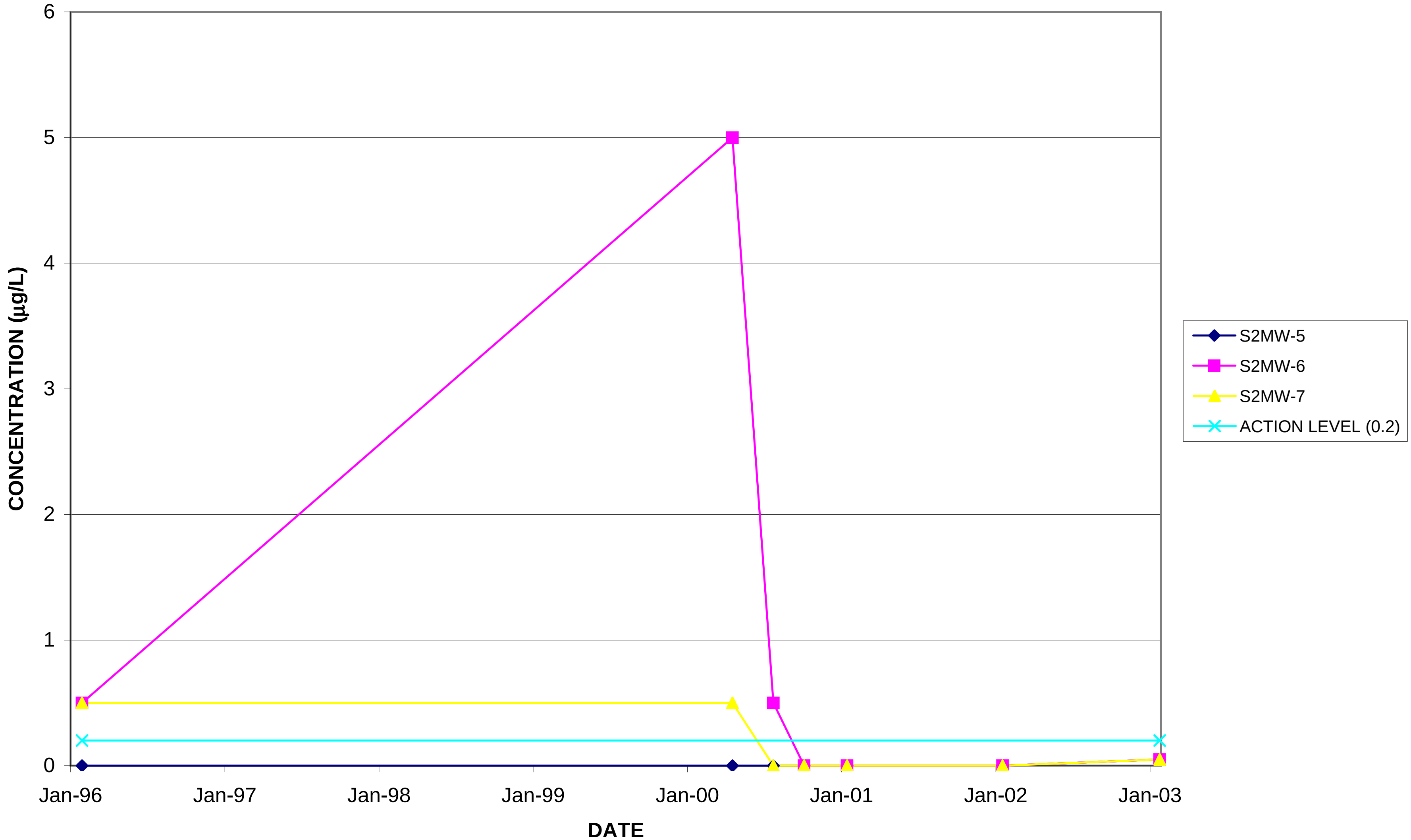


FIGURE 3-5

DDD IN SURFACE WATER
SWMU 2
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

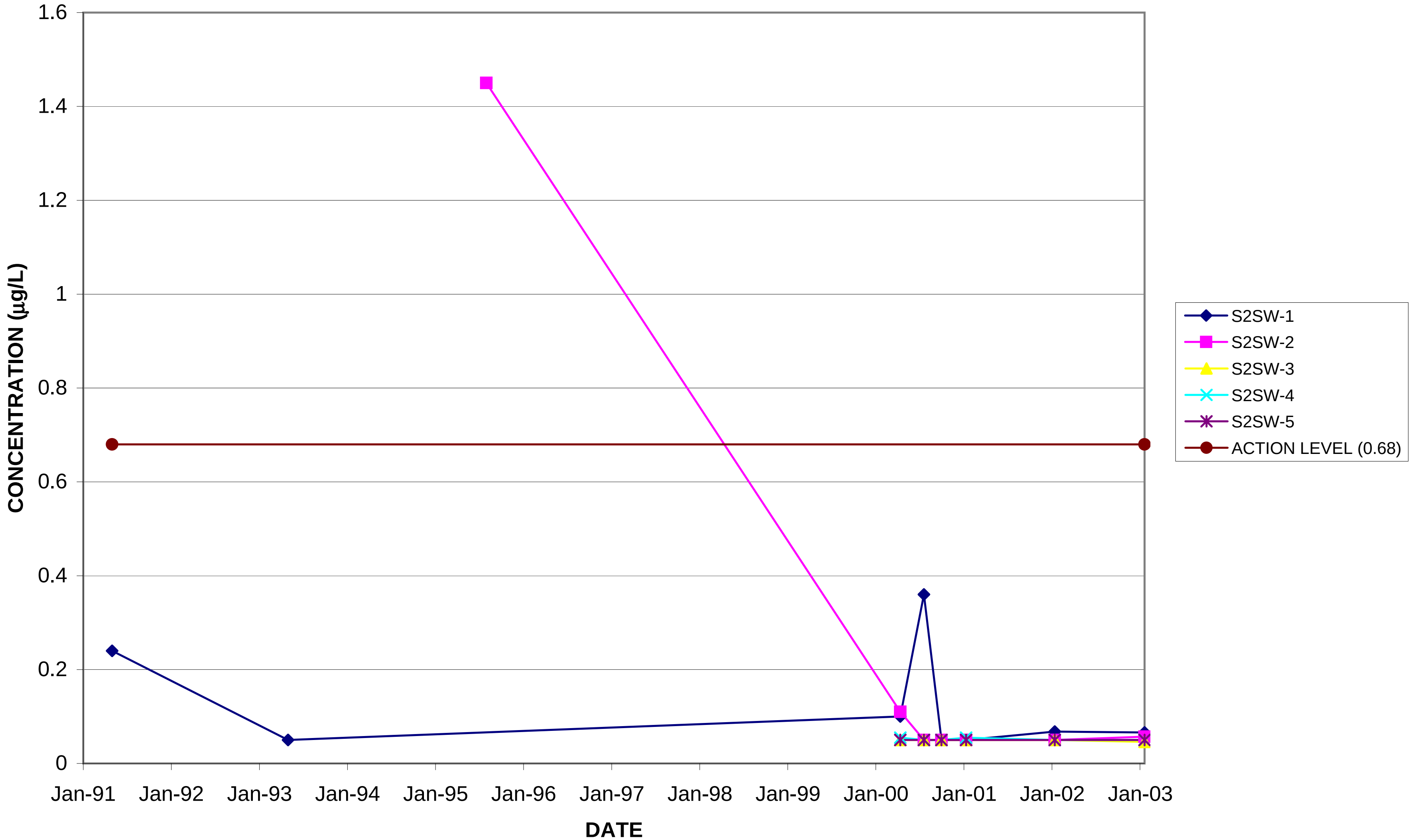


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FIGURE 3-6

DDD IN SEDIMENT
SWMU 2
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

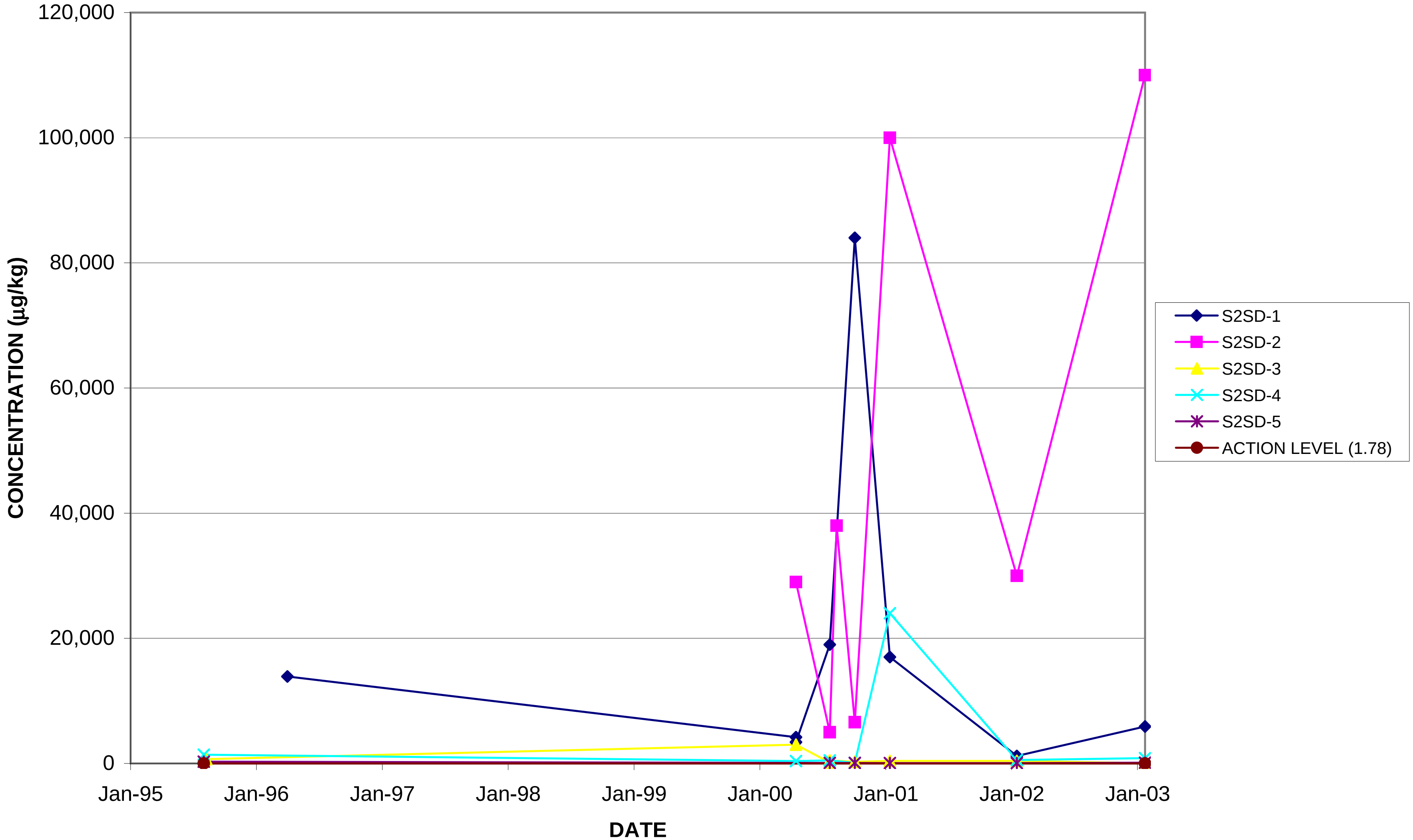


FIGURE 3-7

DDE IN SEDIMENT
SWMU 2
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

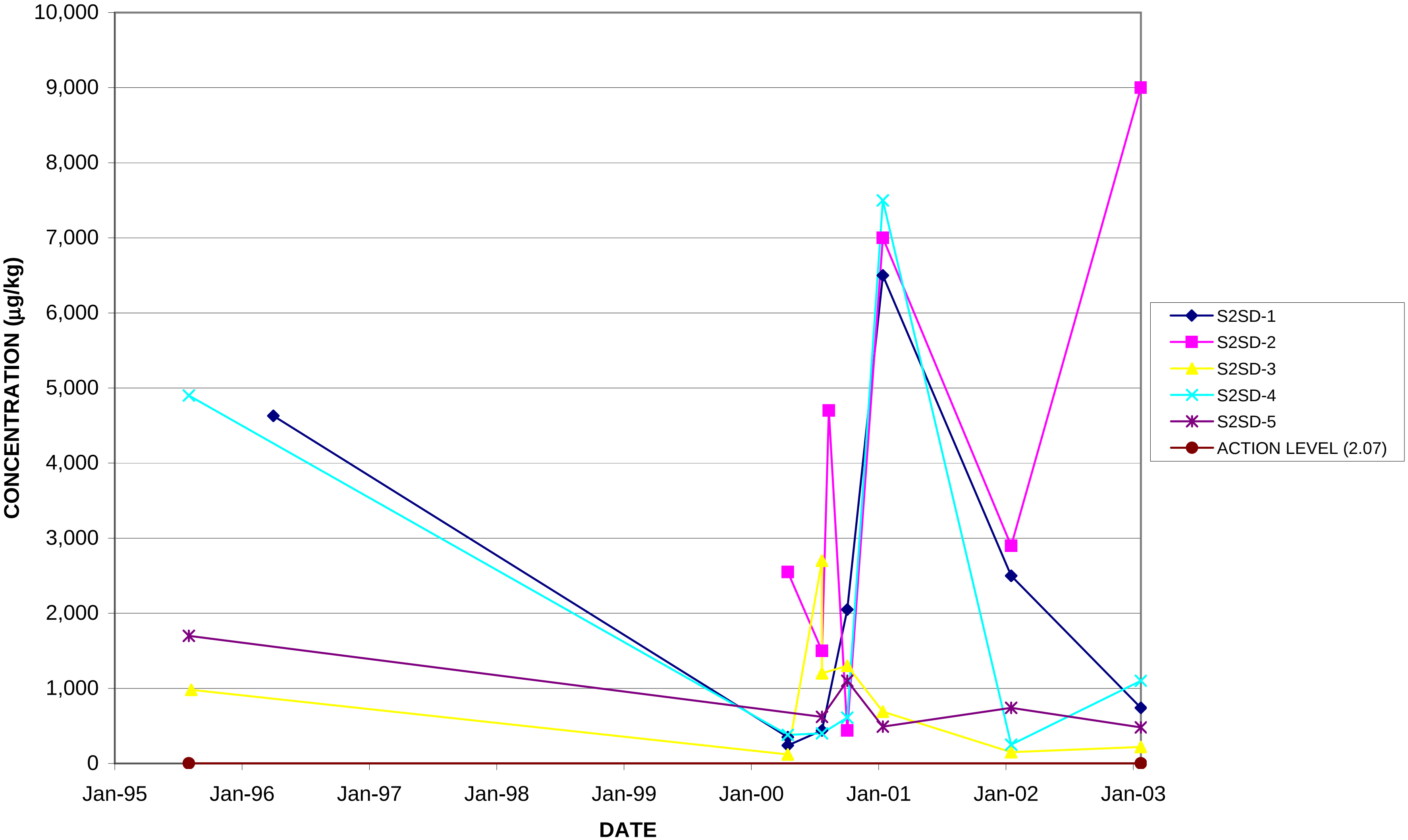


FIGURE 3-8

DDT IN SEDIMENT
SWMU 2
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

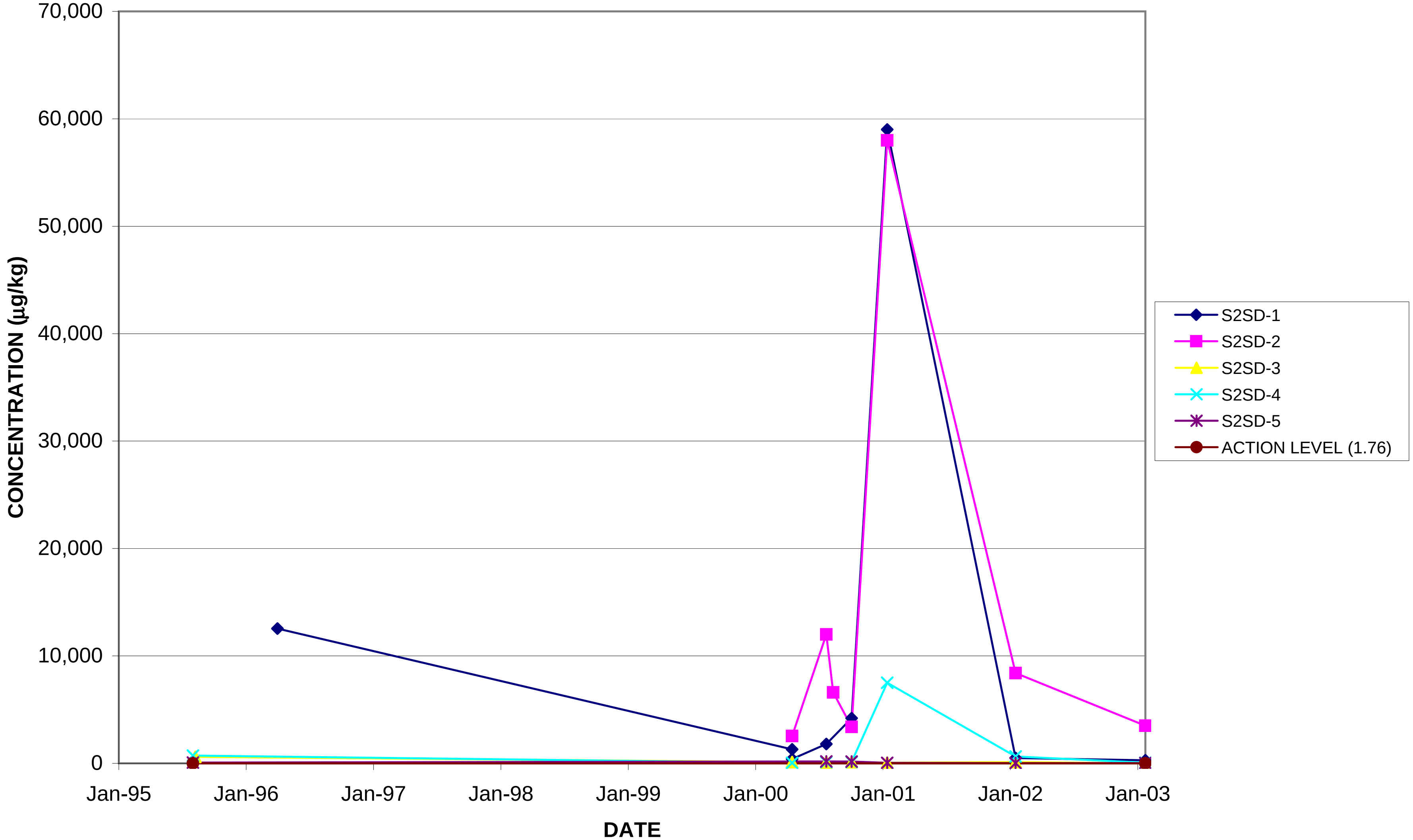
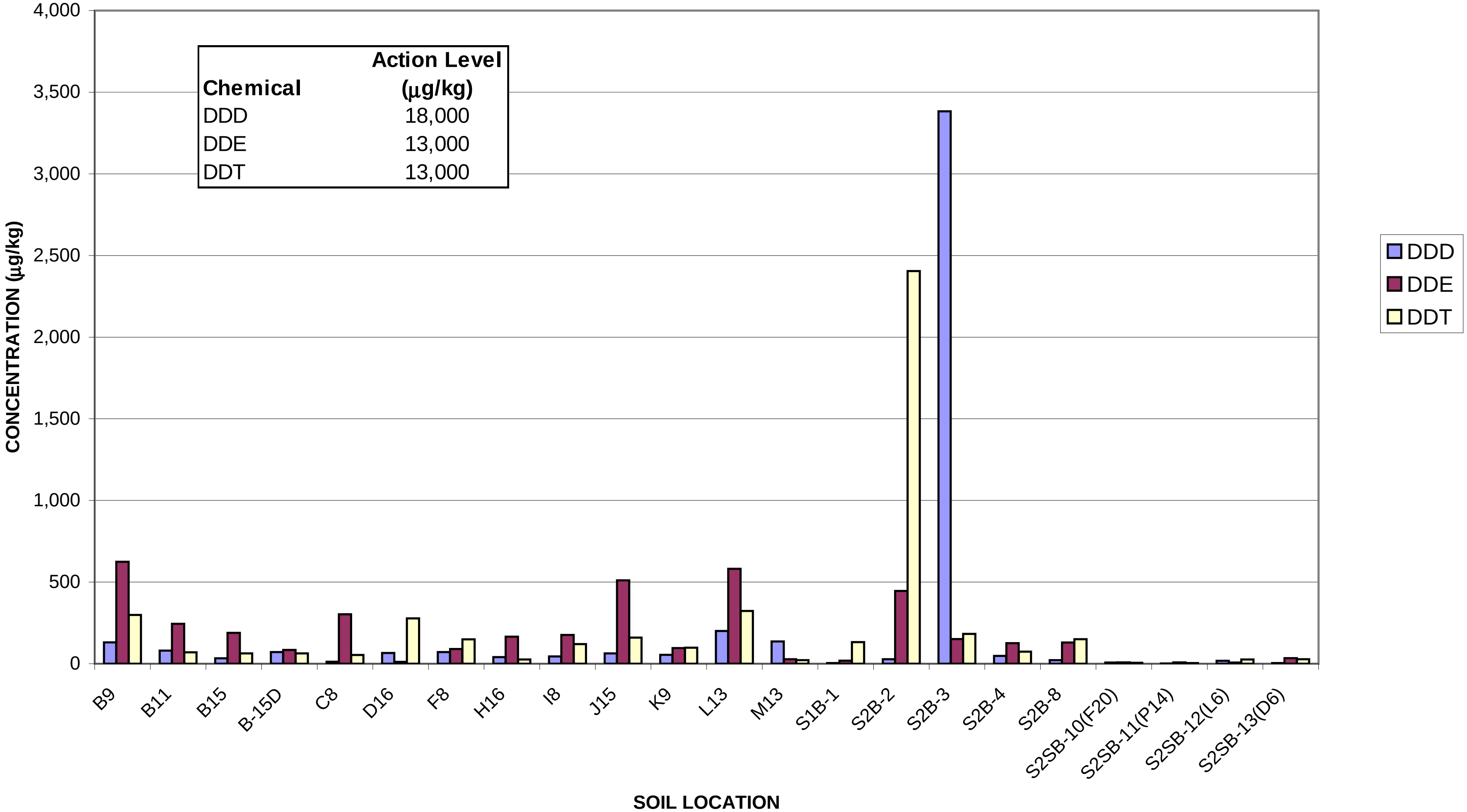


FIGURE 3-9

PESTICIDES IN SOIL
SWMU 2
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA



Note: Soil data collected in 1993, 1995, and 1996

FIGURE 3-10

ORGANIC COCS IN LARGE FISH
SWMU 2
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

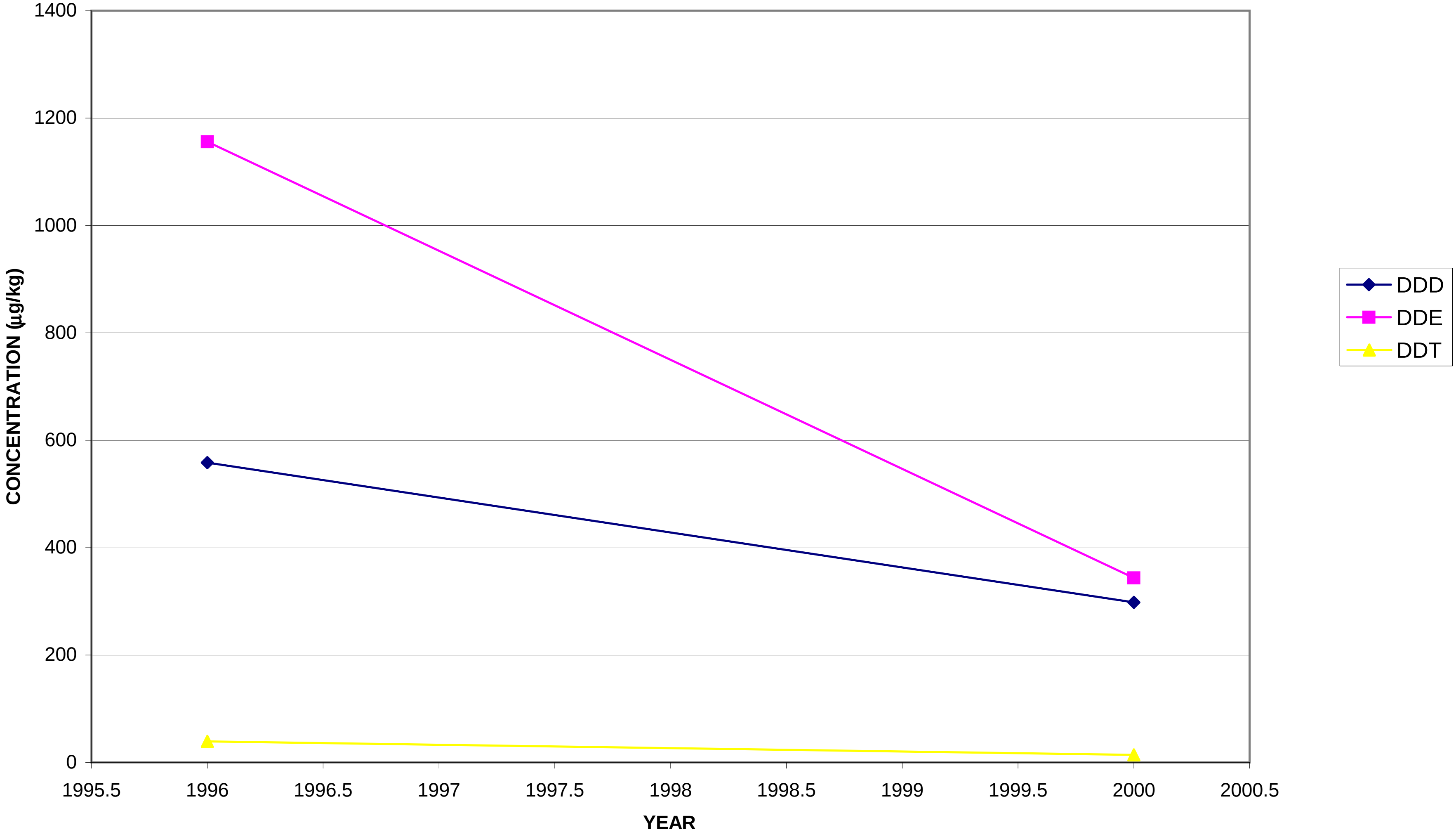


FIGURE 3-11

ORGANIC COCS IN MINNOWS
SWMU 2
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

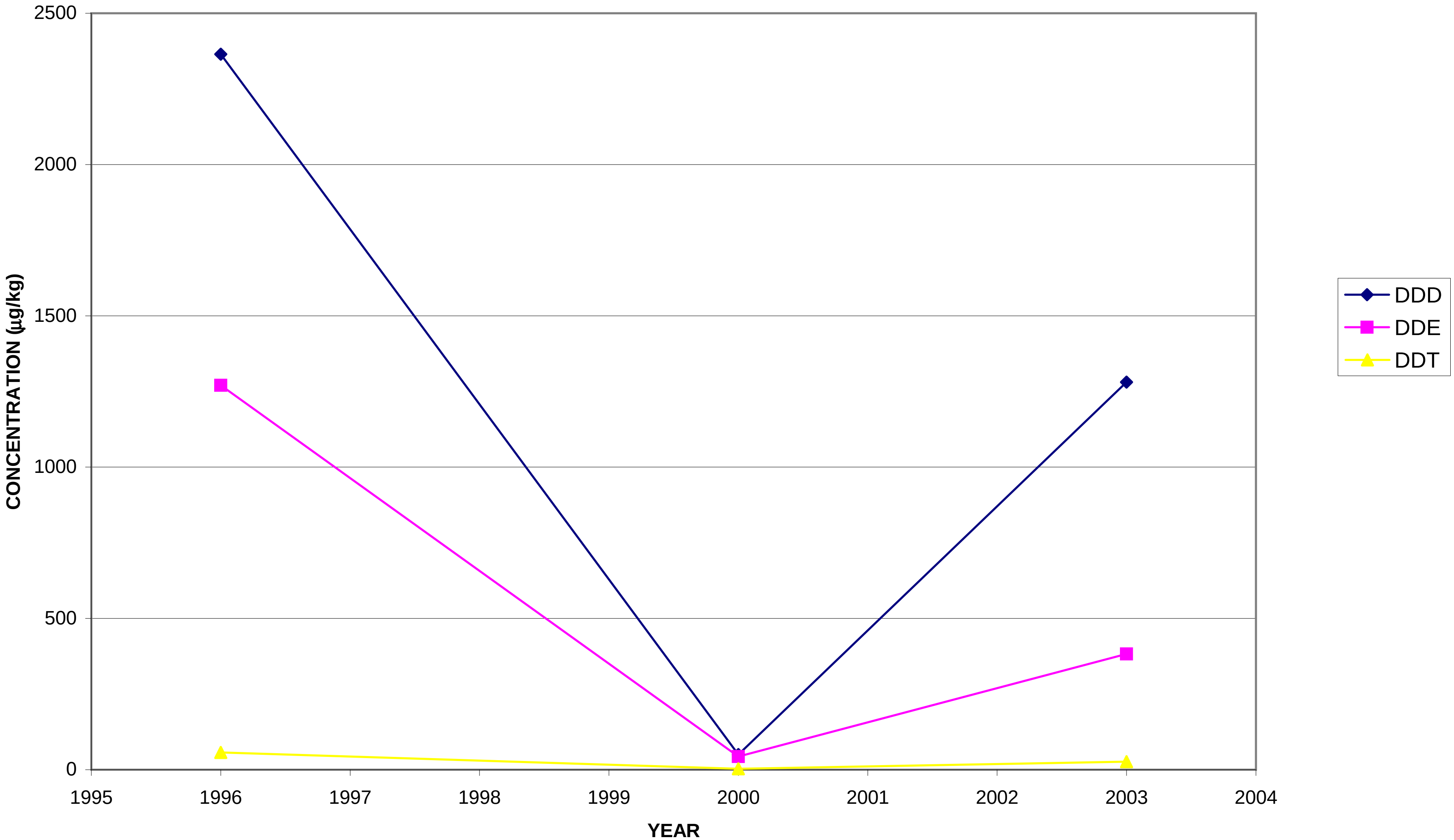
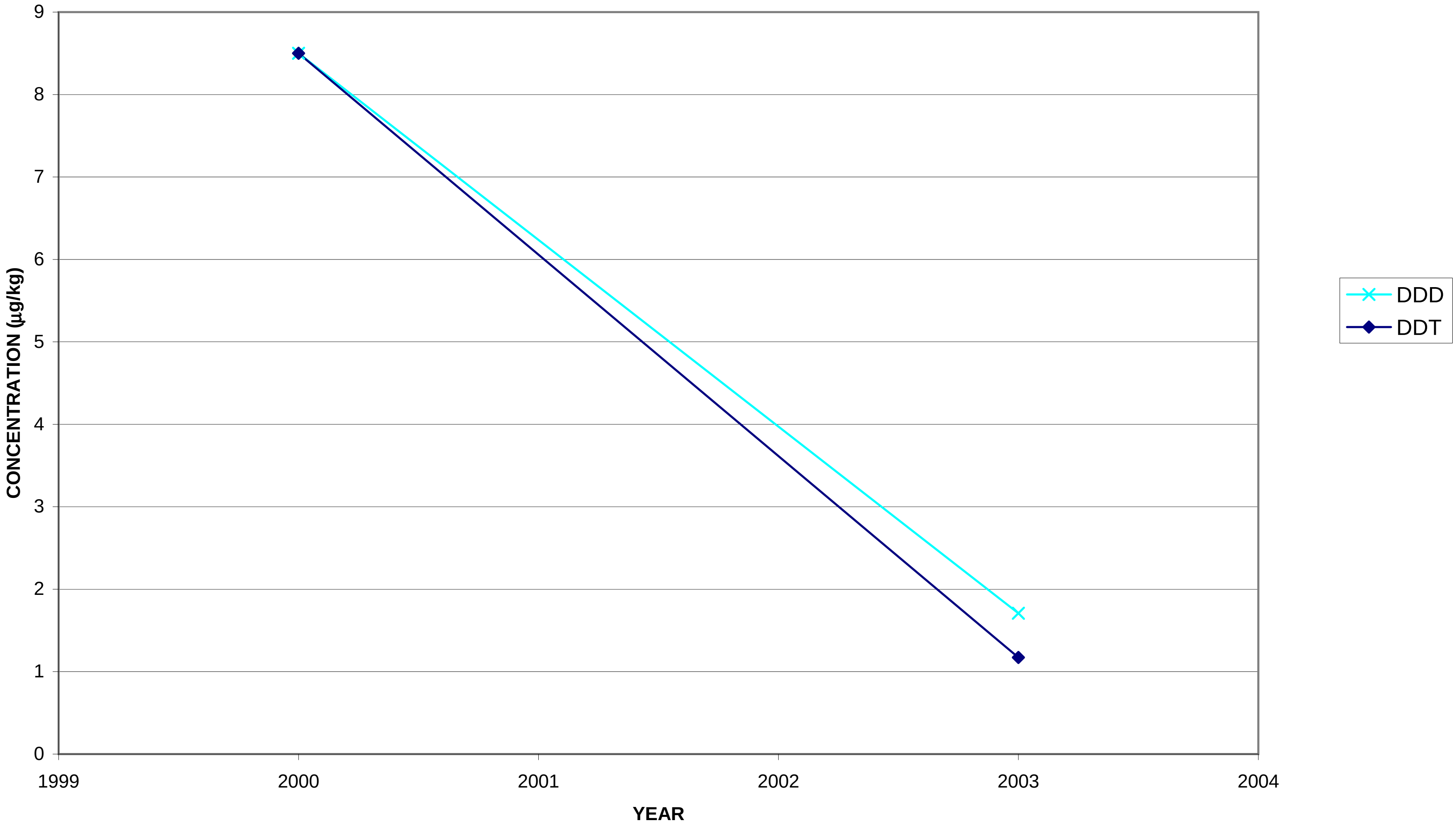


FIGURE 3-12

ORGANIC COCS IN SEA OXEYE DAISY
SWMU 2
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA



4.0 SWMU 3 – BOCA CHICA FIRE-FIGHTING TRAINING AREA

This section describes the five-year review for SWMU 3, the former Boca Chica Fire-Fighting Training Area.

4.1 HISTORY AND SITE CHRONOLOGY

A list of important SWMU 3 historical events and relevant dates in the site chronology is shown below. The identified events are intended to be illustrative, rather than comprehensive.

Investigation/Activity	Date
IAS Report issued by Envirodyne Engineers, Inc.	May 1985
Verification Study Assessment produced by G&M	March 1987
Preliminary RI Report issued by IT	January 1991
RFI/RI Report issued by IT	June 1994
IRA excavation completed by BEI	October 1995
Supplemental RFI/RI Report for High-Priority Sites issued by B&RE	July 1997
Statement of Basis for SWMU 3 issued by TtNUS	July 1998
RCRA CAMP (Rev. 4) issued by TtNUS	July 2003

4.2 BACKGROUND

4.2.1 Site Description

The former Fire-Fighting Training Area is a flat open area located in the southeastern portion of Boca Chica Key, west of the southern blimp pad (Figure 4-1). The site contained aircraft and vehicles that were ignited with flammable liquids (jet fuel, waste oils, or hydraulic fluids) for use in fire-fighting training. The area contained two unlined circular pits, each approximately 100 feet in diameter and 2 to 3 feet deep, which were also ignited using combustible liquids. Approximately 200 feet to the south and west of the former pits is a shallow, 16-acre lagoon. Red and black mangroves are present along the lagoon shoreline. The lagoon is landlocked and is therefore not connected to open ocean water. Dominant fish species in the lagoon are those that are known to be tolerant of high temperatures, low dissolved oxygen concentrations, and fluctuating salinities (e.g., sailfin molly, sheepshead minnow, American eel) (B&RE, 1997).

4.2.2 Summary of Sampling Results

Sampling was performed in 1986, 1990, 1993, 1995, and 1996 during a series of investigations at the site. The 1994 RFI/RI conducted by IT indicated that the fire-fighting training conducted in the pits at SWMU 3 resulted in contamination of the groundwater and soil. Light non-aqueous phase liquid (LNAPL) was discovered on the water table surface in one monitoring well located in the southern pit. The LNAPL was characterized as either diesel fuel, jet propellant (JP-5) fuel, or a combination of both. Petroleum hydrocarbon contamination was also identified in monitoring wells associated with the northern pit (IT, 1994).

4.2.3 1995 IRA

As a result of conclusions in the 1994 RFI/RI, an IRA was conducted at SWMU 3. The IRA objective was contaminant source removal from the southernmost of the two circular pits to prevent further migration of petroleum contamination into groundwater. Data from delineation sampling established the boundary for petroleum-impacted soil as the entire southern burn pit. Approximately 726 cubic yards of soil were removed and disposed from the southern burn pit in 1995 (BEI, 1998).

4.2.4 Summary of Risk

The Supplemental RFI/RI for High-Priority Sites determined that metals were soil, sediment, and surface water contaminants at SWMU 3, but were present at concentrations only slightly above action levels. VOCs and some PAHs were also present in groundwater. Human health and ecological risk assessments were performed as part of the Supplemental RFI/RI. The BRA determined that carcinogenic risks were greater than 1E-06 for the hypothetical adult trespasser, adolescent trespasser, and future resident. Arsenic in sediment was the principal contributor to the carcinogenic risk. Non-carcinogenic residential risk was slightly above the 1.0 benchmark. Antimony and thallium in surface water were the principal contributors to non-carcinogenic risks (B&RE, 1997).

The ecological risk assessment concluded that ecological risks were negligible (B&RE, 1997).

4.3 REMEDIAL ACTIONS

4.3.1 <u>Remedy Selection</u>

The selected remedy, no action with LUCs, was agreed to by the NAS Key West Partnering Team. The LUCs were designed to eliminate or reduce exposure pathways by limiting site access. This remedy is protective of human health by restricting future site use. Additional information regarding the selection of LUCs as a remedy for SWMU 3 is provided in the Statement of Basis for SWMU 3 (TtNUS, 1998c).

4.3.2 <u>Remedy Implementation</u>

LUCs were developed through LUCIPs. These controls were designed to ensure protection of human health and the environment by restricting future site use and accessibility, educating NAS personnel, and maintaining records of contamination. The LUCs documented in the NAS Key West Master Plan prevent future residential use at this site. In addition, access to SWMU 3 is restricted, since the site is near an active air strip on an active military base with no planned change in site usage for the foreseeable future. Furthermore, personnel from the NAS Key West Public Works Department are required to visually inspect SWMU 3 on a quarterly basis to ensure that all LUCs are being implemented and properly maintained. The NAS Key West Public Works Department submits an annual report to FDEP describing the results of the quarterly inspections.

4.3.3 <u>System Operation/Operation and Maintenance</u>

According to cost estimates obtained from the NAS Key West Public Works Environmental Department, the cost associated with the selected remedy is approximately $1,500 per year.

4.4 FIVE YEAR REVIEW PROCESS

4.4.1 <u>Document Review</u>

Because the selected remedy was no action with LUCs, a document review for SWMU 3 is not applicable.

4.4.2 <u>Data Review</u>

Because the selected remedy was no action with LUCs, no analytical data have been generated since the Supplemental RFI/RI for High-Priority Sites. However, data for surface water, sediment, groundwater, and soil evaluated in the Supplemental RFI/RI were compared to current action levels (see Section 4.5.2).

The action levels are concentrations that have been selected by the NAS Key West Partnering Team as representing concentrations below which there is no potential for unacceptable risk to human health or the environment. The action levels were selected from several sources, and are included in Appendix C.

4.4.3 Site Inspection

The site has been inspected on numerous occasions since 1996. No significant issues have been identified at any time regarding the site. Since access to the base is restricted, potential access by trespassers is minimal.

4.5 TECHNICAL ASSESSMENT

The Comprehensive Five-Year Review Guidance (EPA, 2001) states that the technical assessment section should answer three primary questions, each of which is presented below.

4.5.1 Question A

Is the remedy functioning as intended by the decision documents?

The remedy to protect human health and the environment is functioning as intended. SWMU 3 is located on an active military base, and access to the base is restricted. NAS Key West personnel perform quarterly monitoring to ensure adherence to LUCs, and an annual report is submitted to FDEP describing the results of the quarterly monitoring. There is no planned change in site usage for the foreseeable future.

4.5.2 Question B

Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of the remedy selection still valid?

There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. There have been no significant changes change to the standardized risk assessment methodology or toxicity data that could affect the protectiveness of the remedy. However, subsequent to production of the Supplemental RFI/RI Report for High-Priority Sites, the action level selection process was revised by the NAS Key West Partnering Team as presented in the Site Investigation Work Plan for Ten BRAC Parcels (B&RE, 1998b). The current ARARs are included in Appendix C, along with the dates of the latest revisions and method of selection for each medium. Values evaluated for each medium are listed in tables, along with the selected action level.

The current action levels in Appendix C were compared to concentrations of analytes detected in SWMU 3 groundwater, surface water, sediment, and soil samples evaluated in the Supplemental RFI/RI Report for High-Priority Sites. Action levels for arsenic and naphthalene in groundwater have been revised since the Supplemental RFI/RI Report. The arsenic action level in groundwater was 50 µg/L in 1997 but is now 10 µg/L, resulting in exceedances of the action level in six of eight groundwater samples (there were no exceedances based on the earlier action level). The naphthalene action level in groundwater was 10 µg/L in 1997 but is now 6.5 µg/L, resulting in no change in the number of exceedances (five of six samples).

Copper, lead, and thallium are the only detected surface water analytes with concentrations that exceed current action levels that have changed since 1997. For each of these three analytes, however, the action levels have increased since 1997.

Aluminum, arsenic, cobalt, iron, lead, and tin in sediment exceed current action levels. Lead concentrations exceed the action level in three sediment samples, arsenic in two samples, and the other four metals exceed their action levels in one sample. No detected soil analytes exceed current action levels.

The changes in action levels do not appear to have significantly impacted the results of the BRA or ecological risk assessment due either to only slight exceedances and/or exceedances in only a few samples.

4.5.3 Question C

Has any other information come to light that could call into question the protectiveness of the remedy?

No new ecological receptors or human usage of the site have been identified for SWMU 3. No weather related events have affected the protectiveness of the remedy. There is no known information that calls into question the protectiveness of the remedy.

4.5.4 Technical Assessment Summary

Based on the data reviewed and the site inspections, the remedy is functioning as intended by the HSWA Permit. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. There have been no changes to the standardized risk assessment methodology that could affect the protectiveness of the remedy. There is no other information that calls into question the protectiveness of the remedy.

4.6 ISSUES

There are no unresolved issues that could impact the remedy.

4.7 RECOMMENDATIONS AND FOLLOW UP ACTIONS

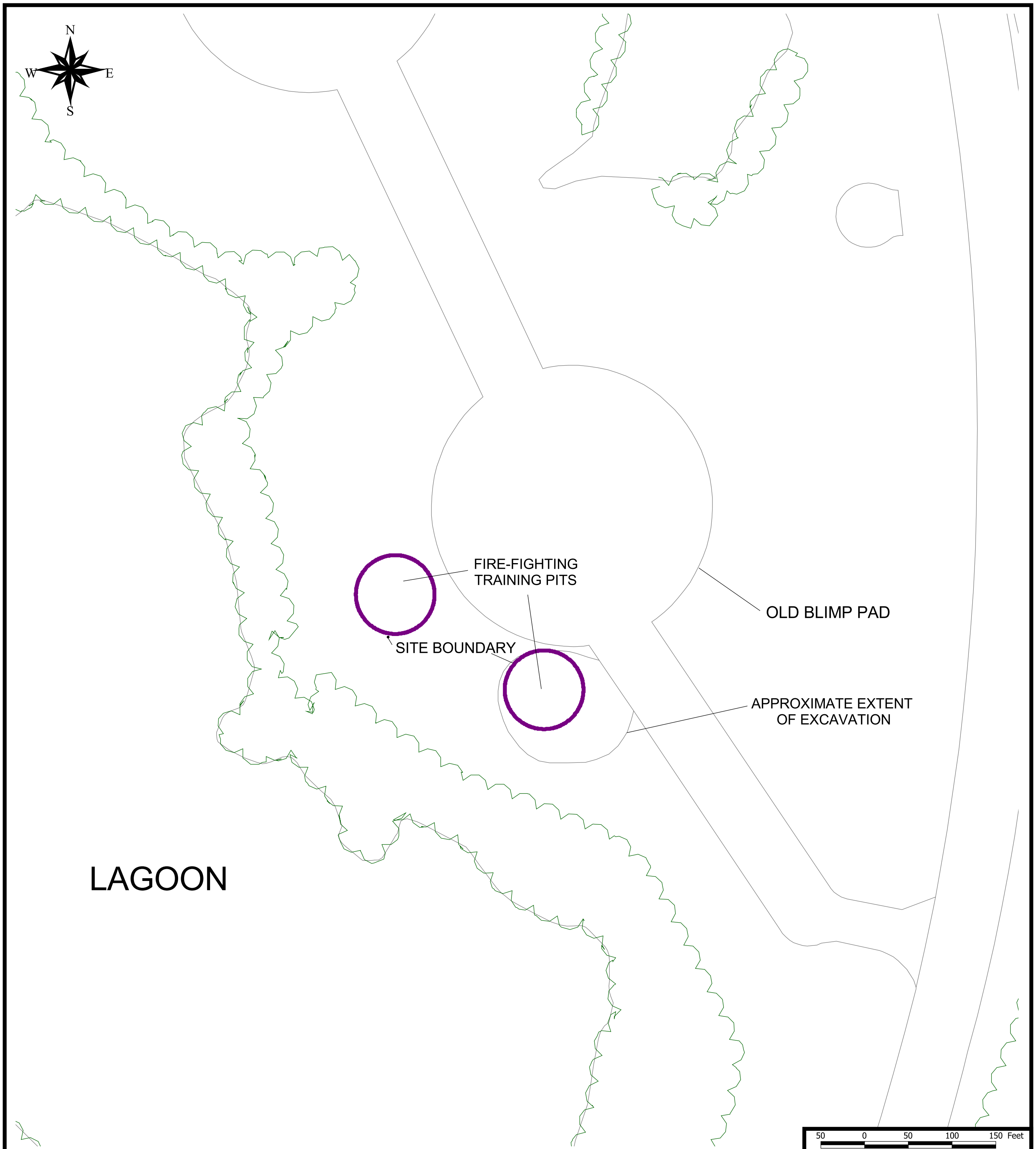
LUCs should remain in place at the site. Florida has recently proposed changes to Chapter 62-777, F.A.C. (Contaminant Cleanup Target Levels). After the new CTLs are promulgated, SWMU 3 should be evaluated for a no further action (NFA) decision. There are no other recommendations or follow-up actions for SWMU 3.

4.8 PROTECTIVENESS STATEMENT

The remedy is expected to continue to be protective of human health and the environment.

4.9 NEXT REVIEW

The next five-year review for SWMU 3 is required by May 2009.



NO.	DATE	REVISIONS

DRAWN BY EHM DATE 11/17/2004
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COST/SCHED-AREA
SCALE AS NOTED

SWMU 3 SITE LAYOUT
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

CONTRACT NO. 5327
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APPROVED BY DATE
FIGURE NO. 4-1 REV. 0

FILE: K:\FIVE YEAR REVIEW.APR LAYOUT: FIGURE 4-1 SWMU 3 SITE LAYOUT DATE: 11/19/2004 BY: EHM

5.0 SWMU 4 – BOCA CHICA AIMD BUILDING A-980

This section describes the five-year review for SWMU 4, Boca Chica AIMD Building A-980.

5.1 HISTORY AND SITE CHRONOLOGY

A list of important SWMU 4 historical events and relevant dates in the site chronology is shown below. The identified events are illustrative, not comprehensive.

Investigation/Activity	Date
Building A-980 constructed	Late 1960s
Two 55-gallon plastic drums installed in-ground	August 1981
Notice of Violation (NOV) issued for contamination of soil by solvents and Freon	May 1987
Drum removal and soil sampling	December 1989
RFI/RI Report issued by IT	June 1994
Supplemental RFI/RI for Eight Sites issued by B&RE	January 1998
Statement of Basis for SWMU 4 issued by TtNUS	July 1998
RCRA CAMP (Rev. 4) issued by TtNUS	July 2003

5.2 BACKGROUND

5.2.1 <u>Site Description</u>

AIMD Building A-980 is located in the northwestern portion of Boca Chica Key (Figure 5-1). The building was constructed in the late 1960s and provides electronics maintenance support to aircraft. A lagoon that is hydrologically connected to the Florida Bay lies on the west, north, and east sides of the building. A small stormwater drainage ditch is located south of the building. Between 1981 and 1987, two in-ground 55-gallon plastic drums were used to receive and store solvents and oil mixtures that were drained from the interior of Building A-980 (IT, 1994).

In August 1981, the first of these 55-gallon plastic drums was installed in-ground on the north side of Building A-980, and used to collect approximately 3 gallons per month of hazardous waste containing approximately 70 percent trichlorotrifluoromethane (TF) freon-113, and 30 percent electrical insulating mineral oil (coolanol-35R). The second drum was installed on the south side of the building and was used during the same period by the Tire Shop. This drum received a mixture of 96 percent water, 2 percent PD-680 (chlorinated organic solvent), 2 percent Turco (a phenolic-based aircraft cleaner), and a residue of PCA 44 Type C (emulsifier cleaner). The contents of the two drums were reportedly pumped out every 60 to 90 days (IT, 1994).

The two drums were gravity-fed by a piping system that drained various mixtures from the interior of the building. The north drum was connected to a floor drain inside Building A-980, which collected incidental spillage from the work area operations. The drain system consisted of a 2-inch polyvinyl chloride (PVC) pipe encased in cement mortar that carried spillage directly to the in-ground drum. The south drum was connected to a dip tank via a similar floor trench drain. The dip tank was used by the Tire Shop for rinsing aircraft wheel rims during routine maintenance. A NOV was issued by the Florida Department of Environmental Regulation (FDER) (since changed to FDEP) on May 11, 1987, because some soil around one in-ground collection drum appeared to be contaminated with solvents and TF Freon. Subsequently, NAS Key West cut and plugged the connecting piping and discontinued use of the in-ground drums for wastewater collection. In December 1989, both drums were removed and stained soil surrounding and under each drum was excavated and disposed off-site (IT, 1994).

5.2.2 <u>Summary of Sampling Results</u>

Initial sampling at SWMU 4 was performed in conjunction with the removal of the in-ground drums and surrounding soil in December 1989. Analysis indicated soil contamination from metals and petroleum hydrocarbons in the area of both drums. Subsequently, an RFI/RI was performed that included soil, sediment, surface water, and groundwater sampling. Characterization of releases at the site indicated that contamination did not appear to be the result of on-site waste disposal operations (IT, 1994).

5.2.3 <u>Summary of Risks</u>

The Supplemental RFI/RI for Eight Sites determined that the low levels of metals and organic compounds in SWMU 4 media would not pose ecological risks or adverse health effects to current human receptors. However, the risk for the future resident exposure scenario slightly exceeded carcinogenic and non-carcinogenic risk benchmarks established by EPA and FDEP (B&RE, 1998a).

5.3 REMEDIAL ACTIONS

5.3.1 Remedy Selection

The selected remedy, no action with LUCs, is designed to eliminate or reduce exposure pathways by limiting site access. This remedy is protective of human health by restricting future site use. Additional information regarding the selection of LUCs as a remedy for SWMU 4 is provided in the Statement of Basis for SWMU 4 (TtNUS, 1998d).

5.3.2 Remedy Implementation

LUCs were developed through LUCIPs. These controls were designed to ensure protection of human health and the environment by restricting future site use and accessibility, educating NAS Key West personnel, and maintaining records of contamination. The LUCs documented in the NAS Master Plan prevent future residential use at this site. In addition, access to SWMU 4 is restricted, since the site is on an active military base with no planned change in site usage for the foreseeable future. Furthermore, personnel from the NAS Key West Public Works Department are required to visually inspect SWMU 4 on a quarterly basis to ensure that all LUCs are being implemented and properly maintained. The NAS Key West Public Works Department submits an annual report to FDEP describing the results of the quarterly inspections.

5.3.3 System Operations and Maintenance

According to cost estimates obtained from the NAS Key West Public Works Environmental Department, the cost associated with the selected remedy is approximately $1,500 per year.

5.4 FIVE YEAR REVIEW PROCESS

5.4.1 Document Review

Because the selected remedy was no action with LUCs, a document review for SWMU 4 is not applicable.

5.4.2 Data Review

Because the selected remedy was no action with LUCs, no analytical data have been generated since the Supplemental RFI/RI for Eight Sites. However, data for groundwater, surface water, sediment, and soil evaluated in the Supplemental RFI/RI were reviewed and compared to current action levels (see Section

5.5.2). The action levels are concentrations that have been selected by the NAS Key West Partnering Team as representing concentrations below which there is no potential for unacceptable risk to human health or the environment. The action levels were selected from several sources and are included in Appendix C.

5.4.3 Site Inspection

The site has been inspected on numerous occasions since the last sampling in 1996. No significant issues have been identified at any time regarding the site. Since access to the base is restricted, potential access by trespassers is minimal.

5.5 TECHNICAL ASSESSMENT

The Comprehensive Five-Year Review Guidance (EPA, 2001) states that the technical assessment section should answer three primary questions, each of which is presented below.

5.5.1 Question A

Is the remedy functioning as intended by the decision documents?

The remedy to protect human health and the environment is functioning as intended. SWMU 4 is located on an active military base and access to the base is restricted. NAS Key West personnel perform quarterly inspections to ensure adherence to LUCs and an annual report is submitted to FDEP describing the results of the quarterly monitoring. There is no planned change in site usage for the foreseeable future.

5.5.2 Question B

Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of the remedy selection still valid?

There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. There have been no significant changes to the standardized risk assessment methodology or toxicity data that could affect the protectiveness of the remedy. However, subsequent to preparation of the Supplemental RFI/RI Report for Eight Sites, the action level selection process was revised by the NAS Key West Partnering Team as presented in the Site Investigation Work Plan for Ten BRAC Parcels (B&RE, 1998b). The current ARARs are included in Appendix C, along with the dates of the latest revisions and method of selection for each medium. Values evaluated for each medium are listed in tables, along with the selected action level.

No additional exceedances for groundwater at SWMU 4 were identified due to changes in action levels. However, two 1996 detections (chloroform in S4MW-6 and vinyl chloride in S4MW-2) that exceeded action levels used during the Supplemental RFI/RI for Eight Sites are no longer considered exceedances.

Antimony and lead exceedances identified in surface water at SWMU 4 in the Supplemental RFI/RI Report for Eight Sites no longer apply due to an update in action levels for these chemicals. However, 1993 tin and n-nitroso-di-n-propylamine detections exceed current action levels and were exceedances when evaluated in the Supplemental RFI/RI.

The current action levels in Appendix C were compared to concentrations of analytes detected in SWMU 4 groundwater, surface water, sediment, and soil samples evaluated in the Supplemental RFI/RI Report for Eight Sites (B&RE, 1998a).

In sediment, changes to action levels have resulted in two additional exceedances of action levels: aluminum exceeded its action level at sediment sample location S4SS-1 and tin exceeded its action level at sample location S4SS-6. Acetone, bis(2-ethylhexyl)phthalate, and lead exceeded action levels in 1998 and exceed current action levels.

Results for surface and subsurface soil samples collected in 1993 and 1996 were compared to current industrial action levels and no exceedances were identified. Multiple contaminants exceeded action levels in soil when assessed during the Supplemental RFI/RI, but changes in action levels have eliminated these exceedances.

The changes in action levels do not appear to have significantly impacted the results of the BRA or ecological risk assessment due either to only slight exceedances and/or exceedances in only a few samples.

5.5.3 Question C

Has any other information come to light that could call into question the protectiveness of the remedy?

No new ecological receptors or human usage of the site have been identified for SWMU 4. No weather related events have affected the protectiveness of the remedy. There is no known information that calls into question the protectiveness of the remedy.

5.5.4 Technical Assessment Summary

Based on the data reviewed and the site inspections, the remedy is functioning as intended by the HSWA permit. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. There have been no significant changes to the standardized risk assessment methodology that could affect the protectiveness of the remedy. There is no other information that calls into question the protectiveness of the remedy.

5.6 ISSUES

There are no unresolved issues that could impact the remedy.

5.7 RECOMMENDATIONS AND FOLLOW UP ACTIONS

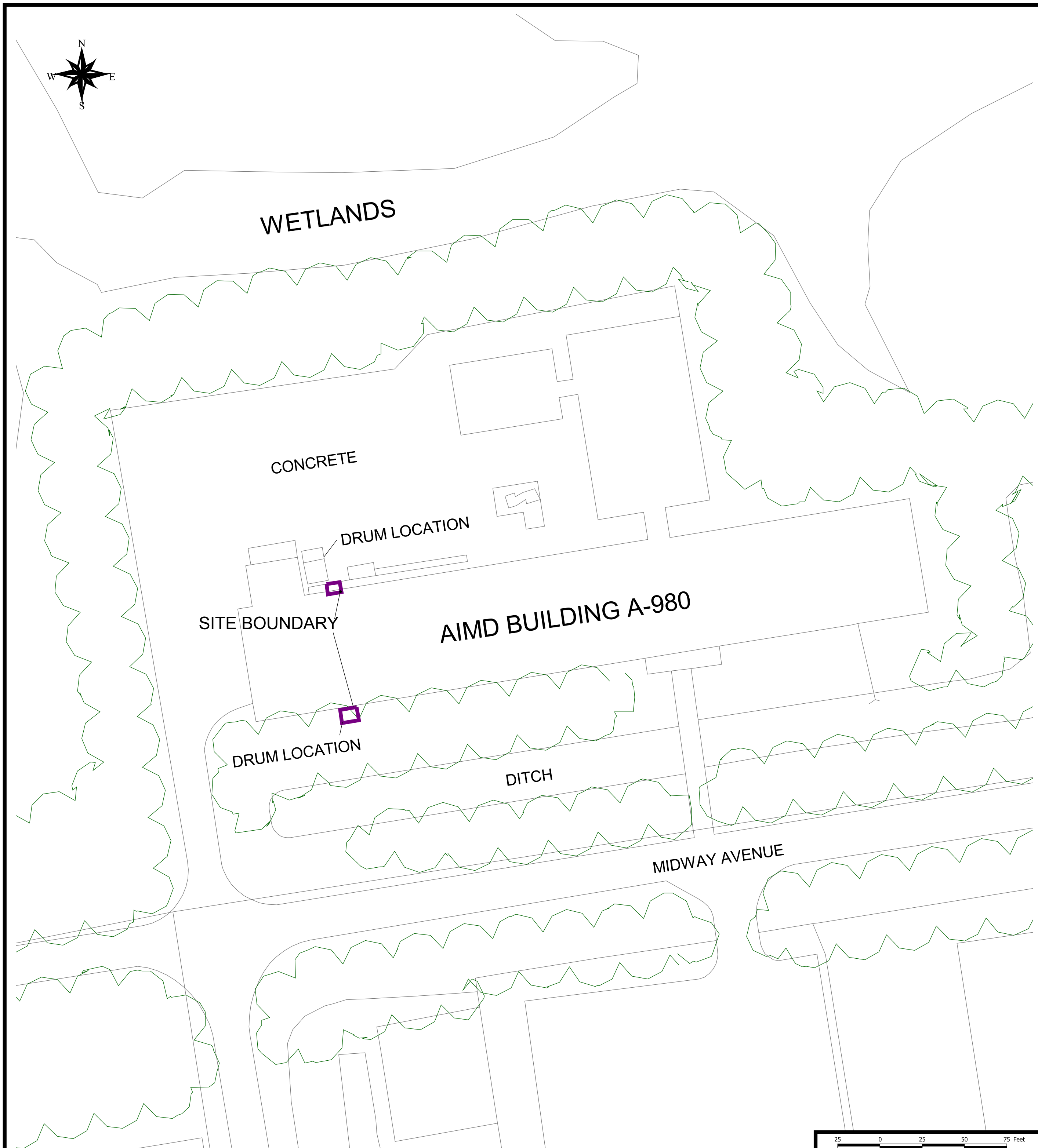
LUCs should remain in place at the site. Florida has recently proposed changes to Chapter 62-777, F.A.C. (Contaminant Cleanup Target Levels). After the new CTLs are promulgated, SWMU 4 should be evaluated for an NFA decision. There are no other recommendations or follow-up actions for SWMU 4.

5.8 PROTECTIVENESS STATEMENT

The remedy is expected to continue to be protective of human health and the environment.

5.9 NEXT REVIEW

The next five-year review for SWMU 4 is required by May 2009.



NO.	DATE	REVISIONS

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FIGURE NO. 5-1
REV. 0

FILE: K:\FIVE YEAR REVIEW.APR LAYOUT: FIGURE 5-1 SWMU 4 SITE LAYOUT DATE: 11/19/2004 BY: EHM

6.0 SWMU 5 – BOCA CHICA AIMD BUILDING A-990 SAND BLASTING AREA

This section describes the five-year review for SWMU 5, Boca Chica AIMD Building A-990 Sand Blasting Area.

6.1 HISTORY AND SITE CHRONOLOGY

A list of important SWMU 5 historical events and relevant dates in the site chronology is shown below. The identified events are intended to illustrative, rather than comprehensive.

Investigation/Activity	Date
Sand Blasting Operations	1970-1995
RFI/RI Report issued by IT Corporation	June 1994
Supplemental RFI/RI Report for Eight Sites issued by B&RE	January 1998
CMS Report for SWMU 5 prepared by TtNUS	March 1999
Statement of Basis SWMU 5 issued by TtNUS	February 1999
First year of Quarterly Performance Monitoring implemented by TtNUS	April 2000
Annual Performance Monitoring performed by TtNUS	Jan 2002
Annual Performance Monitoring performed by TtNUS	Jan 2003
RCRA CAMP (Rev. 4) prepared by TtNUS	July 2003
Annual Performance Monitoring conducted by REA	January 2004

6.2 BACKGROUND

6.2.1 Site Description

SWMU 5, Boca Chica AIMD Building A-990 Sand Blasting Area, is located at the western end of the airfield on Boca Chica Key (Figure 6-1). The sand blasting area was located between Buildings A-990 and A-989, and measured approximately 65 feet by 90 feet. Sand blasting residue was normally left on the ground or stockpiled for disposal. The area was historically used to sand blast “yellow gear” (the ground handling/ground support equipment for aircraft, i.e., moving vehicles and refueling tankers), aircraft parts, and various metal objects as needed by the facility from the early 1970s until 1995. Paint residues and other materials produced by the sand blasting of equipment, parts, and vehicles were potential sources of contamination (B&RE, 1998a).

Immediately south of the site is a concrete ditch that collects stormwater runoff from the AIMD area and transports it westward. The concrete ditch ends in a small grassy area approximately 300 feet west of the site. During heavy rainfall events, stormwater flows overland past this area to a shallow pond. The pond is connected to a culvert under a paved road to an extensive area of large lagoons south of the road. A large berm vegetated with grass, weeds, and Australian pines is located immediately south of the concrete ditch (B&RE, 1998a).

6.2.2 Summary of Sampling Results

In June 1984, the Navy collected soil and groundwater samples at SWMU 5. Phenol was detected in soil samples (IT, 1994). An RFI/RI was conducted in 1993 that included collection and analysis of soil, sediment, surface water, and groundwater from the site. The RFI/RI reported that cyanide exceeded the drinking water standard in groundwater. Surface water and sediment at the site appeared to be impacted by metals, attributed to leaching or transport of waste material from the sand sandblasting area into the ditch. The RFI/RI Report recommended additional sampling of the groundwater, surface water, and sediment, conducting an IRA to reduce migration of contamination, and performing a BRA based on post-IRA sampling data (IT, 1994). However, an IRA was not performed at SWMU 5 following the RFI/RI (B&RE, 1998a).

In 1996, additional sampling was performed as part of the Supplemental RFI/RI. Metals were the most frequent soil and sediment contaminants, but were detected at low concentrations. Metals associated with sandblasting activities (cadmium and chromium) were detected in groundwater and surface water, as well as arsenic, which is not normally associated with sandblasting.

6.2.3 Summary of Risk

A BRA and an ecological risk assessment were performed as part of the Supplemental RFI/RI for Eight Sites (B&RE, 1998a). The BRA determined that contaminants are present at concentrations indicating that adverse carcinogenic and non-carcinogenic health effects might occur for the hypothetical future resident. Arsenic was one of the largest contributors to the human health risk. The Supplemental RFI/RI for Eight Sites recommended that a CMS be conducted (B&RE, 1998a).

The ecological risk assessment concluded that potential risks to terrestrial receptors at SWMU 5 appear to be low (B&RE, 1998a).

6.3 REMEDIAL ACTIONS

6.3.1 Remedy Selection

The CMS determined that the appropriate remedy for SWMU 5 was Institutional Controls, consisting of LUCs with monitoring (TtNUS, 1999a). The LUCs were designed to eliminate or reduce exposure pathways by limiting site access. Additional information regarding the selection of LUCs with monitoring is documented in the Statement of Basis for SWMU 5 (TtNUS, 1999b).

6.3.2 Remedy Implementation

LUCs were developed through LUCIPs. These LUCs were designed to ensure protection of human health and the environment by restricting future site use and accessibility, educating NAS Key West personnel, and maintaining records of contamination. The LUCIP for SWMU 5 includes the placement and maintenance of signs around the site perimeter, which state that trespassing and dumping are not permitted at the site. Personnel from the NAS Key West Public Works Department are required to visually inspect SWMU 5 at least once every three months to ensure that LUCs are being implemented and properly maintained. The NAS Key West Public Works Department submits an annual report to FDEP describing the results of the quarterly inspections.

To implement the monitoring program at SWMU 5, groundwater, surface water, and sediment samples were collected quarterly for the first year. The quarterly monitoring began in April 2000 and was completed in January 2001. Groundwater monitoring was eliminated following the first year of monitoring because inorganic detections were consistently below action levels (TtNUS, 2001a). Sediment and surface water are currently being monitored annually.

6.3.3 System Operations and Maintenance

Seven sampling events have been conducted since April 2000. Four quarterly sampling events were conducted the first year (TtNUS, 2001a). Subsequent annual events took place in January 2002 and 2003 (TtNUS; 2002a, 2003a). Groundwater monitoring was discontinued after the first year of monitoring based on recommendations made in the Performance Monitoring Annual Report (TtNUS, 2001a). According to cost estimates obtained from the NAS Key West Public Works Environmental Department, the approximate annual cost for the long term monitoring and LUCs associated with the remedy at SWMU 5 is $4,700.

6.4 FIVE YEAR REVIEW PROCESS

6.4.1 Document Review

Reports and data from investigations conducted from 1994 through 2003 were reviewed for this five-year review, as discussed in Section 6.2.

6.4.2 Data Review and Evaluation

Concentrations of COCs identified in the Supplemental RFI/RI for Eight Sites were plotted to identify and evaluate trends across various investigations. COCs were identified in soil and sediment at SWMU 5. For COCs in sediment, the plots show concentrations over time for each monitoring location. Surface soil sampling and analysis were not included in the long-term monitoring plan. Therefore, surface soil graphs do not depict concentrations over time; rather concentrations are shown for each sample location. The graphs for sediment and surface soil also show the media-specific action level for each COC. The action levels, selected from several sources, were determined by the NAS Key West Partnering Team and are included in Appendix C.

6.4.2.1 Groundwater and Surface Water

No groundwater or surface water COCs were selected in the Supplemental RFI/RI or CMS. However, both media were included as part of the performance monitoring program. Groundwater was monitored quarterly for one year, but metals did not exceed action levels in groundwater for two consecutive quarters. Therefore, groundwater monitoring was discontinued (TtNUS, 2001a), and is not further evaluated in this report.

Surface water is currently being sampled at sediment locations to monitor any cross-contamination. A few analytes were sporadically detected at concentrations exceeding action levels during the first and second years of performance monitoring (TtNUS, 2001a; 2002a), but concentrations of all surface water analytes were less than action levels in January 2003, the most recent round of sampling for which data are available (TtNUS, 2003a).

6.4.2.2 Sediment

Sediment COCs identified in the Supplemental RFI/RI for Eight Sites for sediment include arsenic, beryllium, and chromium. However, beryllium has not been detected in sediment since 1993. Figures 6-2 and 6-3 depict trends for arsenic and chromium. The action level for arsenic has been revised since the Supplemental RFI/RI from 5.2 mg/kg to 7.24 mg/kg. No arsenic exceedances have occurred at the performance monitoring sampling locations. Chromium exceedances were identified in samples collected in 1993 and 1996, but chromium has not exceeded its action level since implementation of the performance monitoring program in April 2000, as shown in Figure 6-3. Because arsenic, beryllium, and chromium have not been detected above their action levels since 1996, they should not longer be considered COCs for sediment at SWMU 5.

Sediment samples are collected from two locations in the current performance monitoring program; Sample location S5SD-1 is at the north end of a culvert downgradient from SWMU 5, and sample location S5SD-2 is at the south end of the same culvert (Figure 6-1). Concentrations of five metals that were not previously identified as COCs in sediment have exceeded action levels during the three years of the performance monitoring program (TtNUS, 2001a; 2002a; 2003a). In sample S5SD-1, concentrations of aluminum, cadmium, lead, vanadium, and zinc have exceeded action levels in at least one of six monitoring events, and cadmium is the only analyte that has exceeded action levels in sample S5SD2 (see below).

Sample S5SD-1

Chemical	Action Level	# Exceedances in 6 sampling events	Range of Detected Values
Aluminum	2663.8 mg/kg	1	4,100 mg
Cadmium	0.676 mg/kg	5	0.73 – 4.4 mg/kg
Lead	34.2 mg/kg	2	36.3 – 45.4 mg/kg
Vanadium	10.4 mg/kg	3	10.6 – 14.3 mg/kg
Zinc	124 mg/kg	1	128 mg/kg

Sample S5SD-2

Cadmium	0.676 mg/kg	2	0.91 – 0.91 mg/kg

As can be seen in the above data summary, while some values have exceeded action levels in one or more sampling events, the exceedances have been relatively slight, with the exception of cadmium. Cadmium has been responsible for the most frequent action level exeedances, and for the greatest magnitude of exceedance. Its maximum concentration is approximately 6 times greater than its action level, which is an FDEP threshold effects level (TEL) (MacDonald, 1994). All cadmium concentrations have been less than the ER-M of 9.6 mg/kg (Long et al., 1995), but the maximum concentration did exceed the probable effects level (PEL) of 4.21 mg/kg (MacDonald, 1994). Cadmium was not detected in minnows collected from the shallow pool at S5SD-1 in 1996, even though cadmium sediment concentrations ranged from 2.3 to 17.9 mg/kg at that time (B&RE, 1998a). Since cadmium was not elevated in minnows at SWMU 5, potential cadmium-related risk is limited to benthic invertebrates. However, any potential risk to benthic invertebrates is limited to the relatively small area represented by sample S5SD-1. The pool in which this sample is located is approximately 150 feet long and 10 to 40 feet wide during periods of frequent rain, and is almost totally dry at other times (B&RE, 1998a). Cadmium in sample S5SD-2 has only slightly exceeded its action level in two performance monitoring sampling events; this sample is located at the off-site southern end of the culvert, and cadmium was detected at 0.91 mg/kg on both occasions (see table above). Thus, cadmium contamination does not extend into the lagoon south of the site.

In summary, arsenic, beryllium, and chromium have not been detected above their action levels since 1996, and they should not longer be considered COCs for sediment at SWMU 5. Concentrations of aluminum, lead, vanadium, and zinc have only slightly exceeded action levels during performance monitoring events. Cadmium concentrations in sample S5SD-1 have exceeded its action level in five of six performance monitoring events, and cadmium was detected at 1.4 mg/kg in the most recent sampling event (TtNUS, 2003a). All cadmium concentrations in performance monitoring samples have been within the range of values evaluated in the previous ecological risk assessment (B&RE, 1997), in which cadmium-related risk was determined to be low. Concentrations of no other analytes have exceeded action levels in six performance monitoring events.

6.4.2.3 Soil

Soil COCs identified in the Supplemental RFI/RI for SWMU 5 include arsenic and beryllium. The performance program at SWMU 5 did not include the sampling and analysis of soil samples since inorganic concentrations in soil are unlikely to change. Therefore, soil data are from samples collected in 1993 and 1996 only, as shown in Figure 6-4.

Arsenic exceeded its action level in 1996 at one location within the berm at SWMU 5 with a concentration of 13 mg/kg. The current industrial action level for arsenic is 3.7 mg/kg. The BRA performed in the Supplemental RFI/RI for Eight Sites identified arsenic as a main contributor to carcinogenic and non-carcinogenic risk for the hypothetical future resident. In addition, arsenic at one sample location was the main contributor to carcinogenic risk for current scenarios of adult and adolescent trespassers, maintenance worker, and occupational worker.

Beryllium was classified as a COC in the Supplemental RFI/RI in 1996, because it exceeded the action level of 0.15 mg/kg being used at that time. However, the current action level is 800 mg/kg. Therefore, beryllium should no longer be considered a COC at SWMU 5.

6.4.3 Site Inspection

The site has been inspected on numerous occasions during routine monitoring events. No significant issues have been identified regarding the site. Since access to the base is restricted, potential access by trespassers is minimal. In addition, warning signs are in place along the unfenced portion of the site perimeter, notifying base personnel that trespassing is not permitted at SWMU 5.

6.5 TECHNICAL ASSESSMENT

The Comprehensive Five-Year Review Guidance (EPA, 2001) states that the technical assessment section should answer three primary questions, each of which is presented below.

6.5.1 Question A

Is the remedy functioning as intended by the decision documents?

The remedy to protect human health and the environment is functioning as intended. SWMU 5 is located on an active military base, and access is restricted. NAS Key West personnel perform quarterly monitoring to ensure maintenance of LUCs and report annually to FDEP. In addition, warning signs are in place around the unfenced portion of the site perimeter notifying base personnel that trespassing is not permitted at SWMU 5.

6.5.2 Question B

Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of the remedy selection still valid?

There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. There has been no change to the standardized risk assessment methodology or toxicity data that could affect the protectiveness of the remedy. However, following conclusions presented in the Supplemental RFI/RI Report for Eight Sites, the action level selection process was revised by the NAS Key West Partnering Team as presented in the Site Investigation Work Plan for Ten BRAC Parcels (B&RE, 1998b). The current ARARs are included in Appendix C, along with the dates of the latest revisions, and method and selection for each medium. Values evaluated for each medium are listed in tables, along with the selected action level.

Updated action levels were compared to COCs for sediment and soil identified in the Supplemental RFI/RI Report for Eight Sites. Concentrations of all chemicals that were previously identified as COCs in sediment and soil are less than updated action levels. Five metals have been detected in sediment at concentrations greater than action levels. Concentrations of these metals do not appear to pose significant risk.

6.5.3 Question C

Has any other information come to light that could call into question the protectiveness of the remedy?

No new ecological receptors or human usage of the site were identified during performance monitoring or during the five-year review. No weather-related events have affected the protectiveness of the remedy. Hurricane Georges passed directly over Key West in September 1998, with maximum sustained winds near 100 mph on Boca Chica Key, but no erosion or other effects were visible at SWMU 5 as a results of the storm. There is no known information that calls into question the protectiveness of the remedy.

6.5.4 Technical Assessment Summary

Based on the data reviewed and the site inspections, the remedy is functioning as intended by the HSWA permit. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. There have been no significant changes to the standardized risk assessment methodology that could affect the protectiveness of the remedy. There is no other information that calls into question the protectiveness of the remedy.

6.6 ISSUES

There are no unresolved issues that could impact the remedy.

6.7 RECOMMENDATIONS AND FOLLOW UP ACTIONS

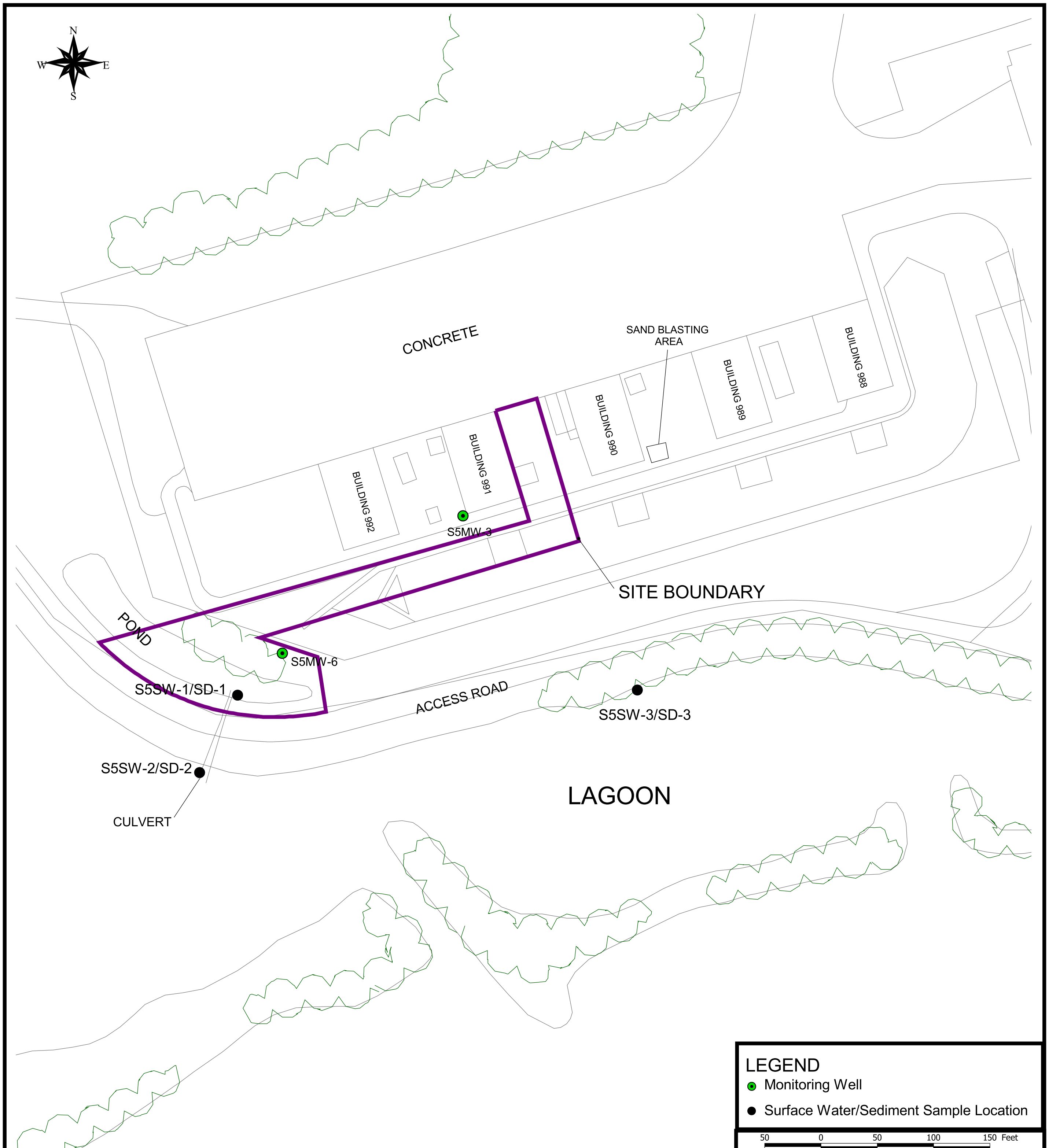
Because sediment COCs no longer exceed action levels at SWMU 5 and other sediment analytes have only slightly exceeded action levels and/or appear to pose negligible risk, long-term monitoring of sediment and surface water should be discontinued at SWMU 5. Surface water was included in the monitoring program to detect any cross contamination that may be occurring, and is therefore not necessary if monitoring of sediment is discontinued. LUCs should remain in place at the site.

6.8 PROTECTIVENESS STATEMENT

The remedy is expected to continue to be protective of human health and the environment.

6.9 NEXT REVIEW

The next five-year review for SWMU 5 is required by May 2009.



NO.	DATE	REVISIONS

DRAWN BY EHM DATE 11/17/2004
CHECKED BY SH DATE 11/18/2004
COST/SCHED-AREA
SCALE AS NOTED

SWMU 5 SITE LAYOUT
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

CONTRACT NO. 5327
APPROVED BY CMB DATE 11/23/2004
APPROVED BY SWMU 5 DATE
FIGURE NO. 6-1
REV. 0

FILE: K:\FIVE YEAR REVIEW.APR LAYOUT: FIGURE 6-1 SWMU 5 SITE LAYOUT DATE: 11/22/2004 BY: EHM

FIGURE 6-2

ARSENIC IN SEDIMENT
SWMU 5
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

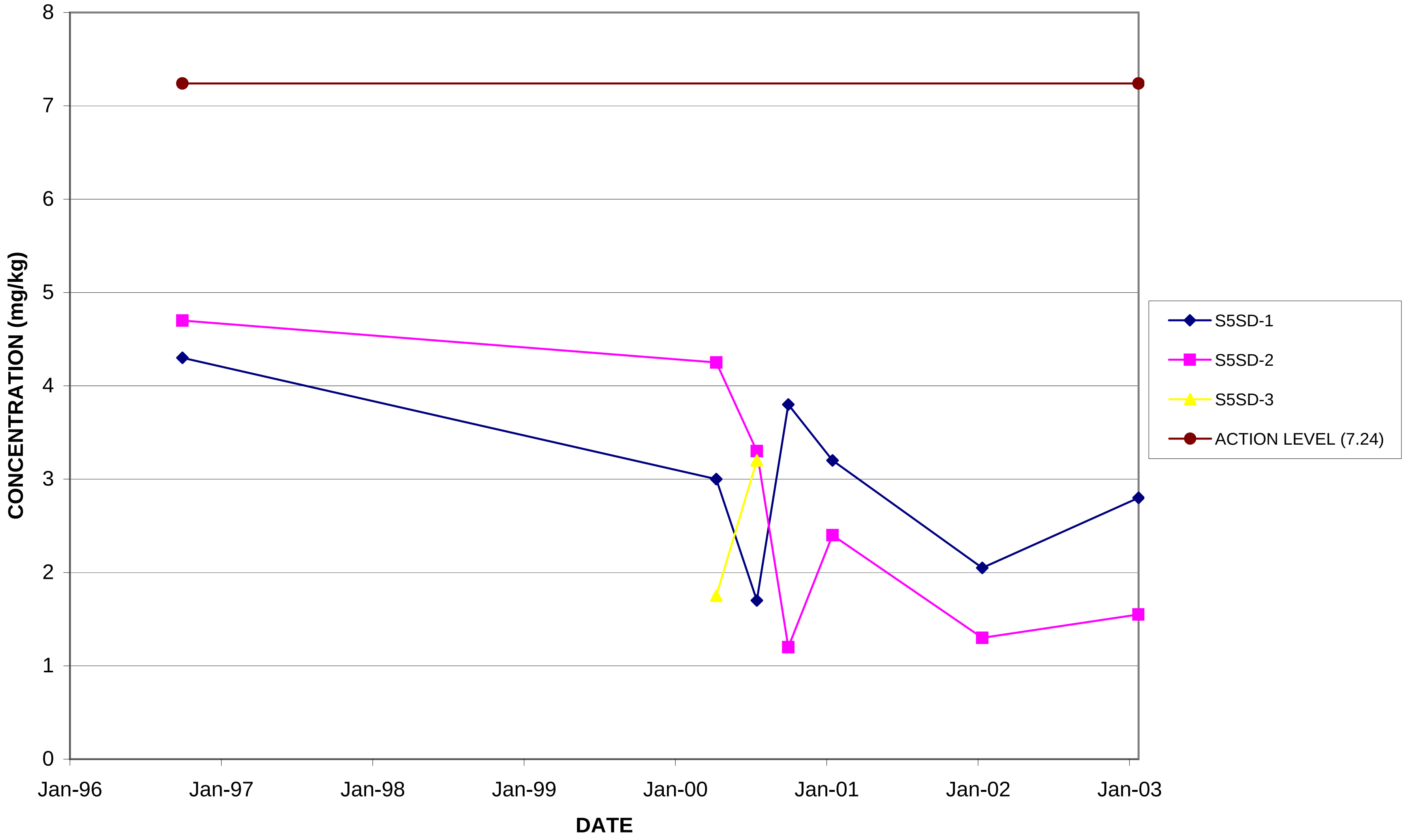


FIGURE 6-3

CHROMIUM IN SEDIMENT
SWMU 5
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

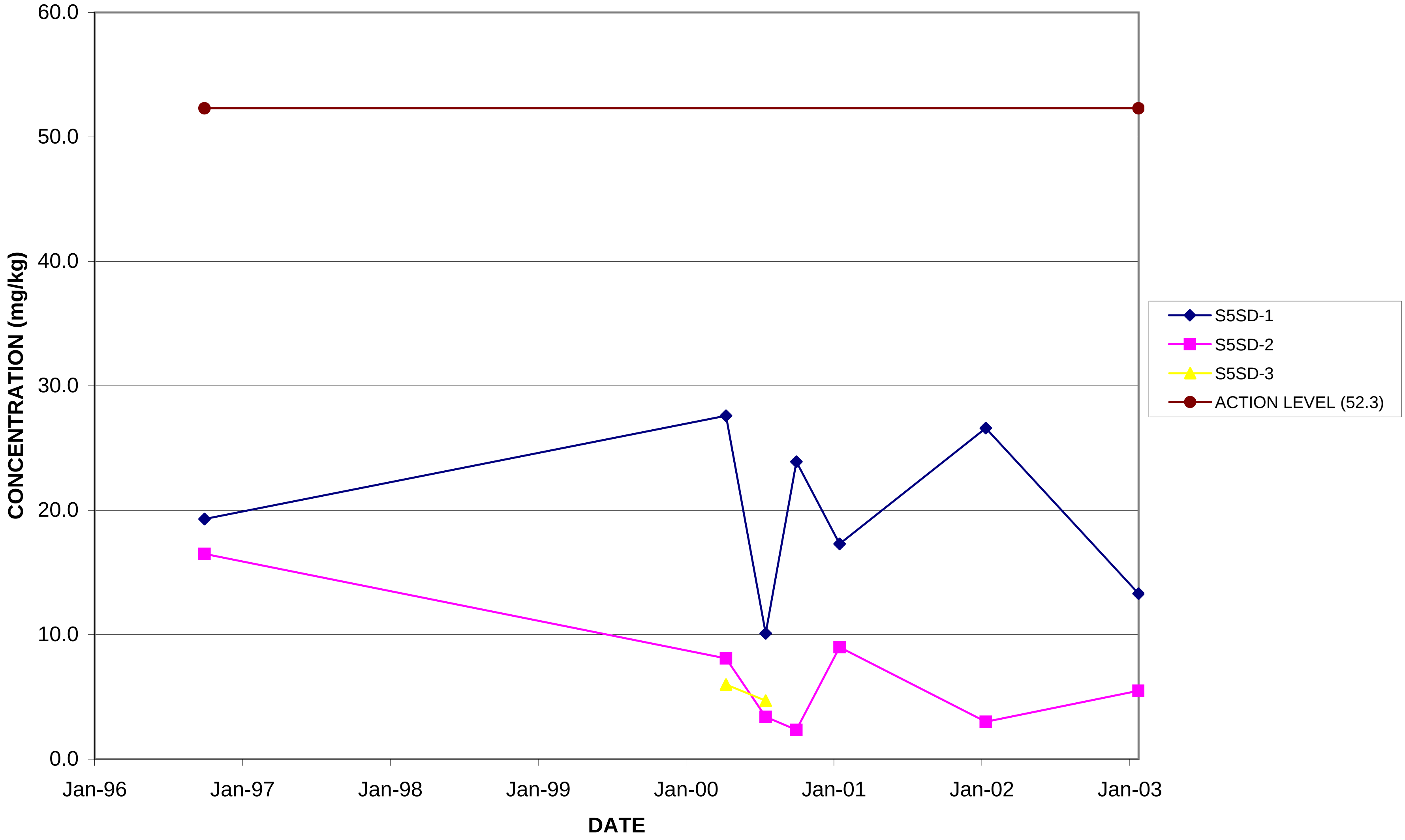
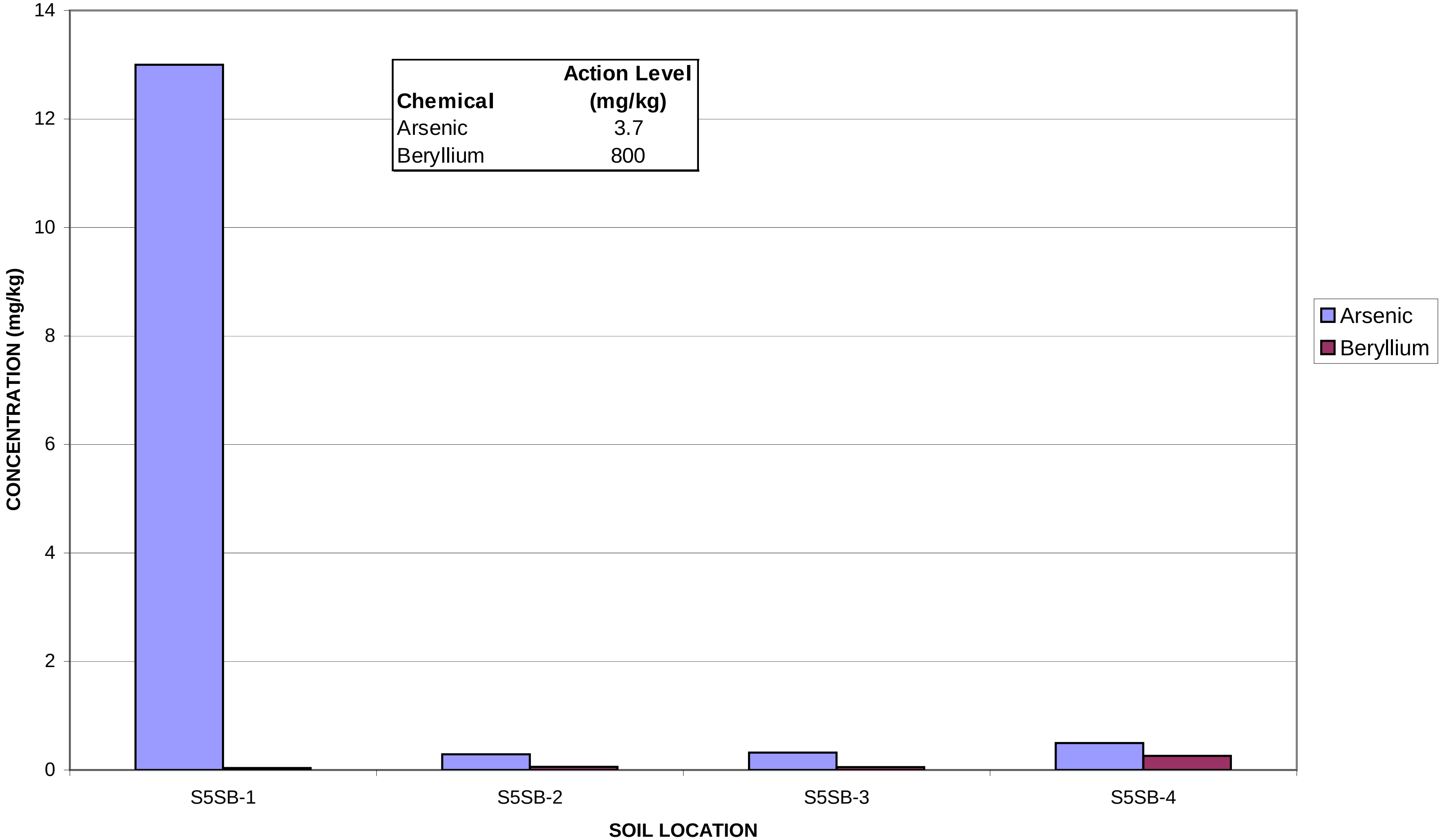


FIGURE 6-4

INORGANIC COCS IN SOIL
SWMU 5
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA



Chemical	Action Level (mg/kg)
Arsenic	3.7
Beryllium	800

Note: Soil data collected in 1993 and 1996.

7.0 SWMU 7 – BOCA CHICA TEMPORARY HAZARDOUS WASTE STORAGE AREA

This section describes the five-year review for SWMU 7, the Boca Chica Temporary Hazardous Waste Storage Area.

7.1 HISTORY AND SITE CHRONOLOGY

A list of important SWMU 7 historical events and relevant dates in the site chronology is shown below. The identified events are intended to be illustrative, rather than comprehensive.

Investigation/Activity	Date
VSI conducted by EPA as documented in the RFA Report	April 1988
Investigation and clean-up by Blasland, Bouck, and Lee, Inc. (BBL)	March 1991
RFI/RI Report issued by IT	June 1994
Delineation Sampling Report produced by BEI	November 1995
IRA excavation completed by BEI	October 1995
Supplemental RFI/RI Report for Eight Sites produced by B&RE	January 1998
CMS Report for SWMU 7 issued by TtNUS	March 1999
Statement of Basis for SWMU 7 issued by TtNUS	February 1999
First year of Quarterly Performance Monitoring implemented by TtNUS	April 2000
Annual Performance Monitoring conducted by TtNUS	January 2002
Annual Performance Monitoring conducted by TtNUS	January 2003
RCRA CAMP (Rev. 4) produced by TtNUS	July 2003
Annual Performance Monitoring conducted by REA	January 2004

7.2 BACKGROUND

7.2.1 Site Description

SWMU 7, the Boca Chica Temporary Hazardous Waste Storage Area, Building A-824, is located in the northern portion of Boca Chica Key, just north of U.S. Highway 1 (Figure 7-1). SWMU 7 consists of Building A-824 and a grassy area enclosed by a chain-link fence that surrounds the building. Two small ponds lie to the north and south of the site. The northern pond is approximately 30 feet by 30 feet in area and 3 to 4 feet deep. The southern pond is approximately 15 feet by 20 feet in area and 2 feet deep. A ditch extends southward from the northern pond to the southern pond approximately 150 feet south of

Building A-824. This ditch is approximately 18 inches deep and 18 inches wide. The ditch branches to the southwest at a point approximately midway between these two small ponds and terminates near a road around the perimeter of the area. The sediment in the ditch consists of material eroded from the limestone and fill material present at the site. Material used as fill at the site was brought in from Boca Chica Channel, Key West Harbor, or Flagler Railroad. Water in the ditch consists of runoff from the site and overflow from the northern pond (B&RE, 1998a). The building currently houses a solvent recovery operation and is used for storage of empty 55-gallon drums, old transformers, and other equipment.

Navy records and interviews indicated that Building A-824 was used in the past to store supplies and small electrical transformers, and served as a temporary staging area for 55-gallon drums of hazardous waste (IT, 1994). Base personnel indicated that transformer oil was occasionally dumped on the ground immediately north of Building A-824 (B&RE, 1998a).

7.2.2 Summary of Sampling Results

In 1991, Blasland, Bouck, and Lee, Inc (BBL) collected samples from sandbags stacked near Building A-824, soils around the building, and the floor of the building. After sampling, BBL performed a series of clean-up activities of the structure and surrounding area in March 1991 (B&RE, 1998a).

IT conducted soil, sediment, surface water, and groundwater sampling during the RFI/RI at SWMU 7 in 1993. Metals and hydrocarbons were detected in soils around the building. In addition, polychlorinated biphenyls (PCBs), pesticides, and metals were detected in sediment from the ditch to the west of the building. The RFI/RI Report recommended additional surface water and sediment sampling to delineate the extent of contamination, receptor identification to determine if ecological risks exist, and that a human health risk assessment be conducted (IT, 1994).

7.2.3 IRA

Following the RFI/RI, delineation sampling was performed by BEI in August 1995 to delineate PCB contamination in soil. The Remediation Work Plan for the contaminated soil was prepared in 1995 (BEI, 1995b). The IRA began August 1995 and was completed in October of that year. Approximately 26 cubic yards of soil were removed and disposed off-site. Confirmation sampling of soil was performed to determine the effectiveness of the removal. PCBs were left in place at the northern fence line near the pond, as well as at the building foundation. The excavation was backfilled with 39 tons of crushed stone to match the existing grade (BEI, 1998).

7.2.4 Summary of Risk

Following the IRA, B&RE performed the Supplemental RFI/RI for Eight Sites, including an ecological and human health risk assessment. The Supplemental RFI/RI concluded that existing conditions at SWMU 7 do not pose significant potential risks to ecological receptors. However, based on the calculated risks in the BRA to hypothetical future residents, trespassers, and occupational workers, the Supplemental RFI/RI recommended preparation of a CMS for SWMU 7 (B&RE, 1998a).

7.3 REMEDIAL ACTIONS

7.3.1 Remedy Selection

The CMS determined that the appropriate remedy for SWMU 7 was Institutional Controls, consisting of LUCs with monitoring (TtNUS, 1999c). The LUCs were designed to eliminate or reduce exposure pathways by limiting site access. Additional information regarding the selection of LUCs with monitoring as a remedy for SWMU 7 is provided in the CMS and summarized in the Statement of Basis for SWMU 7 (TtNUS, 1999d).

7.3.2 Remedy Implementation

LUCs were implemented through LUCIPs. These controls were designed to ensure protection of human health and the environment by restricting future site use and accessibility, educating NAS Key West personnel, and maintaining records of contamination. The LUCIP for SWMU 7 includes the placement and maintenance of signs around the perimeter which state that dumping and trespassing are not permitted at the site. Personnel from the NAS Key West Public Works Department are required to visually inspect SWMU 7 at least once every three months to ensure that all LUCs are being implemented and properly maintained. The NAS Key West Public Works Department submits an annual report to FDEP describing the results of the quarterly inspections.

To implement the monitoring program for this corrective measure, groundwater, surface water, and sediment samples were collected quarterly for the first year and annually thereafter. The quarterly groundwater monitoring began in April 2000 and was completed in January 2001 (TtNUS, 2001a). Additional annual events were performed in January 2002 and 2003 (TtNUS; 2002a, 2003a). Groundwater monitoring was eliminated following the first year of monitoring because inorganic detections were consistently below action levels (TtNUS, 2001a).

7.3.3 System Operations and Maintenance

Seven sampling events have been conducted since April 2000. Four quarterly sampling events were conducted the first year (TtNUS, 2001a). Subsequent annual events took place in January 2002 and 2003 (TtNUS; 2002a, 2003a). According to cost estimates obtained from the NAS Key West Public Works Environmental Department, the approximate annual cost for the long term monitoring and LUCs associated with the remedy at SWMU 7 is $3,100.

7.4 FIVE YEAR REVIEW PROCESS

7.4.1 Document Review

Reports and data from investigations conducted from 1991 through 2003 were reviewed for this five-year review, as discussed in Section 7.2.

7.4.2 Data Review and Evaluation

Concentrations of media-specific COCs identified in the Supplemental RFI/RI for Eight Sites and the CMS were plotted to identify and evaluate trends across various investigations. For COCs that were monitored in surface water and sediment, the plots show concentrations over time at each monitoring location. Chemicals that were detected in surface water and sediment during long term monitoring but not identified as COCs in the Supplemental RFI/RI and/or the CMS were not plotted in this report, but were evaluated and are discussed in their respective media-specific sections.

As explained in Section 7.3.2, groundwater monitoring was eliminated following the first year of monitoring. As a result, groundwater data are not plotted in this report. Surface soil sampling and analysis were not included in the long-term monitoring plan, so the surface soil plots do not show concentrations over time. Instead, the soil plots simply show data for individual samples typically collected only once at a particular sampling location. The plots for sediment, surface water, and soil also show the media-specific action level for each COC. The action levels that have been selected by the NAS Key West Partnering Team represent concentrations below which there is no potential for unacceptable risk to human health or the environment. The action levels were selected from several sources, and are included in Appendix C.

7.4.2.1 Surface Water

Antimony and beryllium were previously identified as COCs in surface water. However, beryllium has not been detected in surface water at performance monitoring locations since implementation of the performance monitoring program. Therefore, contaminant trends were not plotted for beryllium in surface water at SWMU 7. The action level for antimony has been revised from 67 to 4,300 μg/L since the selection of the COCs. As shown in Figure 7-2, concentrations of antimony in surface water have been significantly below the updated action level. Therefore, antimony and beryllium should be eliminated as surface water COCs at SWMU 7. Concentrations of a few metals that were not previously identified as COCs in surface water exceeded action levels in the first two years of the performance monitoring program, but concentrations of all surface water analytes were less than action levels in January 2003, the most recent round of sampling for which data are available (TtNUS, 2003a).

7.4.2.2 Sediment

Sediment COCs identified in the Supplemental RFI/RI for Eight Sites include arsenic, aroclor-1260, and benzo(b)fluoranthene. However, benzo(b)fluoranthene has not been detected at any sediment monitoring locations and therefore trends were not plotted. For arsenic, all concentrations at monitored locations have been below the updated action level of 7.24 mg/kg (Figure 7-3). For aroclor-1260, sediment concentrations have typically exceeded the action level at all sediment monitoring locations as shown in Figure 7-4. Because benzo(b)fluoranthene has not been detected in sediment at SWMU 7 and arsenic has consistently been below the action level, these chemicals should be eliminated as COCs.

Sediment concentrations of several metals have exceeded action levels in various samples; most commonly aluminum, cadmium, cobalt, copper, iron, lead, zinc, and pesticides (TtNUS, 2001a; 2002a; 2003a).

7.4.2.3 Soil

COCs identified in soil at SWMU 7 include antimony, arsenic, beryllium, aroclor-1260, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and indeno(1,2,3-cd)pyrene. However, the SVOCs, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and indeno(1,2,3-cd)pyrene have since been attributed to a fuel spill, and are currently being addressed under the petroleum program. Therefore, these SVOCs should be eliminated as COCs in soil at SWMU 7 because this contamination is not the result of operations at SWMU 7.

Soil data are available from 1993 for inorganics and 1993 and 1995 for aroclor-1260. Antimony, arsenic, and beryllium results are shown on Figure 7-5. Action levels for antimony and beryllium are significantly higher than those used during the Supplemental RFI/RI and concentrations detected in 1993 no longer exceed action levels. For arsenic, the action level has also increased but exceedances identified in the Supplemental RFI/RI remain valid.

The action level for aroclor-1260 has also increased since the Supplemental RFI/RI. However, concentrations of aroclor-1260 in confirmation samples collected next to Building A-824 and adjacent to the northern border of the fence exceed the current action level, as shown on Figure 7-6.

Because the SVOC exceedances identified in the Supplemental RFI/RI no longer apply to SWMU 7 and some inorganics do not exceed action levels due to updates, the following chemicals should be eliminated as soil COCs at SWMU 7: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, indeno(1,2,3-cd)pyrene, antimony, and beryllium. Remaining SWMU 7 soil COCs include arsenic and aroclor-1260.

7.4.3 Site Inspection

The site has been inspected on numerous occasions during routine monitoring events. No significant issues have been identified at any time regarding the site. Since access to the base is restricted, potential access by trespassers is minimal. In addition, warning signs are in place around the site perimeter, notifying base personnel that trespassing is not permitted at SWMU 7.

7.5 TECHNICAL ASSESSMENT

The Comprehensive Five-Year Review Guidance (EPA, 2001) states that the technical assessment section should answer three primary questions, each of which is presented below.

7.5.1 Question A

Is the remedy functioning as intended by the decision documents?

The remedy to protect human health and the environment is functioning as intended. SWMU 7 is located on an active military base, and access to the base is restricted. NAS Key West personnel perform quarterly monitoring to ensure adherence to LUCs, and an annual report is submitted to FDEP describing the results of the quarterly monitoring. In addition, warning signs are in place around the site perimeter, reducing the chance of trespassing and potential exposure of contaminated media to base personnel. There is no planned change in site usage for the foreseeable future.

7.5.2 Question B

Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of the remedy selection still valid?

There have been no changes in the physical conditions of the site that could affect the protectiveness of the remedy. There have been no significant changes to the standardized risk assessment methodology or toxicity data that could affect the protectiveness of the remedy. However, following conclusions presented in the Supplemental RFI/RI Report, the action level selection process was revised by the NAS Key West Partnering Team as presented in the Site Investigation Work Plan for Ten BRAC Parcels (B&RE, 1998a). The current ARARs are included in Appendix C, along with the dates of the latest revisions and the method of selection for each medium. Values evaluated for each medium are listed in tables, along with the selected action level.

Updated action levels were compared to COCs for surface water, sediment, and soil identified in the Supplemental RFI/RI Report for Eight Sites. These comparisons resulted in recommendations to eliminate several chemicals previously identified as COCs that do not exceed current action levels, as discussed in Section 7.4.2. Sediment concentrations of several metals and pesticides, however, have exceeded action levels in various samples.

7.5.3 Question C

Has any other information come to light that could call into question the protectiveness of the remedy?

No new ecological receptors or human usage of the site were identified during performance monitoring or during the five-year review. No weather related events have affected the protectiveness of the remedy. Hurricane Georges passed directly over the Key West are in September 1998, with maximum sustained winds near 100 mph on Boca Chica Key, but no erosion or other effects were visible at SWMU 7 as a result of the storm. There is no known information that calls into question the protectiveness of the remedy.

7.5.4 Technical Assessment Summary

Based on the data reviewed and the site inspections, the remedy is functioning as intended by the HSWA permit. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. There have been no significant changes to the standardized risk assessment methodology that could affect the protectiveness of the remedy.

7.6 ISSUES

There are no unresolved issues that could impact the remedy.

7.7 RECOMMENDATIONS AND FOLLOW UP ACTIONS

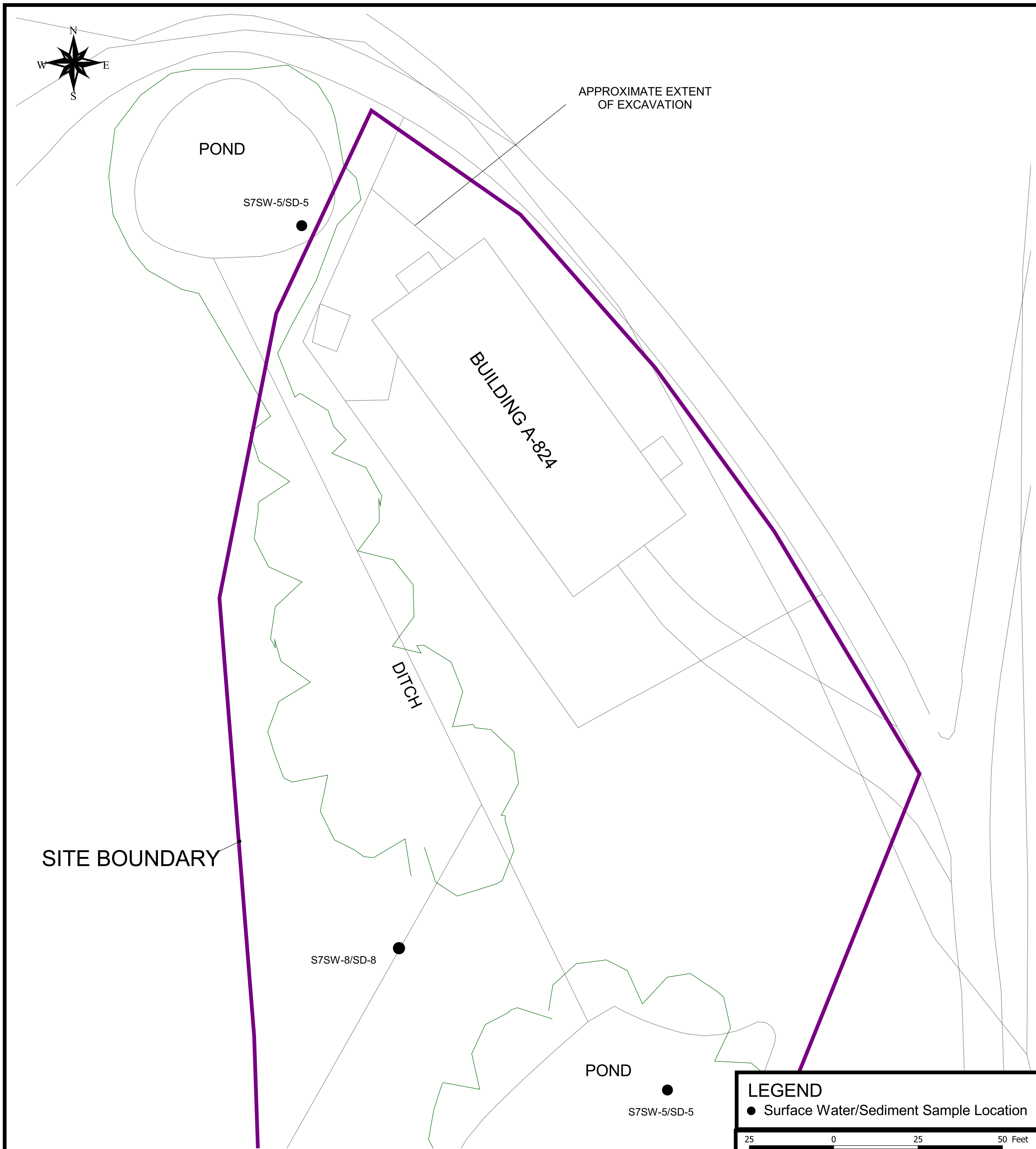
The LUCs and LUCIPs associated with the selected remedy should be continued. Sediment at SWMU 7 should continue to be monitored annually for metals, pesticides, and PCBs. Aroclor-1260 has consistently been detected above action levels in sediment. Metals and pesticides have also been detected above action levels in sediment, although not as consistently as Aroclor-1260. Surface water at SWMU 7 should also be sampled annually to monitor cross-contamination at the site.

7.8 PROTECTIVENESS STATEMENT

The remedy is expected to continue to be protective of human health and the environment.

7.9 NEXT REVIEW

The next five-year review for SWMU 7 is required by May 2009.



NO.	DATE	REVISIONS

DRAWN BY EHM DATE 11/17/2004
CHECKED BY SH DATE 11/18/2004
COST/SCHED-AREA
SCALE AS NOTED

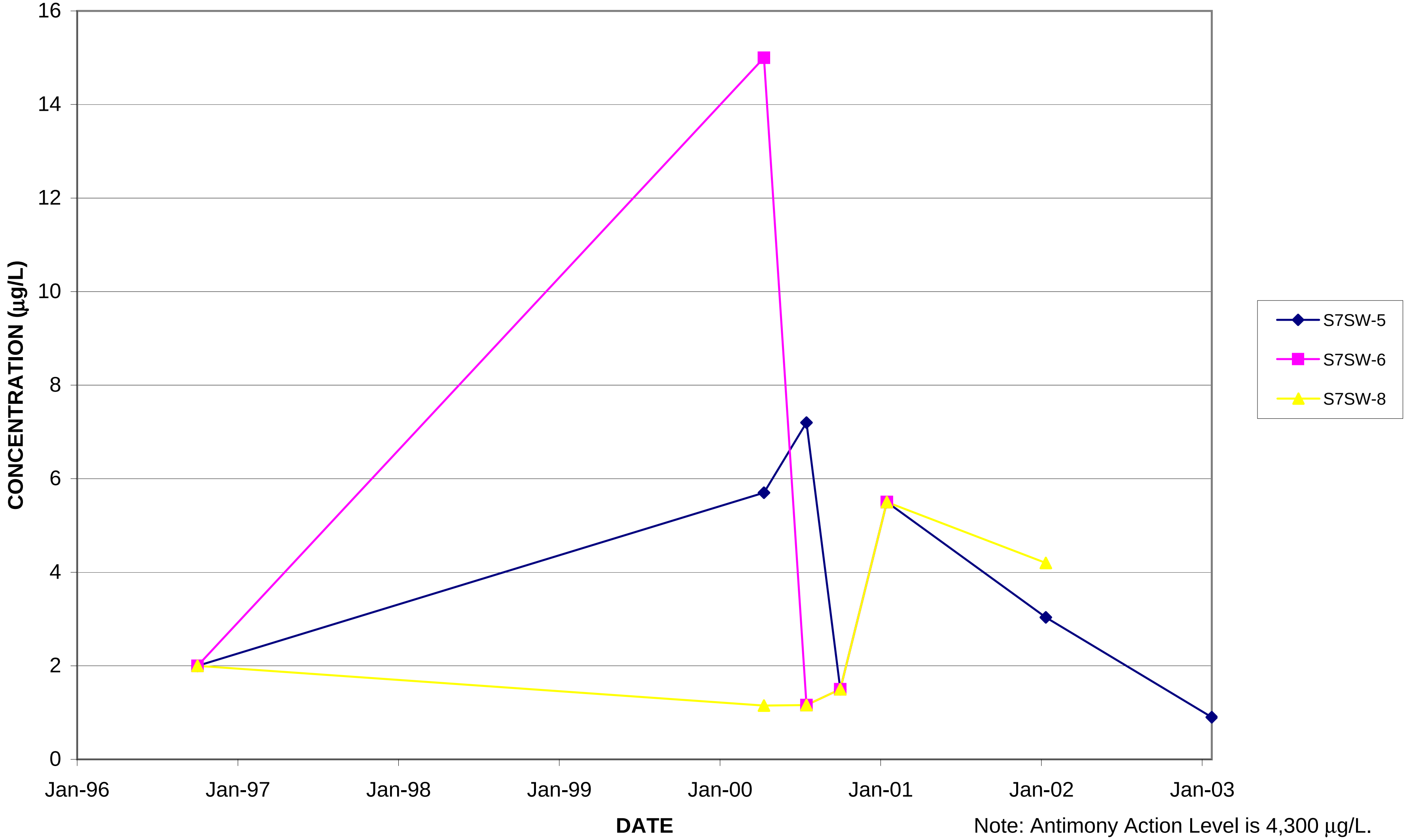
SWMU 7 SITE LAYOUT
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

CONTRACT NO. 5327
APPROVED BY CMB DATE 11/23/2004
APPROVED BY DATE
FIGURE NO. 7-1
REV. 0

FILE: K:\FIVE YEAR REVIEW.APR LAYOUT: FIGURE 7-1 SWMU 7 SITE LAYOUT DATE: 11/23/2004 BY: EHM

FIGURE 7-2

ANTIMONY IN SURFACE WATER
SWMU 7
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA



Note: Antimony Action Level is 4,300 µg/L.

FIGURE 7-3

ARSENIC IN SEDIMENT
SWMU 7
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

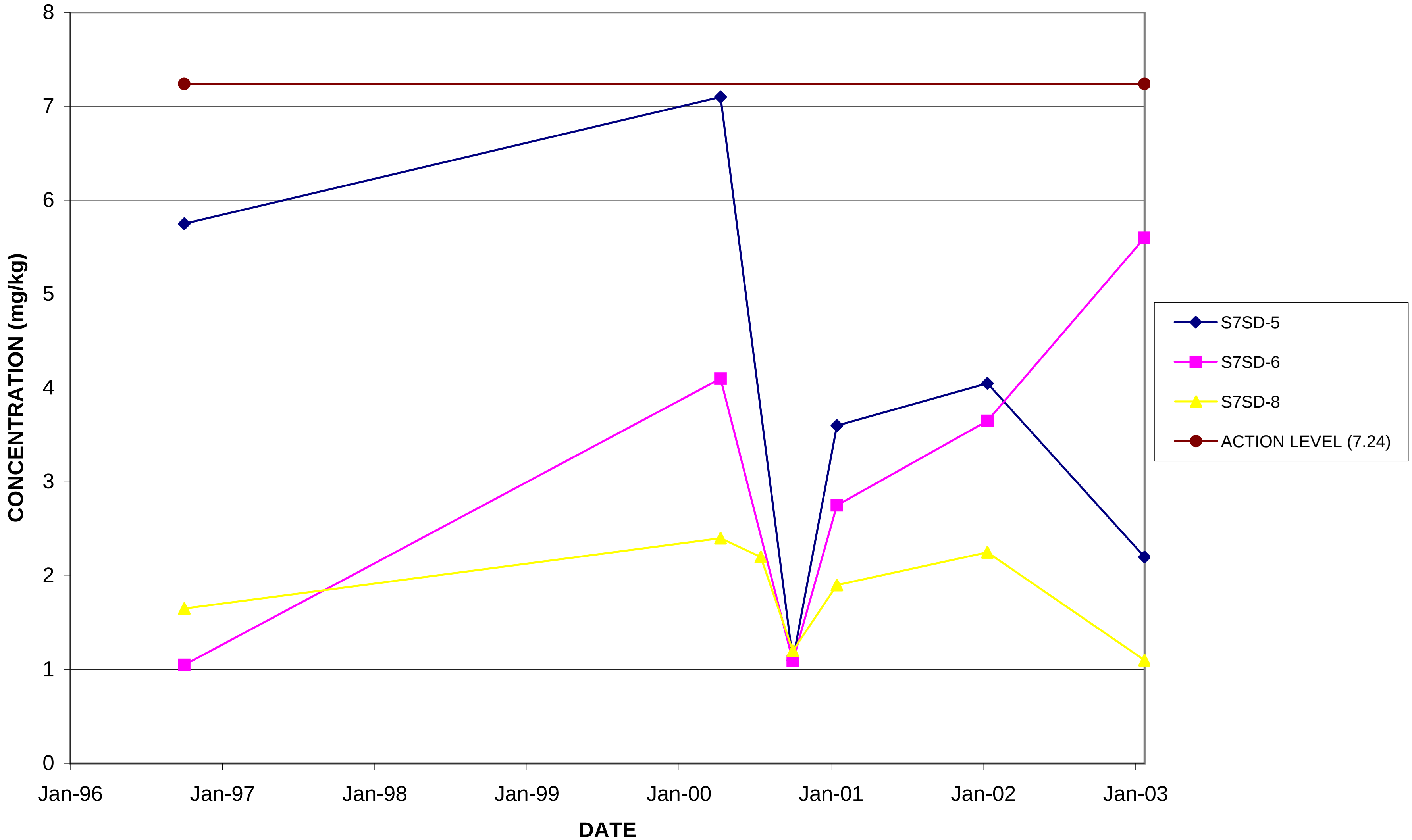


FIGURE 7-4

AROCLOR-1260 IN SEDIMENT
SWMU 7
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

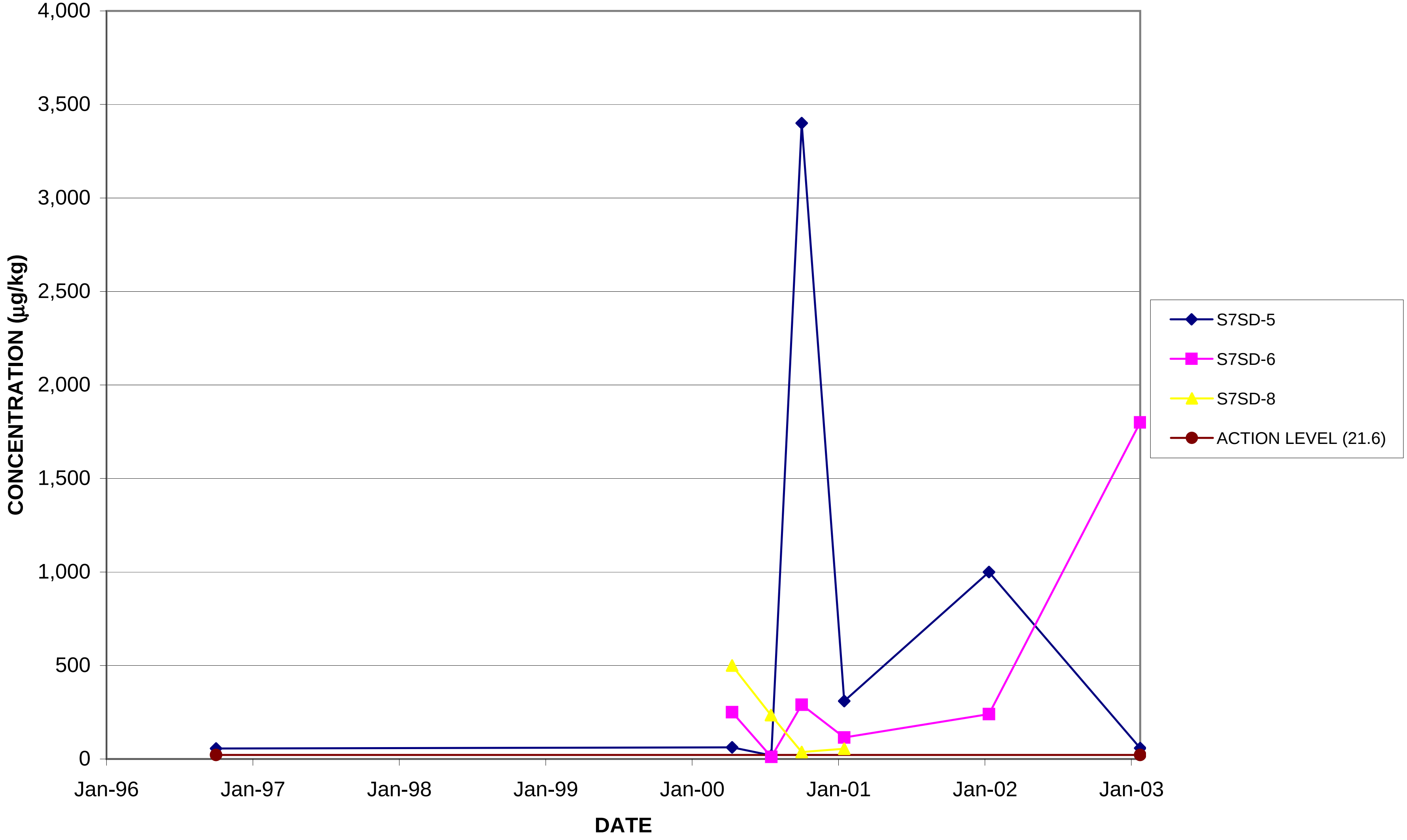
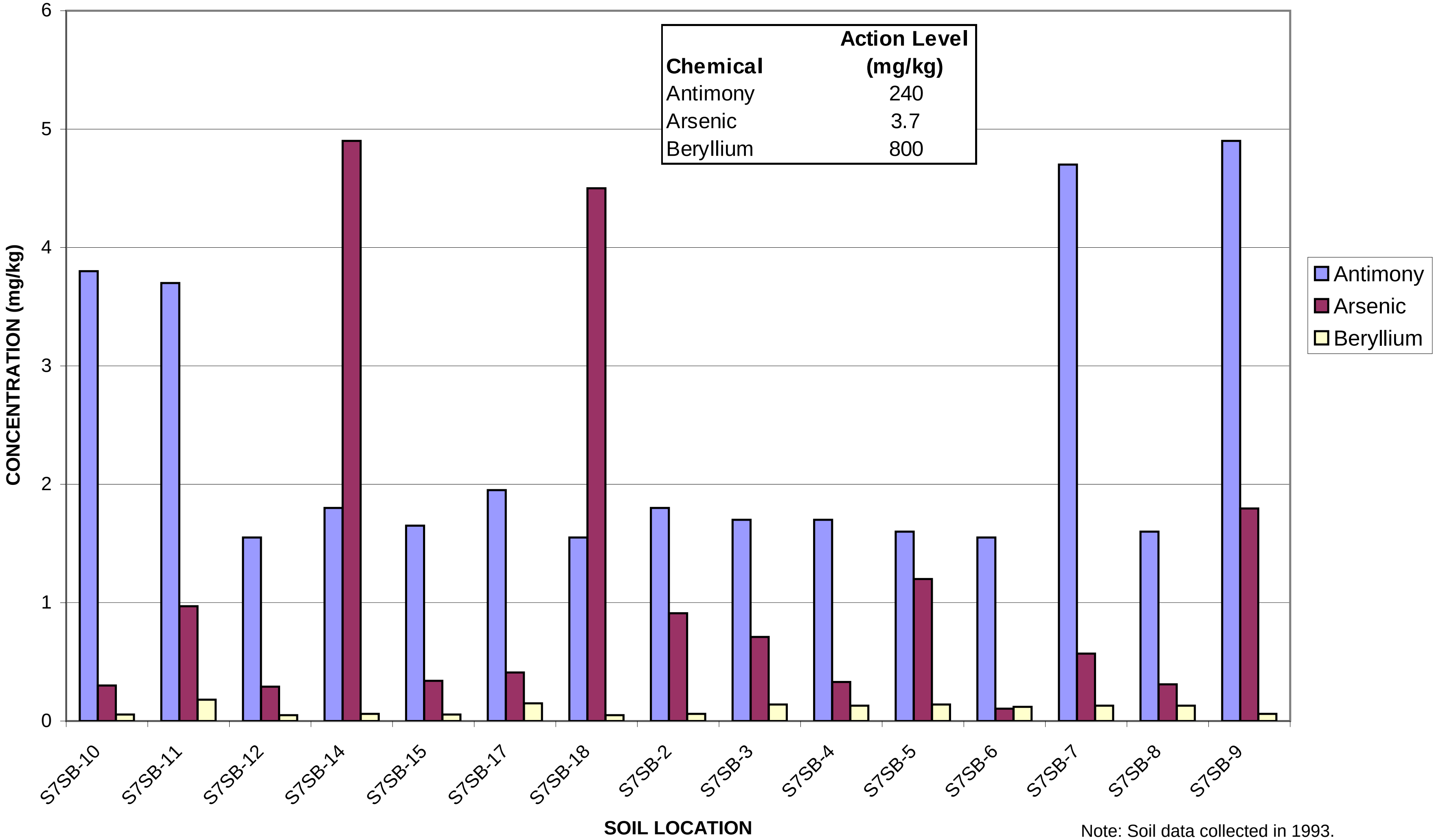


FIGURE 7-5

INORGANIC COCS IN SOIL
SWMU 7
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

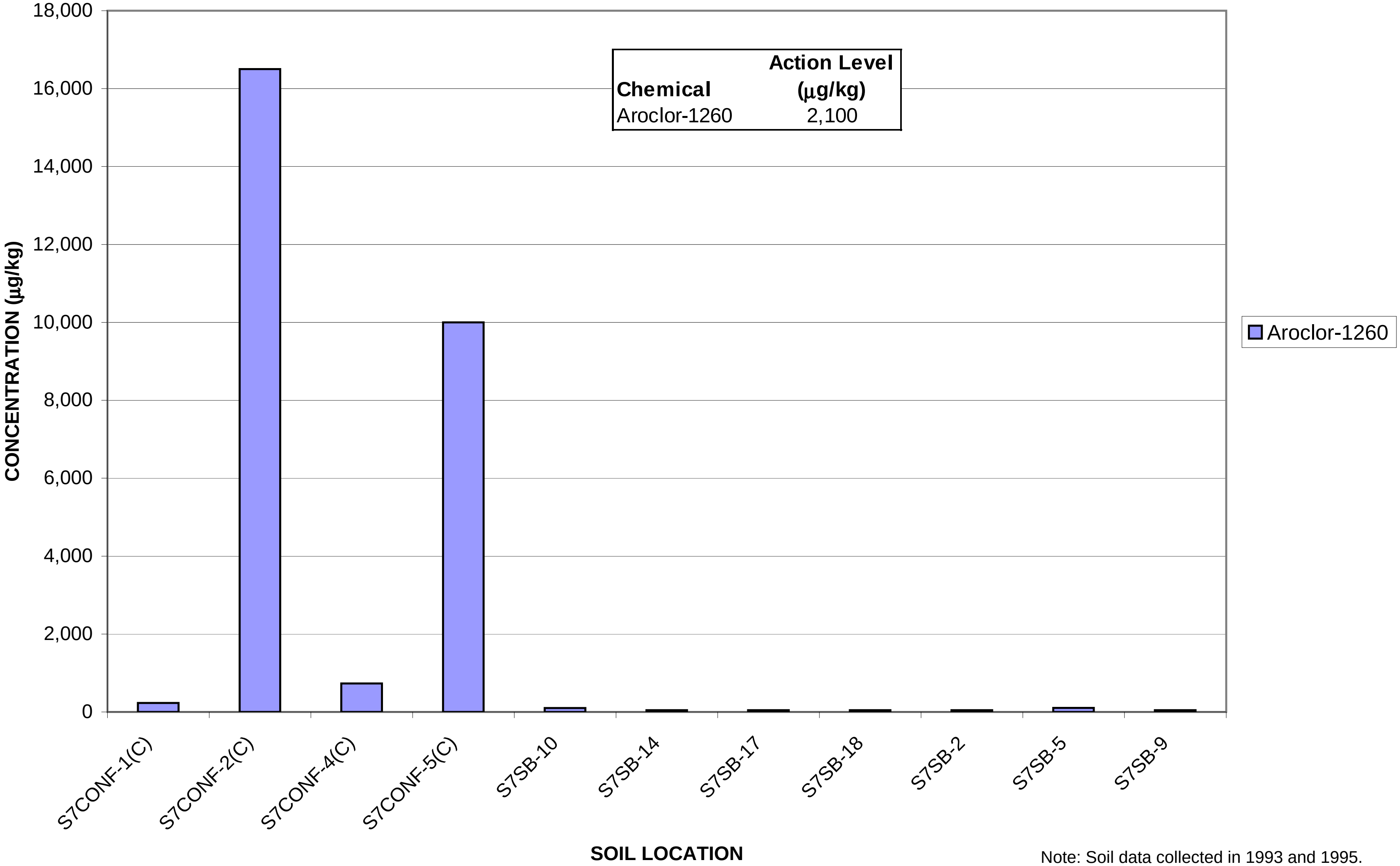


Chemical	Action Level (mg/kg)
Antimony	240
Arsenic	3.7
Beryllium	800

Note: Soil data collected in 1993.

FIGURE 7-6

AROCLOR-1260 IN SOIL
SWMU 7
NAVAL AIR STATION
KEY WEST, FLORIDA



Note: Soil data collected in 1993 and 1995.

8.0 SWMU 9 – BOCA CHICA JET ENGINE TEST CELL

This section describes the five-year review for SWMU 9, the Boca Chica Jet Engine Test Cell.

8.1 HISTORY AND SITE CHRONOLOGY

A list of important SWMU 9 historical events and relevant dates in the site chronology is shown below. The identified events are intended to be illustrative, rather than comprehensive.

Event	Date
SWMU 9 used for testing repaired jet engines	1969 to 1995
5,000-gallon AST used to fuel engines with JP-5 Fuel	1987 to 1995
Filter system leak spills 700 gallons of JP-5 Fuel	January 1989
Initial Remedial Action	January - February 1989
Overturned lube oil drum discovered by ABB Environmental Services, Inc. (ABB)	November 1992
Contamination Assessment Report issued by ABB	June 1994
Remediation Work Plan for Delivery Order No. 0004 issued by BEI	May 1995
Pump & Treatment System operated by BEI	July 1996 – June 1997
Supplemental RFI/RI Report for High-Priority Sites issued by B&RE	July 1997
Natural Attenuation Study results produced by TtNUS	August 1999
Corrective Measures Study Report produced by TtNUS	October 1999
Statement of Basis issued by TtNUS	February 2000
Baseline Groundwater Evaluation to support the Treatability Study performed by TtNUS	April 2000
ORC® and Hydrogen Release Compound (HRC®) injection performed by TtNUS	January 2001
Treatability Study Quarterly Monitoring implemented by TtNUS	July 2001
Pump & Treat Remediation System removed by CCI	March 2002
Annual groundwater sampling event performed by TtNUS	January 2003
RCRA CAMP (Rev. 4) issued by TtNUS	July 2003

8.2 BACKGROUND

8.2.1 Site Description

SWMU 9, the former Jet Engine Test Cell site, is located in the eastern portion of the Boca Chica airfield between a taxiway and inlet (Figure 8-1). The site, consisting of an area of approximately 0.5 acre, is relatively flat with grass and scrub brush cover. An inlet of Florida Bay is located north of the site and a narrow strip of red mangroves is located along the shoreline of the inlet. The site has been identified as Lower Keys marsh rabbit habitats.

Beginning in 1969, SWMU 9 was used for testing repaired jet engines. These engines were fueled with JP-5 from the bermed 5,000-gallon AST from 1987 through 1995. Organic solvents, ketones and trichloroethene (TCE), were reportedly used to clean jet engines and the engine test areas. When it was in use, this facility included a cradle for securing jet engines, a concrete pad, jet blast deflectors, ASTs storing jet fuel, and a storage shed (formerly an approved hazardous waste storage site). Engine testing activities were suspended in 1995 and most of the equipment was removed at that time. No other known activities have been conducted at the site (B&RE, 1997).

Two documented spills occurred at the former Jet Engine Test Cell. In January 1989, a fuel filter system leak resulted in the release of approximately 700 gallons of JP-5 fuel. Approximately 600 gallons were recovered by pumping free product during initial remediation activities. Following free product recovery, 10 cubic yards of contaminated soil were excavated and removed from the spill site. The second spill, in November 1992, involved an overturned lubrication oil drum. Stained soil was observed in a small area. Presumably, contamination from this spill was removed shortly after its discovery (B&RE, 1997).

8.2.2 Summary of Sampling Results

Fuels, oils, and solvents stored at SWMU 9 are potential sources of contamination. Chlorinated volatile organic compounds (VOCs) have been the most frequently detected groundwater contaminants, although they are not components of jet fuel. No documentation of solvent spills exists; however, the chlorinated VOCs most likely came from solvents used for cleaning and degreasing at the site (B&RE, 1997).

During the site investigation of the fuel spill, the groundwater was found to be contaminated by chlorinated solvents. Several investigations have taken place at SWMU 9 since 1993. Sampling events in 1993, 1994, 1995, and 1996 were performed at SWMU 9 to characterize constituent types and distributions. Groundwater contaminant plumes of benzene and 1,2-dichloroethene (DCE) were identified in the eastern part of the site. Benzene, toluene, ethylbenzene, and xylenes (collectively known as BTEX), naphthalenes, total recoverable petroleum hydrocarbons (TRPH), and several chlorinated VOCs were detected in the groundwater samples. TRPH and total naphthalenes concentrations exceeded Florida Groundwater Standards in the vicinity of the jet engine testing pad, while concentrations of 1,2-DCE and TCE exceeded their respective maximum contaminant levels in the vicinity of the storage shed. Low concentrations of these same VOC and SVOC contaminants were found in soil, but metals and inorganics were the primary soil contaminants. Surface water and sediment contaminants at the shoreline on the northern edge of the site also were predominantly metals and inorganics.

8.2.3 1996 IRA

A pump and treat groundwater remediation system was installed at SWMU 9 in 1996 to recover and treat groundwater impacted by chlorinated solvents. The system operated for one year, but did not recover any free product. The remediation system was removed in 2002 and site restoration activities were conducted in March 2003.

8.2.4 Summary of Risk

The estimated carcinogenic risks for future residents, adult trespassers, and adolescent trespassers are within EPA's target risk range of 1E-04 to 1E-06. The other use scenarios are well below the EPA target risk range. The calculated non-carcinogenic risk for future residents exceeded the benchmark of 1.0. Because of the borderline human health risks posed by contamination at the site, a CMS was recommended in the Supplemental RFI/RI for High-Priority Sites (B&RE, 1997).

The ecological risk assessment concluded that no current ecological hazard exists at SWMU 9. Ecological risks to terrestrial receptors posed by surface contaminants at the site were judged to be negligible due to the limited extent of contaminants in the soil. Migration of groundwater contaminants to the nearby inlet had not occurred based on benthic monitoring, but the potential of ecological risks from the contaminant migration to surface water and sediment exists (B&RE, 1997).

8.3 REMEDIAL ACTIONS

8.3.1 Remedy Selection

The CMS determined that the appropriate remedy for the SWMU 9 was Enhanced Biodegradation with Long-Term Monitoring. The remedy used a mixture of ORC® and HRC® to enhance the performance of naturally occurring microbes in biodegrading the contaminants in the groundwater (TtNUS, 1999e). The remedy is summarized in the Statement of Basis for SWMU 9 (TtNUS, 2000a).

8.3.2 Remedy implementation

Groundwater sampling was performed in April 2000 to determine ORC® and HRC® injection amounts and locations. Parameters sampled for during this event included VOCs, VOC degradation products (ethene, ethane, methane, carbon dioxide, and hydrogen), and geochemical parameters [dissolved oxygen (DO), alkalinity, sulfate, sulfide, hydrogen sulfide, and oxidation/reduction potential (ORP)] (TtNUS, 2000b).

The treatability study targeted the source areas of two groundwater contaminant plumes for enhanced biodegradation. The target for the ORC® injection was the petroleum hydrocarbon plume defined by historically elevated concentrations of dissolved benzene. The target for the HRC® injection was the source area for the chlorinated solvents plume defined by elevated concentrations of cis- and trans-1,2-DCE. ORC® and HRC® injection activities took place in January 2001. There were two objectives for this treatability study. The first objective was to determine the effectiveness of ORC® at reducing the contaminant concentrations within the petroleum-contaminated source area. This strategy relied on the release of DO to increase the microbial activity, thereby increasing contaminant reduction through aerobic respiration (TtNUS, 2000b). Approximately 330 pounds of ORC® were injected into the subsurface at SWMU 9 using direct-push technology (DPT) (TtNUS, 2001c). The second objective of the treatability study was to determine the effectiveness of HRC® at reducing the contaminant concentrations within the solvent-contaminated source area. This strategy relied on the increased dissolved hydrogen concentration to increase the reductive microbial activity, thereby decreasing contaminant concentrations through reductive dechlorination (TtNUS, 2000b). Approximately 3,660 pounds of HRC® were injected into the groundwater in different locations at SWMU 9. Following injection of the ORC® and HRC®, monitoring of groundwater was implemented (TtNUS, 2001c).

8.3.3 System Operations and Maintenance

Five sampling events have been conducted since July 2001. Four of the sampling events conducted quarterly between July 2001 and April 2002 (TtNUS, 2002b). The fifth sampling event occurred in January 2003 (TtNUS, 2003a). The estimated costs for the remedy are $51,000 capital; $15,500 to $60,500 operating ($/year); and $183,982 present worth (TtNUS, 1999e).

8.4 FIVE YEAR REVIEW PROCESS

8.4.1 Document Review

Reports and data from investigations conducted from 1983 through 2004 were reviewed for this five-year review, as discussed in Section 8.2.

8.4.2 Data Review

Concentrations of media-specific COCs identified in the CMS were plotted to identify and evaluate trends across various investigations. At SWMU 9, COCs were only selected for groundwater and include benzene, cis-1,2-DCE, trans-1,2-DCE, and TCE. Figures 8-2 through 8-5 present concentrations over time at each monitoring location.

In 1993, benzene was detected in monitoring well S9MW-5 at a concentration of 56 μg/L. Benzene was also detected in other monitoring wells on site, but at significantly lower levels. The benzene concentration in monitoring well S9MW-5 decreased from 56 μg/L in 1993 to 10 μg/L when sampled in April 2000 to establish baseline conditions. Following ORC® injection in January 2001, a slight increase in concentration was observed for the first two quarters of monitoring, followed by a decrease in concentration. The last measured concentration of benzene in monitoring well S9MW-5 was 3 μg/L in January 2003, above its action level of 1 µg/L, but below the baseline benzene concentration of 10 mg/L measured before the ORC® injection. Figure 8-2 presents contaminant trends for benzene in groundwater at SWMU 9.

Cis- and trans-1,2-DCE concentrations over time are shown on Figures 8-3 and 8-4, respectively. Historically, concentrations of cis- and trans-1,2-DCE have been highest in monitoring wells S9MW-14 and -15. Concentrations of cis- and trans-1,2-DCE decreased significantly following injection of HRC® in January 2001. A rebound of cis-1,2-DCE and trans-1,2-DCE was observed in January 2003 in one source well (S9MW-15) and one downgradient well (S9MW-22) in the chlorinated solvent plume area, but decreased from the previous event in April 2002. January 2003 VOC, natural attenuation, and geochemical results indicated that residual amounts of ORC® and HRC® remained in groundwater at the site, but were almost depleted. Overall, cis-1,2-DCE and trans-1,2-DCE concentrations have decreased significantly in groundwater at SWMU 9. However, the chlorinated solvent plume appeared to have migrated downgradient, based on an observed increase of cis-1,2-DCE and trans-1,2-DCE concentrations in some downgradient monitoring wells in January 2003.

TCE was selected as a COC in the CMS. However, as shown in Figure 8-5, the chemical has not exceeded its action level in recent monitoring. Therefore, it is recommended that TCE be eliminated as a COC at SWMU 9.

8.4.3 <u>Site Inspection</u>

The site has been inspected on numerous occasions during routine monitoring events. No significant issues have been identified at any time regarding the site. Since access to the base is restricted, potential access by trespassers is minimal. In addition, warning signs are in place around the site perimeter, notifying base personnel that trespassing is not permitted at SWMU 9.

8.5 TECHNICAL ASSESSMENT

The Comprehensive Five-Year Review Guidance (EPA, 2001) states that the technical assessment section should answer three primary questions, each of which is presented below.

8.5.1 Question A

Is the remedy functioning as intended by the decision documents?

The remedy, enhanced biodegradation with long-term monitoring, lowered chlorinated solvent and fuel contaminant concentrations significantly at SWMU 9. However, further evaluation of other treatability study options at the site is recommended to protect human health and the environment. Because the chlorinated solvent concentrations have not been completely degraded, and the HRC® injected at SWMU 9 is more than likely depleted by this time, alternative tractability study options should be evaluated.

8.5.2 Question B

Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of the remedy still valid?

There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. There have been no significant changes to the standardized risk assessment methodology or toxicity data that could affect the protectiveness of the remedy. The action level selection process has been revised since preparation of the Supplemental RFI/RI as presented in the Site Investigation Work Plan for Ten BRAC Parcels (B&RE, 1998b). The current ARARs are included in Appendix C, along with the dates of the latest revisions and method of selection for each medium. For SWMU 9, action levels for 1,2-DCE (total) and TCE have been updated, but these changes make no difference in groundwater COCs at the site.

8.5.3 Question C

Has any other information come to light that could call into question the protectiveness of the remedy?

As discussed in Section 8.5.1, the groundwater treatment selected as the remedy for the site did not successfully lower groundwater contaminant concentrations to below action levels. Therefore, further evaluation of other treatability study options at the site is recommended to protect human health and the environment. An additional investigation is planned to take place at SWMU 9 to further delineate contamination, and provide more information for evaluation of further treatment options (TtNUS, 2004).

8.5.4 Technical Assessment Summary

Based on the data reviewed and the site inspections, the remedy is not functioning to the extent it was intended. Additional remedial options should be considered to successfully protect human health and the environment.

8.6 ISSUES

Issues that may affect selection of an alternative remedy at the site include the classification of SWMU 9 as endangered species habitat for the Lower Keys marsh rabbit. SWMU 9 is also considered a wetland area. Consultations and/or permits from the U.S. Fish and Wildlife Service (FWS), FDEP, and the U.S. Army Corps of Engineers (COE) will be necessary to perform additional investigative and remedial work at SWMU 9.

8.7 RECOMMENDATIONS AND FOLLOW UP ACTIONS

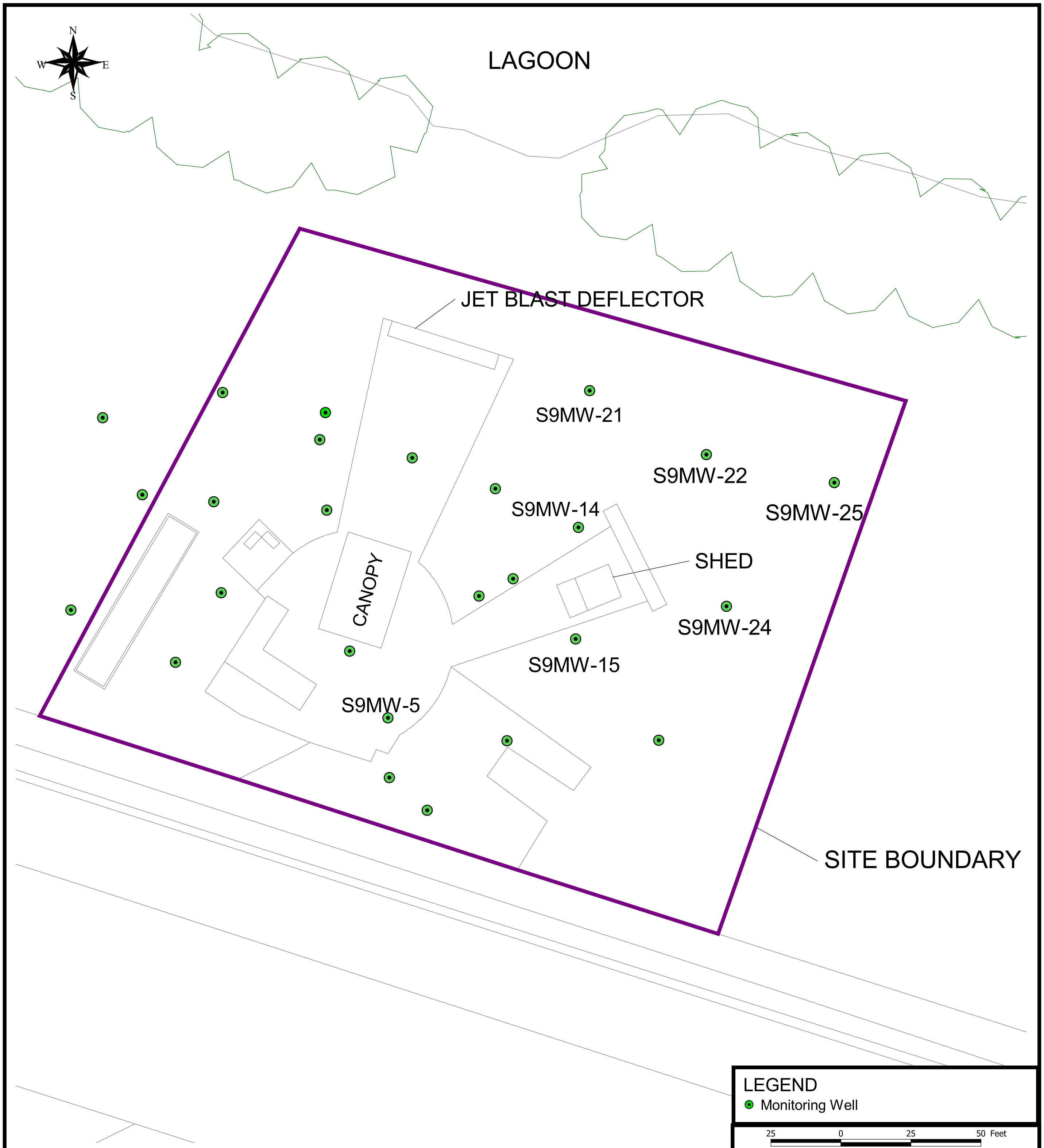
Additional investigation is recommended at SWMU 9 to further delineate groundwater at the site. The investigation will involve using a Membrane Interface Probe (MIP) and monitoring well installation to delineate soil and groundwater contamination. The objective of the investigation is to further characterize the nature and extent of contamination present at SWMU 9. Additional data collection is needed to better characterize the suspected source area and the extent of dissolved phase contaminants. Results of this investigation will be used to select and design an appropriate follow-on remedial measure at this site (TtNUS, 2004).

8.8 PROTECTIVENESS STATEMENT

Additional remedial action is necessary to maintain protectiveness of human health and the environment.

8.9 NEXT REVIEW

The next five-year review for SWMU 9 is required by May 2009.



NO.	DATE	REVISIONS

DRAWN BY: EHM — DATE: 11/17/2004
CHECKED BY: SH — DATE: 11/18/2004
COST/SCHED-AREA
SCALE: AS NOTED

SWMU 9 SITE LAYOUT
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

CONTRACT NO. 5327
APPROVED BY: CMB — DATE: 11/23/2004
APPROVED BY: ___ — DATE: ___
FIGURE NO. 8-1 — REV. 0

FILE: K:\FIVE YEAR REVIEW.APR LAYOUT: FIGURE 8-1 SWMU 9 SITE LAYOUT DATE: 11/19/2004 BY: EHM

FIGURE 8-2

BENZENE IN GROUNDWATER
SWMU 9
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

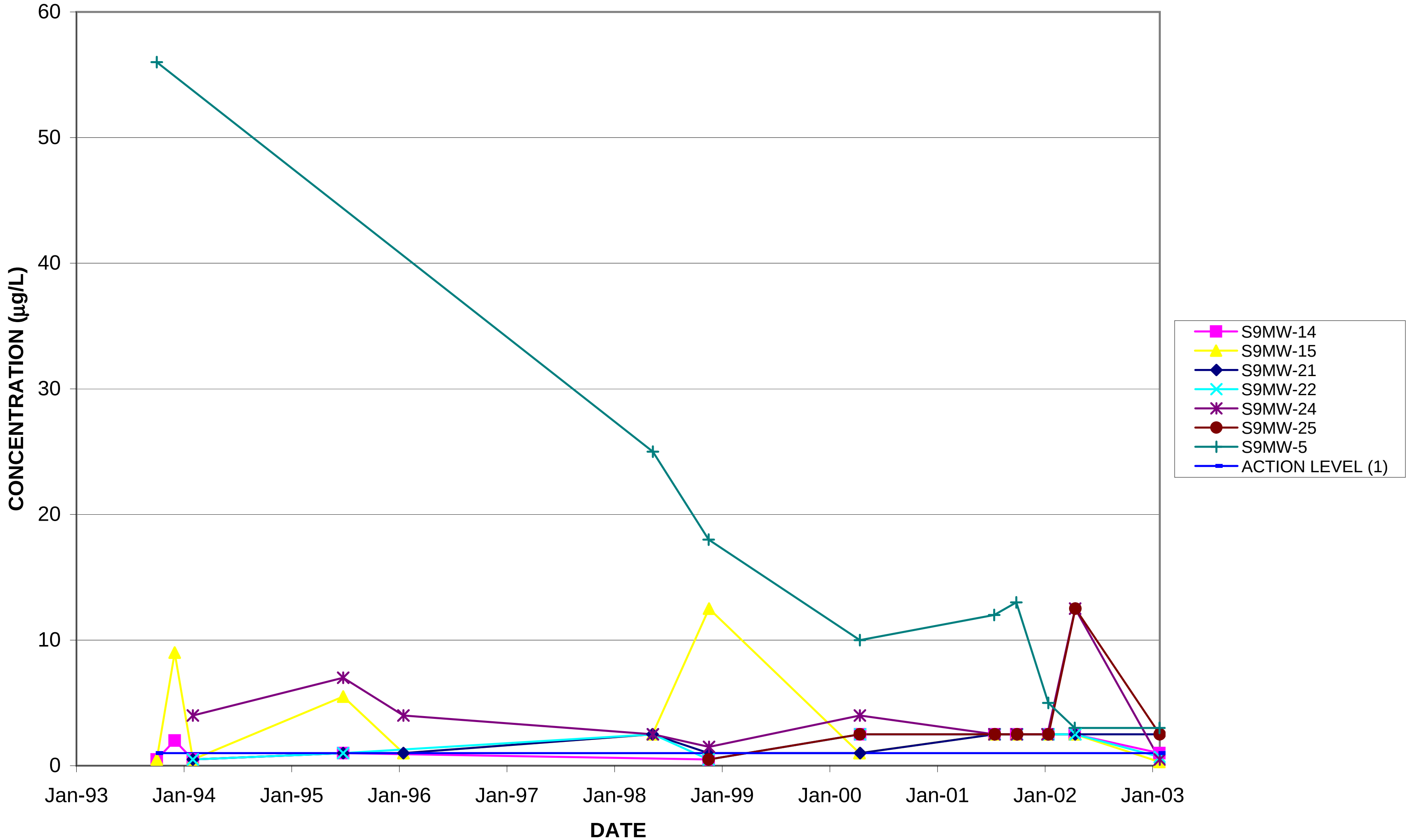


FIGURE 8-3

CIS-1,2-DCE IN GROUNDWATER
SWMU 9
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

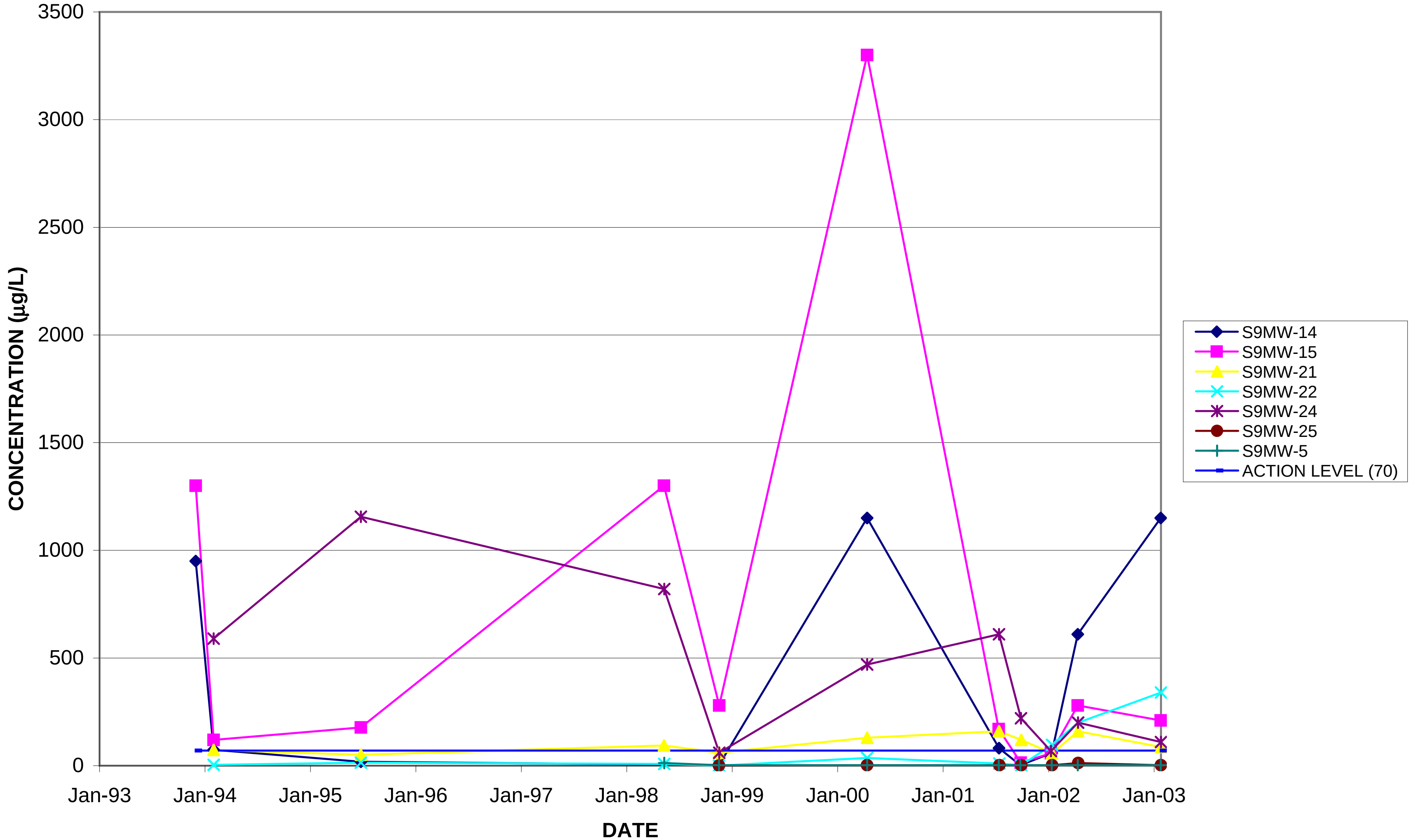


FIGURE 8-4

TRANS-1,2-DCE IN GROUNDWATER
SWMU 9
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

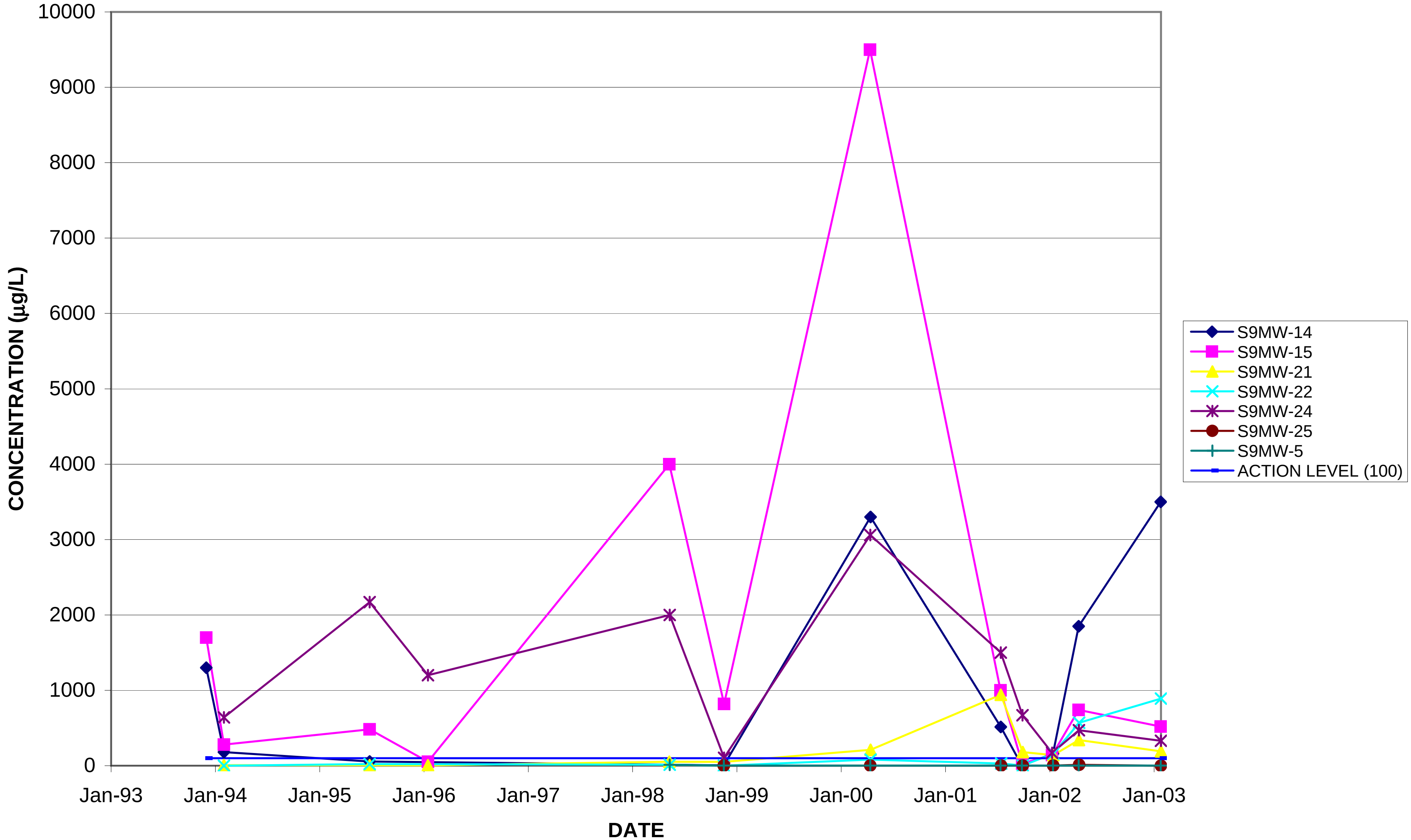
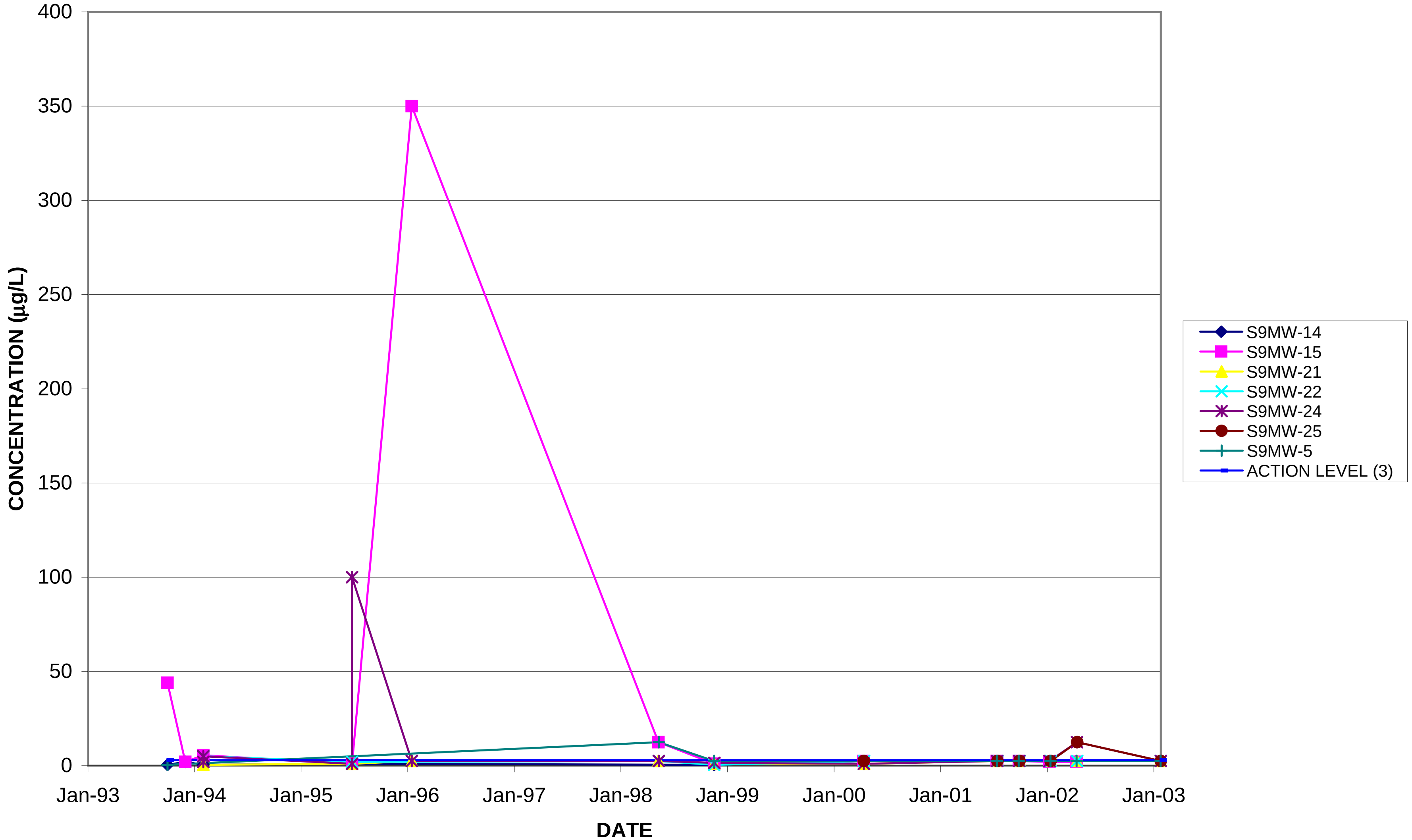


FIGURE 8-5

TCE IN GROUNDWATER
SWMU 9
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA



9.0 AOC B - BIG COPPITT KEY ABANDONED CIVILIAN DISPOSAL AREA

This section describes the five-year review for AOC B, the Big Coppitt Key Abandoned Civilian Disposal Area.

9.1 HISTORY AND SITE CHRONOLOGY

A list of important AOC B historical events and relevant dates in the site chronology is shown below. The identified events are intended to be illustrative, rather than comprehensive.

Investigation/Activity	Date
Navy purchased property	1985
IAS Report produce by Envirodyne Engineers, Inc.	May 1985
RFI/RI Report issued by IT	June 1994
Delineation Sampling Report issued by BEI	November 1995
IRA excavation completed by BEI	April 1996
Supplemental RFI/RI Report for Eight Sites issued by B&RE	January 1998
Proposed Plan issued by TtNUS	October 1998
Decision Document for IR 3, IR7, and AOC B issued by TtNUS	April 1999

9.2 BACKGROUND

9.2.1 <u>Site Description</u>

The Big Coppitt Key Abandoned Civilian Disposal Area is located east of the NAS Key West airfield on Big Coppitt Key (Figure 9-1). The Navy purchased the property in 1985 to comply with Federal Aviation Administration (FAA) requirements for an Aircraft Compatibility Usage Installation Zone. The site encompasses approximately 10 acres, of which approximately 1.6 acres are occupied by a dead end canal. At the southeastern end of the site is the former disposal area used by civilians for discarded automobile body and frame parts. A mangrove wetland extends to the east, west, and south of the former disposal area. The canal and a large cleared area are located north of the former disposal area. The ground elevations at the site vary from sea level to approximately 2 feet above sea level. All runoff from precipitation appears to drain directly into the canal and into the mangrove wetlands (B&RE, 1998a).

9.2.2 Summary of Sampling Results

An RFI/RI was performed in 1993 by IT Corporation. Groundwater, surface water, sediment, and soil at AOC B were investigated. Analytical results indicated metal concentrations above background in all media, and PCBs were detected in surface water. The RFI/RI Report recommended an IRA to remove waste from the site or prevent further contact between the waste and surface water and sediment. Installing groundwater monitoring wells to determine groundwater flow direction and delineate the extent of groundwater contamination was also recommended, along with a potable water well survey, an ecological receptor survey, and baseline human health risk assessment, and additional sediment sampling (IT, 1994).

9.2.3 1996 IRA

In 1996, BEI performed an IRA, removing 1,251 cubic yards of soil. Trash and debris were also removed from the site. Confirmation samples were collected from the excavated area to verify the removal of the impacted soil. The area was backfilled with organic substrate material until the ground surface contours matched the existing wetlands elevations (BEI, 1998).

9.2.4 Summary of Risk

Following the IRA, a Supplemental RFI/RI was performed that included a BRA and an ecological risk assessment. Metals and pesticides were the most frequently detected contaminants at AOC B. PCBs were detected in isolated surface water and sediment samples. VOCs and SVOCs were rarely detected in any medium. The BRA concluded that contaminants were present at sufficient levels to cause possible adverse non-carcinogenic health effects to future residential receptors. The ecological risk assessment concluded that contaminants may pose potential risks to benthic organisms. However, it was determined that remediation of sediments at AOC B would not improve the quality of the benthic habitat and could resuspend contaminants in water, potentially increasing their bioavailability. The Supplemental RFI/RI Report for Eight Sites recommended that a no further action (NFA) decision document be prepared for AOC B, with the provision that a future residential scenario be prevented by institutional controls (B&RE, 1998a).

9.3 REMEDIAL ACTIONS

9.3.1 Remedy Selection

Because the risk assessment demonstrated that AOC B was not appropriate for unrestricted use and unrestricted exposure, LUCs are in place at the site. The selected remedy, LUCs, is summarized in the Proposed Plan for AOC B (TtNUS, 1998e) and documented in the Decision Document for IR 3, IR 7, and AOC B (TtNUS, 1999f).

9.3.2 Remedy Implementation

LUCs were developed through LUCIPs. These controls were designed to ensure protection of human health and the environment by restricting future site use and accessibility, educating NAS Key West personnel, and maintaining records of contamination. The LUCs documented in the NAS Master Plan prevent future residential use at this site. In addition, access to AOC B is restricted, since the site is on an active military base with no planned change in site usage for the foreseeable future. Furthermore, personnel from the NAS Key West Public Works Department are required to visually inspect AOC B on a quarterly basis to ensure that all LUCs are being implemented and properly maintained. The NAS Key West Public Works Department submits an annual report to FDEP describing the results of the quarterly inspections.

9.3.3 System Operations and Maintenance

According to cost estimates obtained from the NAS Key West Public Works Environmental Department, the cost associated with the selected remedy is approximately $1,500 per year.

9.4 FIVE YEAR REVIEW PROCESS

9.4.1 Document Review

Because the selected remedy was LUCs, a document review for AOC B is not applicable.

9.4.2 Data Review and Evaluation

Because the selected remedy was LUCs, no analytical data have been generated since the Supplemental RFI/RI for Eight Sites (B&RE, 1998a). However, COCs for AOC B were selected in Supplemental RFI/RI and include arsenic and iron in sediment and antimony in surface water. Concentrations of these COCs were plotted to identify and evaluate trends across the various investigations. The plots show concentrations over time, as well as the media-specific action level for each COC. The action levels are concentrations that have been selected by the NAS Key West Partnering Team as representing concentrations below which there is no potential for unacceptable risk to human health or the environment. The action levels were selected from several sources and are included in Appendix C.

9.4.2.1 Surface Water

Antimony in surface water was identified as a COC in the Supplemental RFI/RI for Eight Sites. Figure 9-2 shows surface water results for two sampling events in March 1993 and October 1996. The action level for antimony in surface water has changed from 67 to 4,300 μg/L since preparation of the Supplemental RFI/RI. Antimony in surface water no longer exceeds the action level and should be eliminated as a COC.

9.4.2.2 Sediment

The screening value for arsenic has been revised since preparation of the Supplemental RFI/RI from 5.2 to 7.24 mg/kg, resulting in some detections previously identified as exceedances that no longer exceed the action level. However, one arsenic detection in the latest sampling event (September 1996) exceeded the updated action level, as shown in Figure 9-3. The majority of iron detections in sediment exceed the updated action level because it has been lowered significantly since preparation of the Supplemental RFI/RI (from 23,000 to 2,398 mg/kg). Figure 9-4 shows contaminant trends for iron in sediment. Both arsenic and iron should remain COCs in sediment at AOC B.

9.4.3 Site Inspection

The site has been inspected on numerous occasions since the last sampling in 1996. No significant issues have been identified. Since access to the site is restricted, trespassing is minimal.

9.5 TECHNICAL ASSESSMENT

The Comprehensive Five-Year Review Guidance (EPA, 2001) states that the technical assessment section should answer three primary questions, each of which is presented below.

9.5.1 Question A

Is the remedy functioning as intended by the decision documents?

The remedy is functioning as intended. Access to AOC B is restricted. NAS Key West personnel perform quarterly monitoring to ensure adherence to LUCs, and an annual report is submitted to FDEP describing the results of the quarterly monitoring. There is no planned change in site usage for the foreseeable future.

9.5.2 Question B

Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of the remedy selection still valid?

There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. There have been no significant changes to the standardized risk assessment methodology or toxicity data that could affect the protectiveness of the remedy. However, subsequent to preparation of the Supplemental RFI/RI Report, the action level selection process was revised by the NAS Key West Partnering Team as presented in the Site Investigation Work Plan for Ten BRAC Parcels (B&RE, 1998b). The current ARARs are included in Appendix C, along with the dates of the latest revisions and method of selection for each medium. Values evaluated for each medium are listed in tables, along with the selected action level.

The current action levels in Appendix C were compared to concentrations of COCs detected in AOC B sediment and surface water samples evaluated in the Supplemental RFI/RI Report for Eight Sites.

In sediment, changes to action levels have resulted in fewer exceedances of the action levels for arsenic, but more for iron. Because exceedances still exist for both chemicals, they should remain as COCs in sediment at AOC B. However, antimony detections in surface water at AOC B no longer exceed the current action level. Therefore, antimony should be eliminated as a COC in surface water, resulting in sediment being the only medium at AOC B where COCs remain.

9.5.3 Question C

Has any other information come to light that could call into question the protectiveness of the remedy?

No new ecological receptors or human usage of the site have been identified for AOC B. No weather related events have affected the protectiveness of the remedy. There is no known information that calls into question the protectiveness of the remedy.

9.5.4 Technical Assessment Summary

Based on the data reviewed and the site inspections, the remedy is functioning as intended by the Decision Document. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. There have been no significant changes to the standardized risk assessment methodology that could affect the protectiveness of the remedy. There is no other information that calls into question the protectiveness of the remedy.

9.6 ISSUES

There are no unresolved issues that could impact the remedy.

9.7 RECOMMENDATIONS AND FOLLOW UP ACTIONS

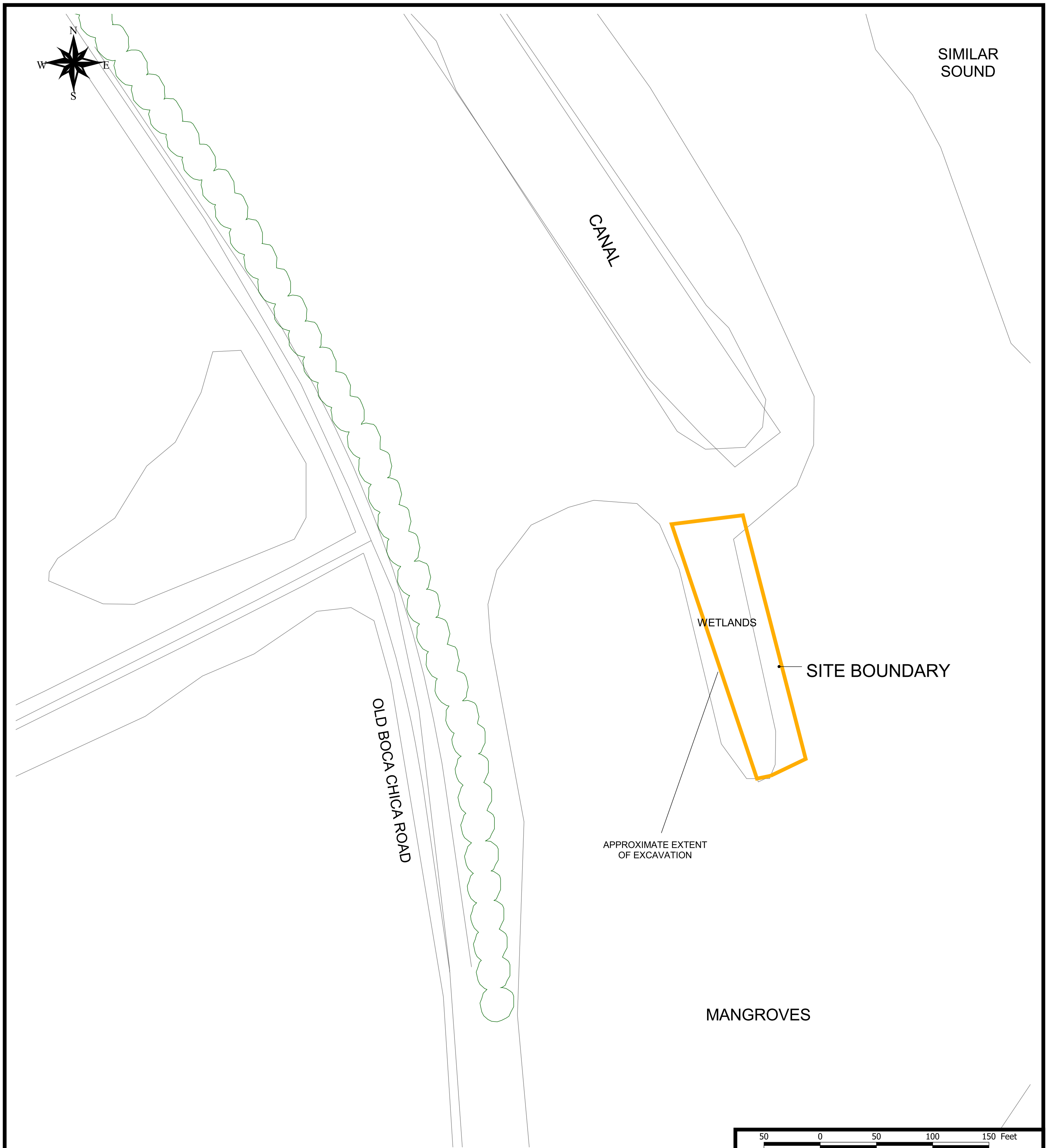
LUCs should remain in place at the site. Florida has recently proposed changes to Chapter 62-777, F.A.C. (Contaminant Cleanup Target Levels). After the new CTLs are promulgated, AOC B should be evaluated for an NFA decision. There are no other recommendations or follow-up actions for AOC B.

9.8 PROTECTIVENESS STATEMENT

The remedy is expected to continue to be protective of human health and the environment.

9.9 NEXT REVIEW

The next five-year review for AOC B is required by May 2009.



NO.	DATE	REVISIONS

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COST/SCHED-AREA
SCALE AS NOTED

NAVAL AIR STATION KEY WEST FLORIDA

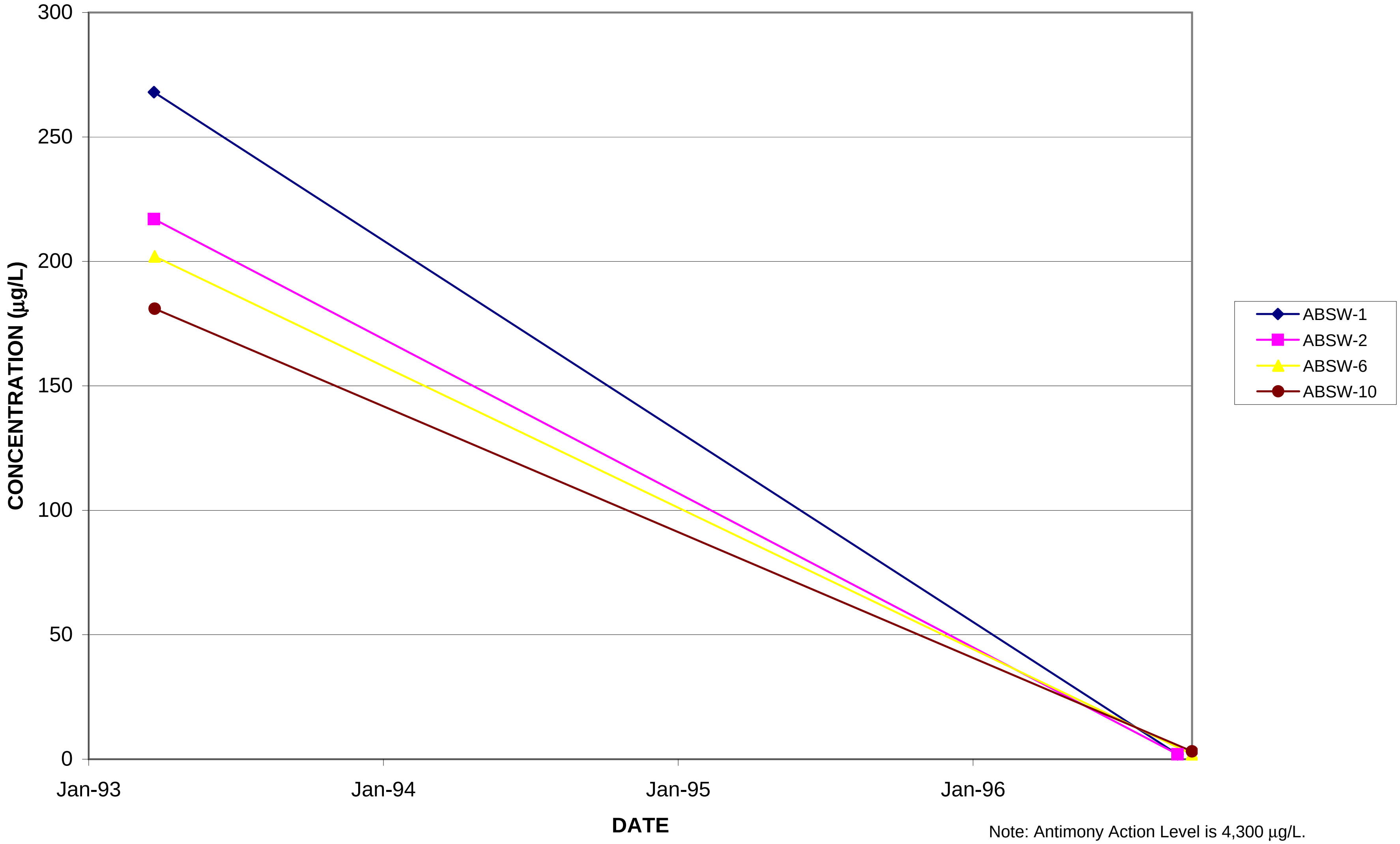
AOC B SITE LAYOUT
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

CONTRACT NO. 5327
APPROVED BY CMB DATE 11/23/2004
APPROVED BY DATE
FIGURE NO. 9-1
REV. 0

FILE: K:\FIVE YEAR REVIEW.APR LAYOUT: FIGURE 9-1 AOC B SITE LAYOUT DATE: 11/19/2004 BY: EHM

FIGURE 9-2

ANTIMONY IN SURFACE WATER
AOC B
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA



Note: Antimony Action Level is 4,300 µg/L.

FIGURE 9-3

ARSENIC IN SEDIMENT
AOC B
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

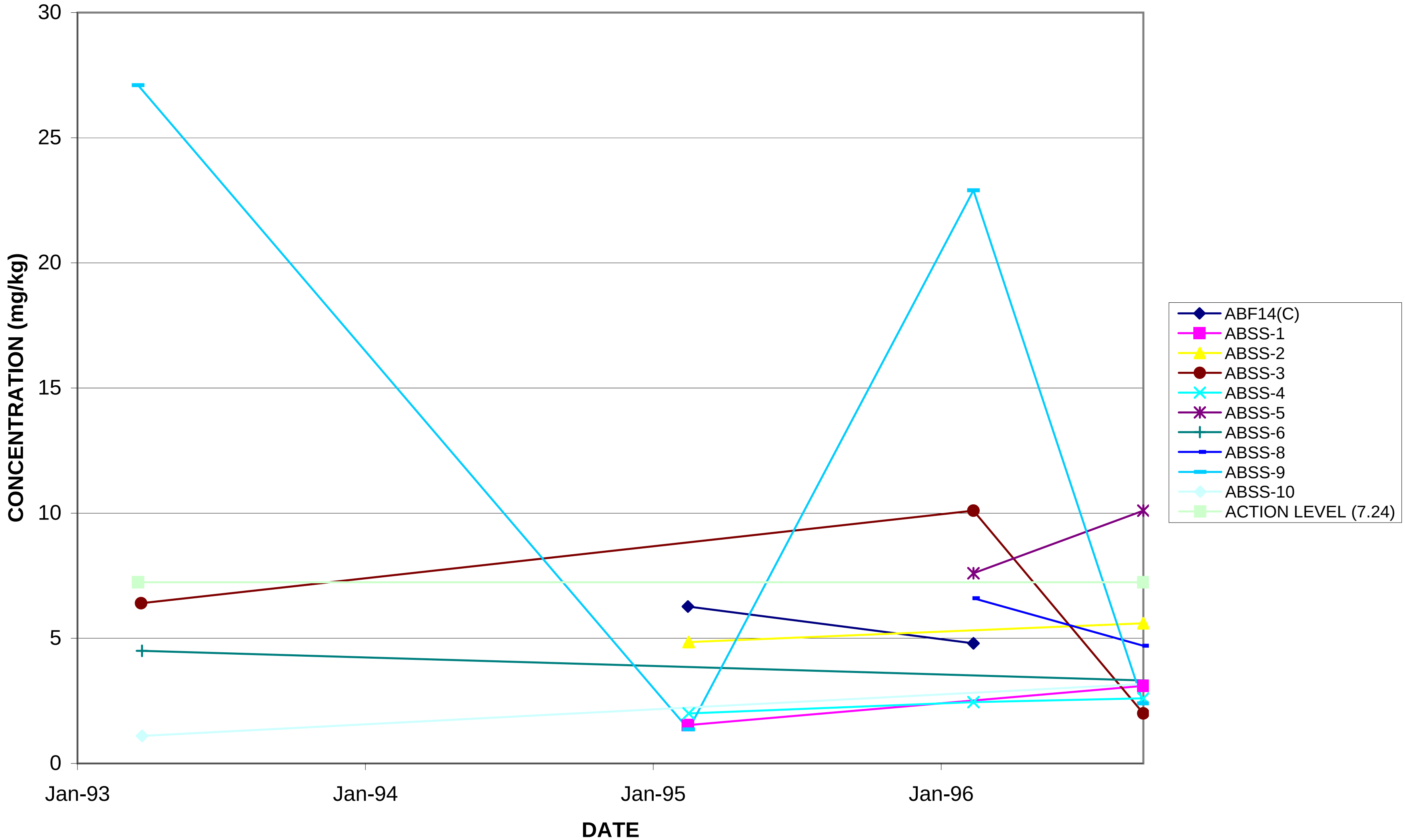
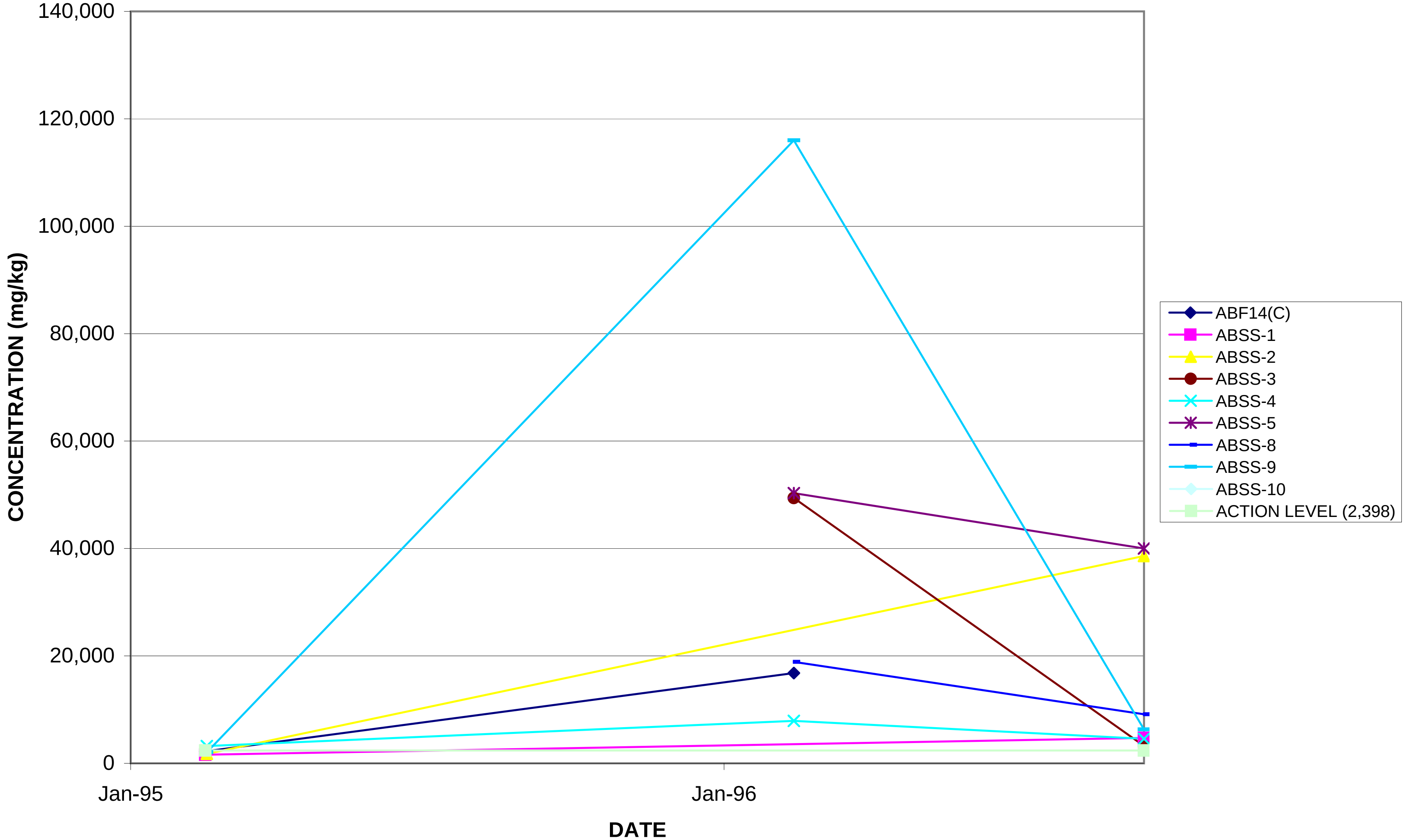


FIGURE 9-4

IRON IN SEDIMENT
AOC B
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA



10.0 IR 1 - TRUMAN ANNEX REFUSE DISPOSAL AREA

This section describes the five-year review for IR 1, the Truman Annex Refuse Disposal Area.

10.1 HISTORY AND SITE CHRONOLOGY

A list of important historical events and relevant dates in the site chronology is shown below. The identified events are intended to be illustrative rather than comprehensive.

Investigation/Activity	Date
Refuse Disposal Area operations	1952 to mid-1960s
IAS Report produced by Envirodyne Engineers, Inc.	May 1985
Verification Study Assessment issued by G&M	March 1987
Preliminary RI Report produced by IT	January 1991
RFI/RI Report issued by IT	June 1994
IRA excavation completed by BEI	March 1996
Supplemental RFI/RI Report for Eight Sites issued by B&RE	January 1998
Sediment Toxicity Study Report produced by TtNUS	August 1999
Proposed Plan for IR 1 issued by TtNUS	February 2000
Decision Document for IR 1 and IR 8 issued by TtNUS	September 2000
First year of Quarterly Performance Monitoring implemented by TtNUS	July 2001
Annual Performance Monitoring conducted by TtNUS	January 2003
IR 1 Letter Report addressing Focused Soil Investigation issued by TtNUS	December 2003
Annual Performance Monitoring conducted by REA	January 2004

10.2 BACKGROUND

10.2.1 <u>Site Description</u>

The Truman Annex Refuse Disposal Area (IR 1) is located along the south shore of Truman Annex on Key West (Figure 10-1). The site covers an area of approximately 7 acres, including an antenna field and area to the immediate north. A chain-link fence surrounds the site and access to IR 1 is strictly controlled. The shoreline has erosion protection consisting of large concrete rubble and debris. The main sewer outfall line for Key West runs through the property, and treated sewage is pumped to the outfall point 3,600 feet southwest of IR 1 (B&RE, 1998a).

From 1952 until the mid-1960s, the Truman Annex Refuse Disposal Area was used for general refuse disposal and open burning. No restrictions were placed on the types of wastes disposed at the site. General refuse, waste paint thinners, and solvents may have been disposed of at the site. As a result of these activities, the soils, groundwater, and sediment at the site have been contaminated with metals, PCBs, and pesticides at concentrations greater than action levels. The shoreline around IR 1 is protected from erosion by boulders and fill material (riprap).

10.2.2 Summary of Sampling Results

Several investigations have been performed at IR 1 since the mid-1980s to identify, confirm, or delineate contamination. In 1986, G&M performed a preliminary investigation at IR 1 (G&M, 1987). Analytical results indicated that metals were present in the groundwater and soil, and that hydrocarbons were present in the groundwater. Based on the results of the preliminary investigation, IT performed a preliminary RI at IR 1 in 1990. The preliminary RI indicated the presence of metals in groundwater and suggested that migration of metals toward the Atlantic Ocean could be occurring. Further investigation was recommended to determine the extent of contamination (IT, 1991).

In 1993, IT Corporation performed an RFI/RI that concluded that sediment surrounding the edge of the site had been contaminated with metals, certain pesticides, and PCBs, and that groundwater was contaminated by metals and trace amounts of certain pesticides. Metal contamination in soil at the site also appeared to be extensive. The Final RFI/RI Report prepared by IT recommended additional sampling, the performance of a feasibility study (FS) and an IRA, and conducting a BRA based on post-IRA sampling data (IT, 1994).

10.2.3 1995 IRA

Subsequent to the submittal of a Draft Supplemental RFI/RI Workplan by ABB in 1995 (ABB, 1995), a Delineation Study focusing on metals was performed by BEI at IR 1 to supplement the previous data, determine the extent of lead-contaminated soil, and delineate the limits of required excavation (BEI, 1995a). BEI then performed an IRA, excavating lead contaminated soil to a depth of 12 to 18 inches at IR 1, and removing 4,878 cubic yards of soil for offsite treatment and disposal. The IRA reduced the highest lead concentration in soil from 35,200 mg/kg to 680 mg/kg. Samples were collected from the excavation area to confirm removal of contaminated soil (BEI, 1998).

10.2.4 Summary of Risk

In the fall of 1996, B&RE performed the Supplemental RFI/RI sampling at IR 1 (B&RE, 1998a). The Supplemental RFI/RI concluded that elevated concentrations of some contaminants remain at IR 1. Metals were detected with high frequencies in soil at IR 1 and also detected in sediment, surface water, and groundwater. Several VOCs, SVOCs, pesticides, and PCBs were also detected at the site. A BRA and an ecological risk assessment were performed during the Supplemental RFI/RI. An FS was recommended for IR 1 in the Supplemental RFI/RI to evaluate possible site remedies. However, the BRA revealed only one scenario (residential) with risks above EPA's carcinogenic target risk range and non-carcinogenic threshold. Therefore, the NAS Key West Partnering Team made the decision to perform a Sediment Toxicity Study instead of an FS to more fully characterize ecological risks to benthic organisms at IR 1. The Sediment Toxicity Report for IR 1 concluded that potential ecological risks to benthic organisms exist in the vicinity of two sediment sample locations; DDT, lead, and copper were elevated at one sample location, while aroclor-1260 and DDE were elevated at the other sample location (TtNUS, 1999g).

10.3 REMEDIAL ACTIONS

10.3.1 <u>Remedy Selection</u>

As summarized in the Proposed Plan (TtNUS, 2000c) and documented in the Decision Document for IR 1 and IR 8 (TtNUS, 2000d), the remedy selected for IR 1 is LUCs with performance monitoring of groundwater, sediment, and biota. The sampling locations for sediment and biota were based on sampling conducted in October 1998, when sediment samples were collected from 10 locations along the shoreline of IR 1. These samples were subjected to sediment toxicity tests and chemical analyses. Adverse impacts to the sediment toxicity test organism (*Leptocherus plumulosus)* were observed at 2 of 10 sampling locations (TtNUS, 1999g).

10.3.2 <u>Remedy Implementation</u>

IR 1 is on an active military base with no planned change in site usage for the foreseeable future. To address human health risks, LUCs, consisting of limited site access, were implemented. LUCs were developed through LUCIPs. These controls were designed to ensure protection of human health and the environment by restricting future site use and accessibility, educating NAS Key West personnel, and maintaining records of contamination. The LUCs documented in the NAS Key West Base Master Plan prevent future residential use at this site. The LUCIP for IR 1 includes the placement and maintenance of signs around the site perimeter which state that dangerous material may be present below ground surface. Personnel from the NAS Key West Public Works Department are required to visually inspect IR 1 at least once every three months to ensure that all LUCs are being implemented and properly maintained. The NAS Key West Public Works Department submits an annual report to FDEP describing the results of the quarterly inspections.

To implement the monitoring program for this corrective measure, sediment, and groundwater samples were collected quarterly for the first year and annually thereafter. The quarterly monitoring began in July 2001 and was completed in April 2002 (TtNUS, 2002c). An annual event was conducted in January 2003 (TtNUS, 2003a). Monitoring of ecological receptors, including sediment toxicity testing, was performed in January 2002, and involved the analysis of aquatic vegetation (turtlegrass) tissue for metals, pesticides, and PCBs (TtNUS, 2002d).

10.3.3 System Operations and Maintenance

Five sampling events involving the monitoring of groundwater and sediment have been conducted since July 2001. Sampling was conducted quarterly during the first year (TtNUS, 2002c), and once in January 2003 (TtNUS, 2003a). Biological monitoring has been performed once since the remedy was implemented, in January 2002 (TtNUS, 2002d). According to cost estimates obtained from the NAS Key West Public Works Environmental Department, the approximate annual cost for the long term monitoring and LUCs associated with the remedy at IR 1 is $6,260.

10.4 FIVE YEAR REVIEW PROCESS

10.4.1 Document Review

Reports and data from investigations conducted from 1985 through 2003 were reviewed for this five-year review, as discussed in Section 10.2.

10.4.2 Data Review

Concentrations of media-specific COCs identified in the Supplemental RFI/RI for Eight Sites were plotted to identify and evaluate trends across investigations. For COCs in sediment, the plots show concentrations over time at each monitoring location. Surface soil sampling and analysis were not included in performance monitoring, and surface soil plots do not show concentrations over time. Instead, the soil plots simply show data for individual samples typically collected only once at a particular sampling location. The plots for sediment and soil also show the media-specific action level for each COC. The action levels are concentrations that have been selected by the NAS Key West Partnering Team as representing concentrations below which there is no potential for unacceptable risk to human health or the environment. The action levels were selected from several sources, and are included in Appendix C.

The plots of turtlegrass data show all detected chemicals in turtlegrass that were COCs in sediment or soil. Turtlegrass data plots show average concentrations of all samples in each of two sampling events in which turtlegrass has been collected (1996 and 2002).

There were no groundwater COCs identified in the Supplemental RFI/RI. Chemicals that were detected in groundwater and sediment during long term monitoring but not identified as COCs in the Supplemental RFI/RI were not plotted in this report, but were evaluated and are discussed in Section 10.4.2.1 (groundwater) and 10.4.2.2 (sediment).

10.4.2.1 Groundwater Monitoring

Performance monitoring initially consisted of the collection and analyses of groundwater samples from six locations, and groundwater samples were analyzed for TAL metals, Target Compound List (TCL) pesticides, and PAHs. Because pesticides and PCBs were not detected in groundwater at IR 1 during the first and second quarters of monitoring, the NAS Key West Partnering Team decided to delete pesticide and PAH analyses in subsequent groundwater sampling. Similarly, two monitoring wells were removed from the monitoring plan after the second quarterly monitoring event (TtNUS, 2002c).

Antimony and thallium are the only groundwater analytes that have exceeded action levels in the five performance monitoring events (TtNUS, 2002c; 2003a). Thallium has exceeded its action level (4.62 µg/L) only once, at 14.4 µg/L in the first quarterly monitoring event. During the first year of monitoring, antimony exceeded its action level (6 µg/L) at least once in three of four monitoring wells, and its maximum concentration was 36.6 µg/L (TtNUS, 2002c). Antimony exceeded its action level in two monitoring wells during 2003, at a maximum concentration of 13.3 µg/L (TtNUS, 2003a).

10.4.2.2 Sediment Monitoring

Sediment COCs identified in Supplemental RFI/RI for Eight Sites include aroclor-1254, aroclor-1260, arsenic, and iron. Sediment toxicity tests conducted in 1998 identified adverse impacts to test organisms at two of 10 sampling locations (TtNUS, 1999g). Locations for performance monitoring of sediment were centered on these two locations, and four samples were collected from each of the two locations (8 samples total).

Figures 10-2 through 10-5 show contaminant trends for sediment COCs at IR 1. Aroclor-1254 was below action levels for the majority of the performance monitoring sampling events. However, aroclor-1254 exceeded its action level in more than half of the samples collected in January 2003, as shown in Figure 10-2. Aroclor-1260 has consistently exceeded its action level in sediment at IR 1. Figure 10-3 illustrates the magnitude of aroclor-1260 concentrations in sediment compared to the action level of 21.6 μg/kg. Arsenic in sediment exceeded its action level in one sample in January 2003, but exhibited several exceedances in April 2002, as shown in Figure 10-4. Figure 10-5 presents contaminant trends for iron in sediment. Iron has exceeded its action level (a background concentration) multiple times before and after implementation of the selected remedy. All COCs identified in the Supplemental RFI/RI continue to exceed action levels, and should remain COCs until re-evaluated during the next five-year review.

Cobalt, copper, iron, lead, zinc, PAHs, DDD, DDE, DDT, dieldrin, endrin, and heptachlor epoxide have been frequently detected above action levels in IR 1 sediment during the five monitoring events (TtNUS, 2002c; 2003a). Thus, metals, PAHs, and pesticides should be considered to be COCs until re-evaluation during the next five-year review.

10.4.2.3 Soil Samples

Soil COCs identified in the Supplemental RFI/RI for Eight Sites include antimony, arsenic, copper, iron, and mercury. Figure 10-6 presents antimony and mercury concentrations in soil samples collected in 1993, 1995, and 2003. Figures 10-7 presents arsenic data from 1995 and 2003, and Figure 10-8 presents copper and iron concentrations in soil from samples collected in 1995 and 2003.

As seen in Figure 10-6, antimony and mercury in soil no longer exceed the updated action levels, and should be eliminated as COCs at IR 1. Likewise, copper and iron concentrations in soil are significantly below industrial action levels (Figure 10-8). However, arsenic should remain a COC in soil at IR 1 due to the multiple exceedances shown on Figure 10-7.

10.4.2.4 Biota Monitoring

Turtlegrass samples were initially collected at IR 1 in 1996 for use in the Supplemental RFI/RI for Eight Sites. At that time, Florida spiny lobsters, hermit crabs, and vase conchs were also collected for laboratory analysis and subsequent evaluation in the Supplemental RFI/RI. The Performance Monitoring Plan (TtNUS, 2000e) calls for the collection of turtlegrass and vase conchs, but only one vase conch specimen was collected at IR 1 in the 2002 sampling event, despite intensive search (TtNUS, 2002d).

Copper, lead, and zinc in turtlegrass samples varied very little over time (Figure 10-9). Concentrations of DDT, aroclor-1260, and endrin in turtlegrass samples were considerably less in 2002 than in 1996 (Figure 10-10). Concentrations of these COCs in turtle grass from IR 1 have been similar to concentrations from two reference locations (Appendix B, Table B-3).

Vase conch tissue data were not plotted and are not presented in this report. As mentioned above, only one vase conch specimen was collected at IR 1 in the 2002 sampling event. No COCs were elevated in this single sample, but the detection limits were relatively high due to the small sample mass available for analysis (TtNUS, 2002d).

Sediment toxicity testing was performed during the third quarterly monitoring event in January 2002. Test organisms, methods, endpoints, and reference locations were the same as in initial (1998) toxicity tests (28-day toxicity tests, amphipod *Leptocheirus plumulosus* as a test organism, with survival, growth, and reproduction as endpoints). Four samples were collected from each of the two locations (8 samples total) where the 1998 toxicity tests had identified adverse impacts to test organisms. Reduced survival, growth, or reproduction was observed in 6 of 8 samples in 2002. Concentrations of one or more of the following chemicals were elevated in all eight sediment samples: aroclor-1260, DDT, DDD, dieldrin, lead, and PAHs. Aroclor-1260 concentrations exceeded the PEL in six of eight samples, and approached the PEL in the other two samples. The co-occurrence of multiple contaminants suggests cumulative toxicity in some samples.

10.4.3 <u>Site Inspection</u>

The site has been inspected on numerous occasions during routine monitoring events. No significant issues have been identified at any time regarding the site. Since access to the base is restricted and a fence is in place surrounding IR 1, trespassing is minimal. In addition, warning signs are in place around the perimeter of the site, warning base personnel not to disturb the soil because dangerous material may be present below ground surface.

10.5 TECHNICAL ASSESSMENT

The Comprehensive Five-Year Review Guidance (EPA, 2001) states that the technical assessment section should answer three primary questions.

10.5.1 <u>Question A</u>

Is the remedy functioning as intended by the decision documents?

The remedy to protect human health and the environment is functioning as intended. IR 1 is located on an active military base, and access to the base is restricted. NAS Key West personnel perform quarterly monitoring to ensure adherence to LUCs, and an annual report is submitted to FDEP describing the results of the quarterly monitoring. In addition, warning signs are in place around the site perimeter, reducing the chance of trespassing and potential exposure to base personnel. There is no planned change in site usage for the foreseeable future.

Data collected during several sampling events indicate that elevated sediment concentrations of COCs are limited to two locations along the shoreline of IR 1. Within the vicinity of these locations, however, concentrations of several chemicals, especially aroclor-1260, DDT, DDD, dieldrin, lead, and PAHs have been elevated, indicating risk to benthic (sediment dwelling) invertebrate receptors. PCBs and organochlorine pesticides such as DDT, DDD, and dieldrin are long-lived in the environment, and these chemicals are expected to remain in IR 1 sediments for the foreseeable future. Since the two locations where these compounds are elevated represent relatively small areas in which risk to benthic receptors exists, the existing remedy appears to be protective of ecological receptors.

10.5.2 Question B

Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of the remedy selection still valid?

There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. There have been no significant changes to the standardized risk assessment methodology or toxicity data that could affect the protectiveness of the remedy. However, following conclusions presented in the Supplemental RFI/RI Report for Eight Sites, the action level selection process was revised by the NAS Key West Partnering Team as presented in the Site Investigation Work Plan for Ten BRAC Parcels (B&RE, 1998b). The current ARARs are included in Appendix C, along with the dates of the latest revisions and method of action level selection. Values evaluated for each medium are listed in tables, along with the selected action level.

Updated action levels were compared to COCs for sediment and soil identified in the Supplemental RFI/RI Report for Eight Sites. These comparisons resulted in several chemicals that were previously identified as COCs that no do not exceed current action levels. Soil COCs that no longer exhibit any exceedances of the selected action level include antimony, copper, iron, and mercury.

Cobalt, copper, iron, lead, zinc, PAHs, DDD, DDE, DDT, dieldrin, endrin, and heptachlor epoxide were frequently detected above action levels in IR 1 sediment during the five monitoring events. Thus, metals, PAHs, and pesticides should be considered to be COCs until re-evaluation during the next five-year review.

10.5.3 Question C

Has any other information come to light that could call into question the protectiveness of the remedy?

No new ecological receptors or human usage of the site were identified during performance monitoring or during the five-year review. No weather related events have affected the protectiveness of the remedy. Hurricane Georges, a Category 1 hurricane, passed over Key West on September 25, 1998. The hurricane caused significant damage and erosion to the shoreline at IR 1. Repairs to the shoreline protection system increased the elevation of the shoreline at IR 1 to match the top of the seawall using boulders and riprap. In addition, the fence along the seawall and signs indicating restricted access were replaced.

10.5.4 Technical Assessment Summary

Based on the data reviewed and the site inspections, the remedy is functioning as intended by the Decision Document for IR 1 and IR 8 (TtNUS, 2000d). There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. There have been no significant changes to the standardized risk assessment methodology that could affect the protectiveness of the remedy. There is no other information that calls into question the protectiveness of the remedy.

10.6 ISSUES

There are no unresolved issues that could impact the remedy.

10.7 RECOMMENDATIONS AND FOLLOW UP ACTIONS

LUCs should remain in place at the site. Groundwater at IR 1 should continue to be monitored annually for metals. Sediment at IR 1 should continue to be monitored annually for metals, PAHs, pesticides, and PCBs.

The collection of additional biological samples as part of long-term monitoring should be discontinued the following reasons:

- Concentrations of COCs in turtlegrass from IR 1 were similar to background values.

- Vase conchs are not consistently available for collection, and thus, they are not reliable as samples.

- Since aquatic habitat at IR 1 is an ocean shoreline, fish and other mobile aquatic species (e.g., lobsters, crabs, and conchs) are not good indicators of source-specific contamination when such contamination is limited to relatively small areas, as at IR 1.

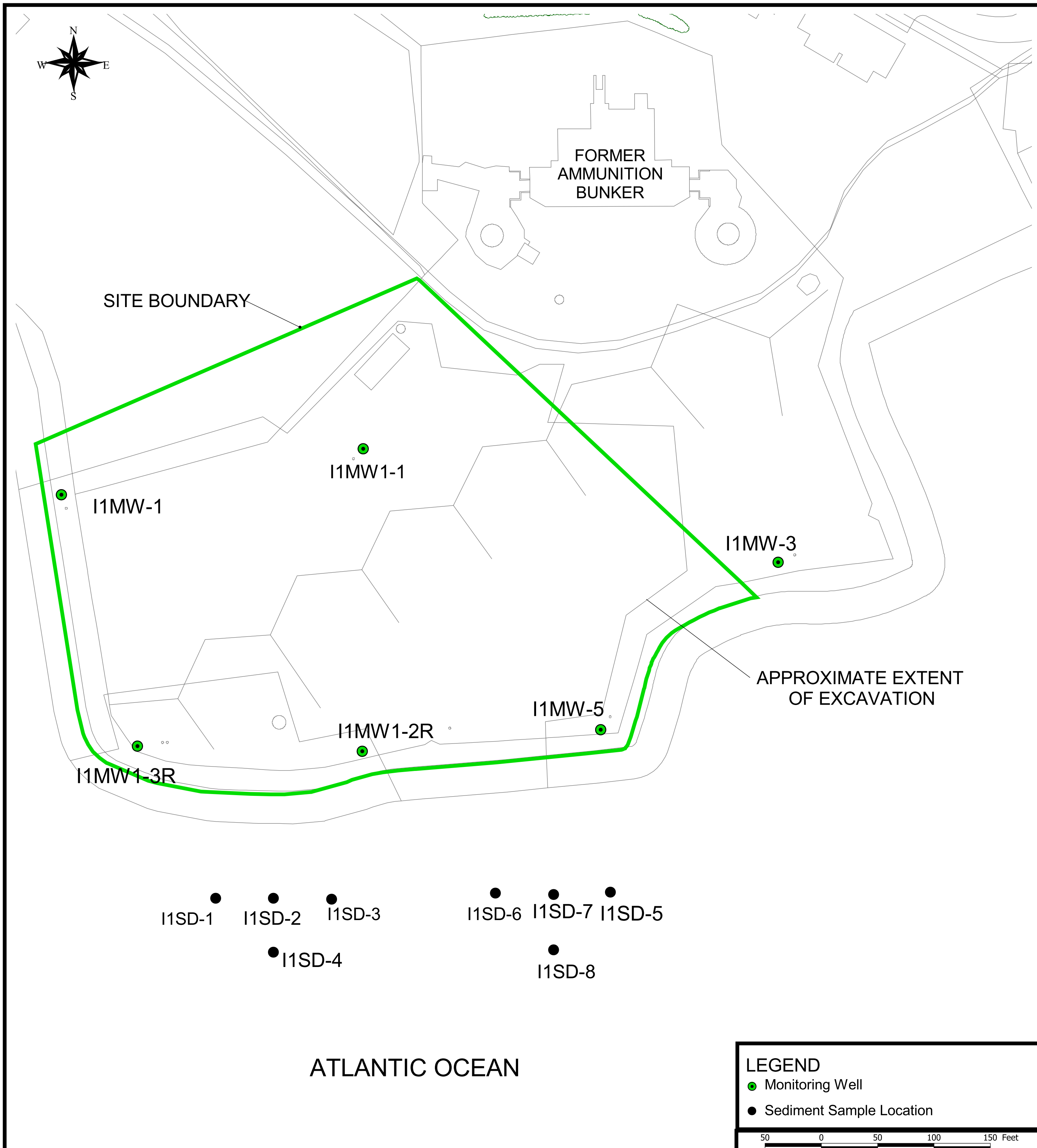
PCBs and organochlorine pesticides such as DDT, DDD, and dieldrin are long-lived in the environment, and these chemicals are expected to remain in IR 1 sediments for the foreseeable future. Since the two locations where these compounds and lead were elevated represent relatively small areas in which risk to benthic receptors exists, the collection of additional biological samples as part of long-term monitoring is not considered necessary. It is recommended that the collection of additional biological samples as part of long-term monitoring be discontinued. If concentrations of COCs in abiotic media substantially increase, then tissue monitoring could be re-established.

10.8 PROTECTIVENESS STATEMENT

The remedy is expected to continue to be protective of human health and the environment.

10.9 NEXT REVIEW

The next five-year review for IR 1 is required by May 2009.



NO.	DATE	REVISIONS

DRAWN BY EHM DATE 11/17/2004
CHECKED BY SH DATE 11/18/2004
COST/SCHED-AREA
SCALE AS NOTED

NAVAL AIR STATION KEY WEST FLORIDA

SITE LAYOUT
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

CONTRACT NO. 5327
APPROVED BY CMB DATE 11/23/2004
APPROVED BY DATE
FIGURE NO. 10-1
REV. 0

FILE: K:\FIVE YEAR REVIEW.APR LAYOUT: FIGURE 10-1 IR 1 SITE LAYOUT DATE: 11/19/2004 BY: EHM

FIGURE 10-2

AROCLOR-1254 IN SEDIMENT
IR 1
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

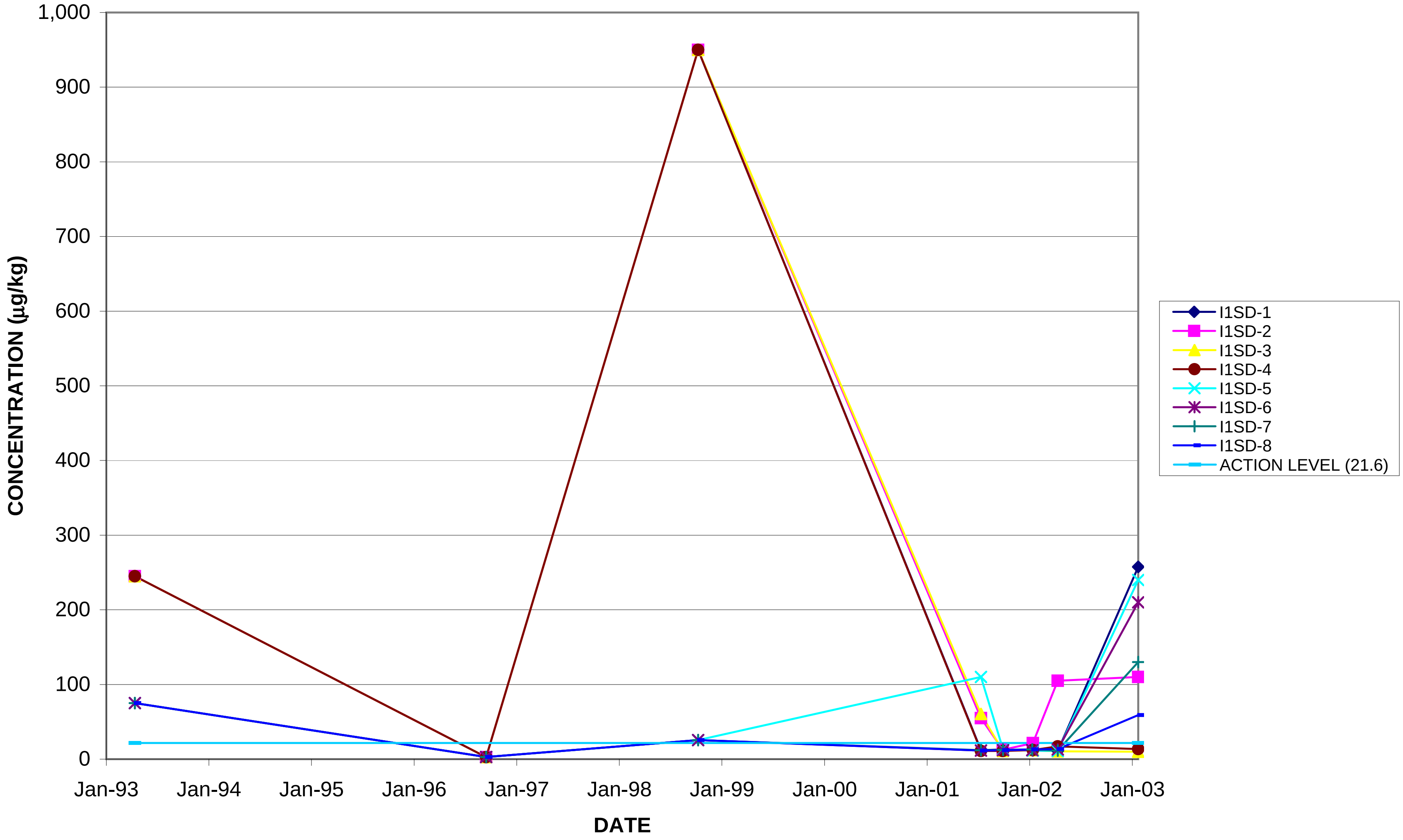


FIGURE 10-3

AROCLOR-1260 IN SEDIMENT
IR 1
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

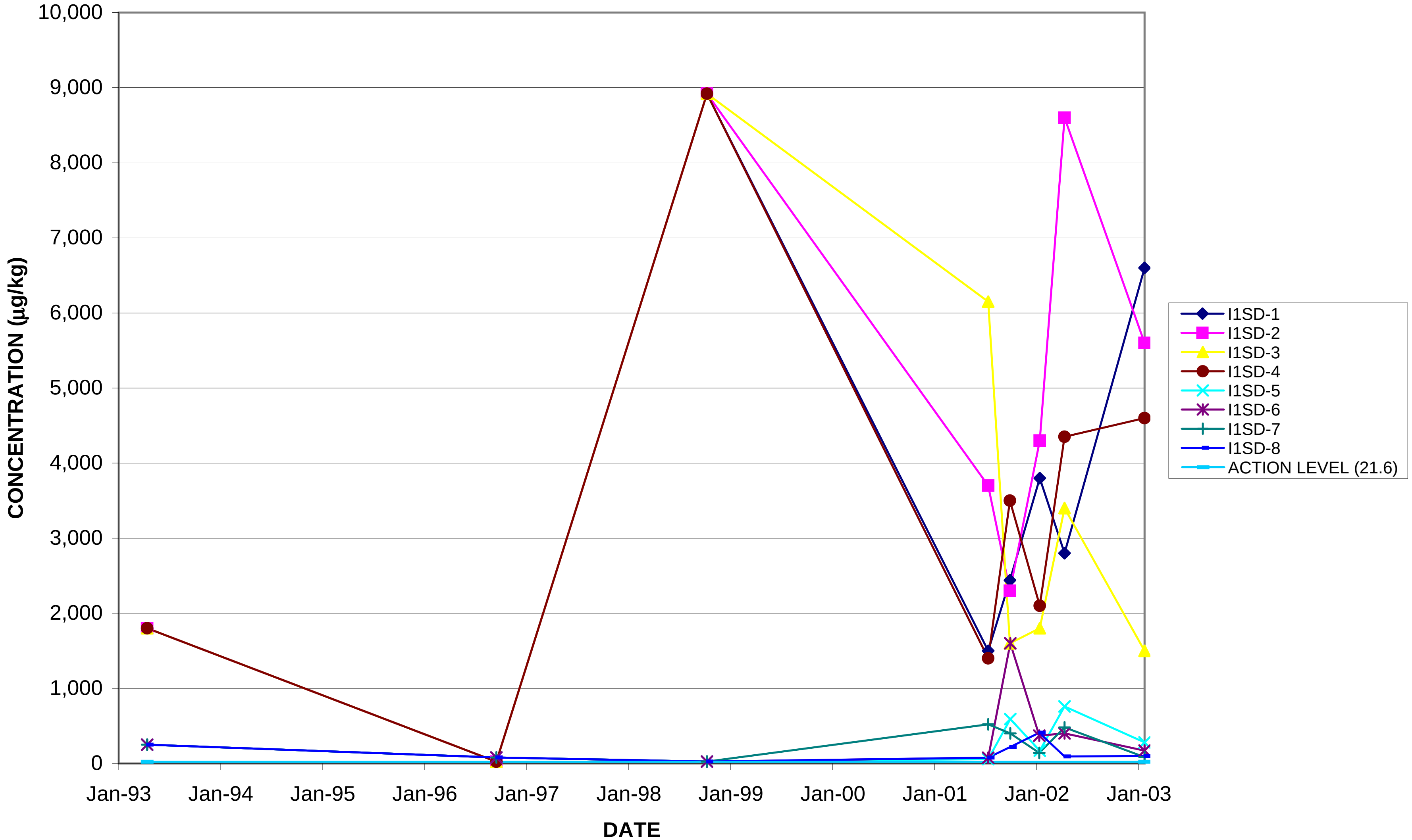


FIGURE 10-4

ARSENIC IN SEDIMENT
IR 1
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

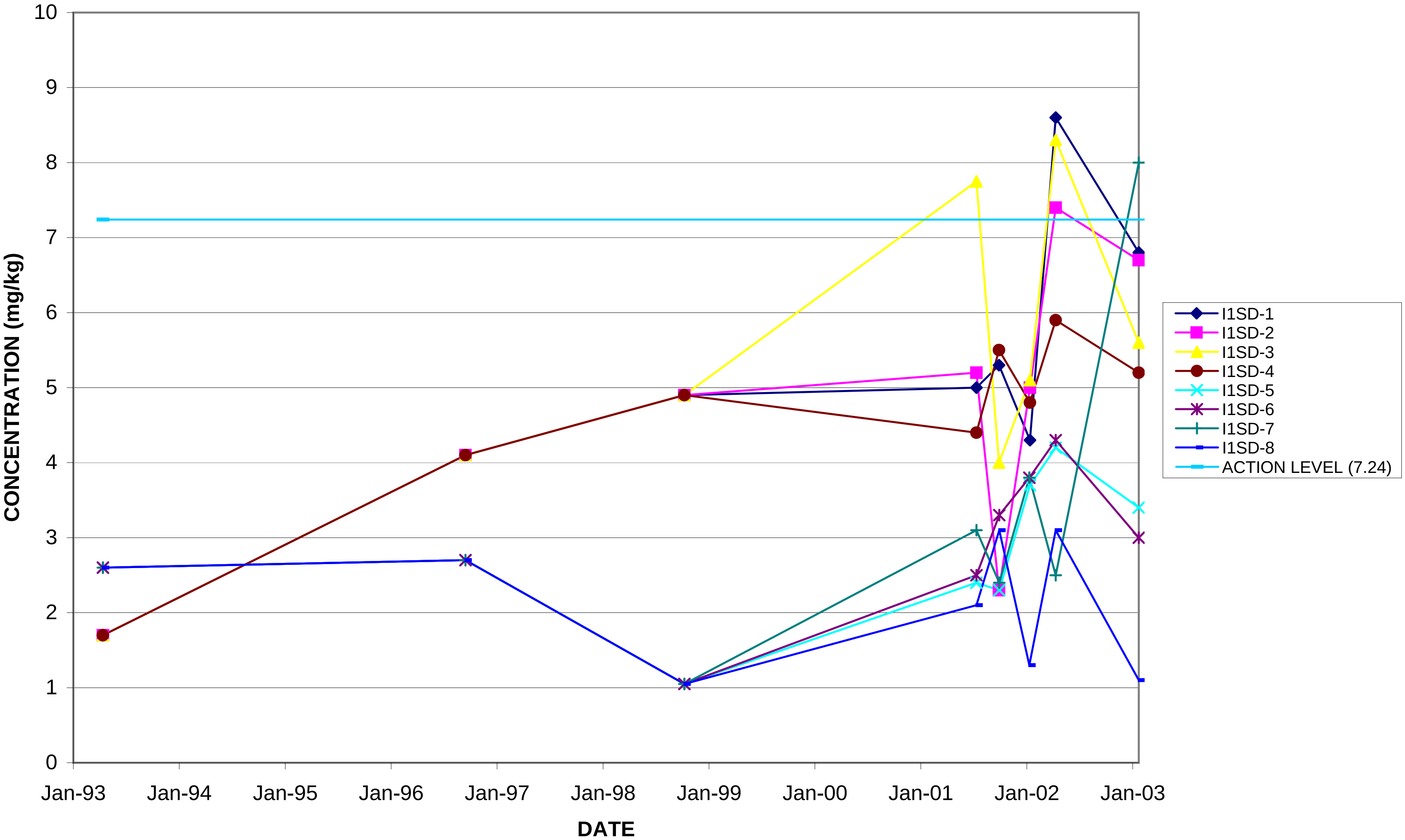


FIGURE 10-5

IRON IN SEDIMENT
IR 1
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

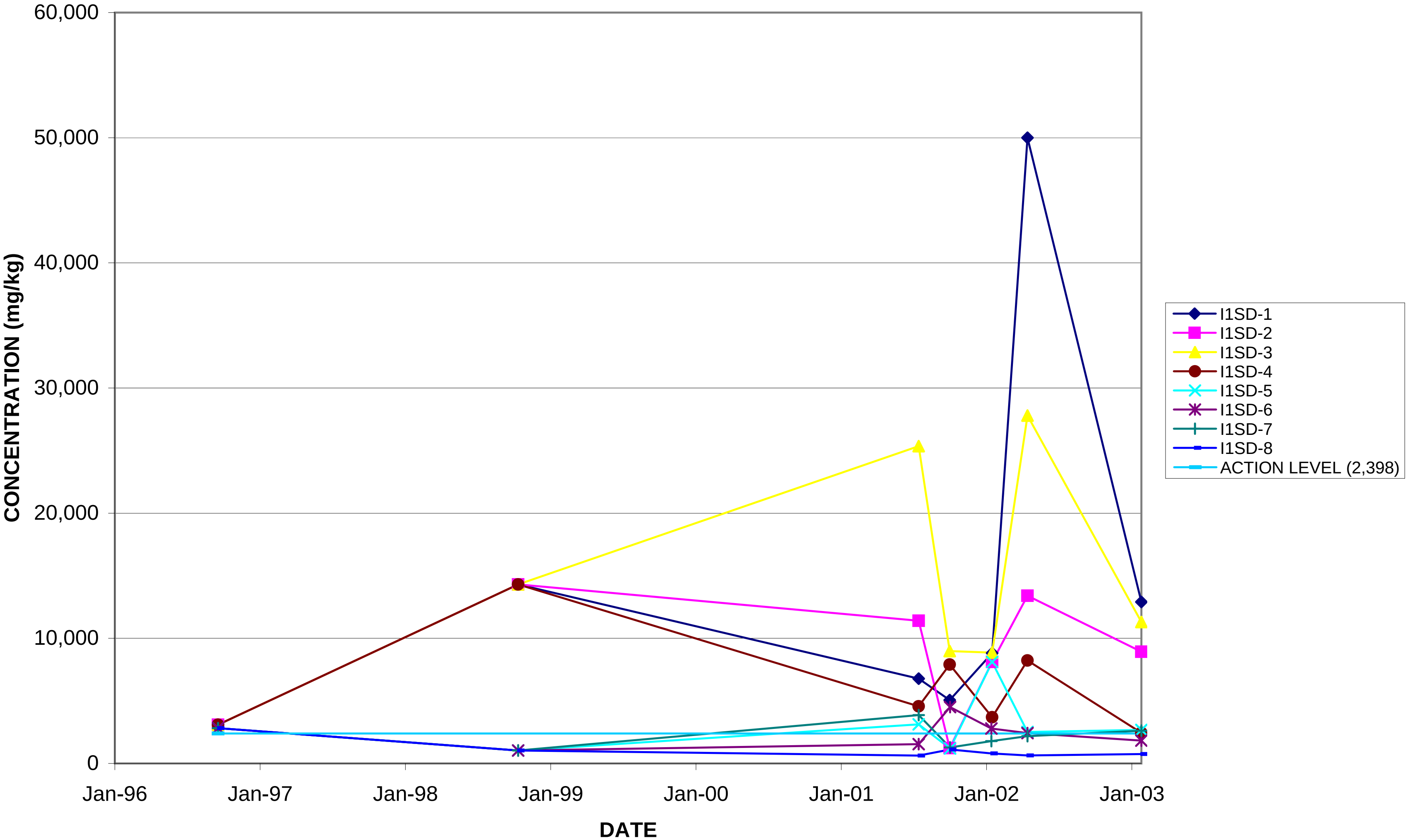


FIGURE 10-6

INORGANIC COCS IN SOIL
IR 1
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

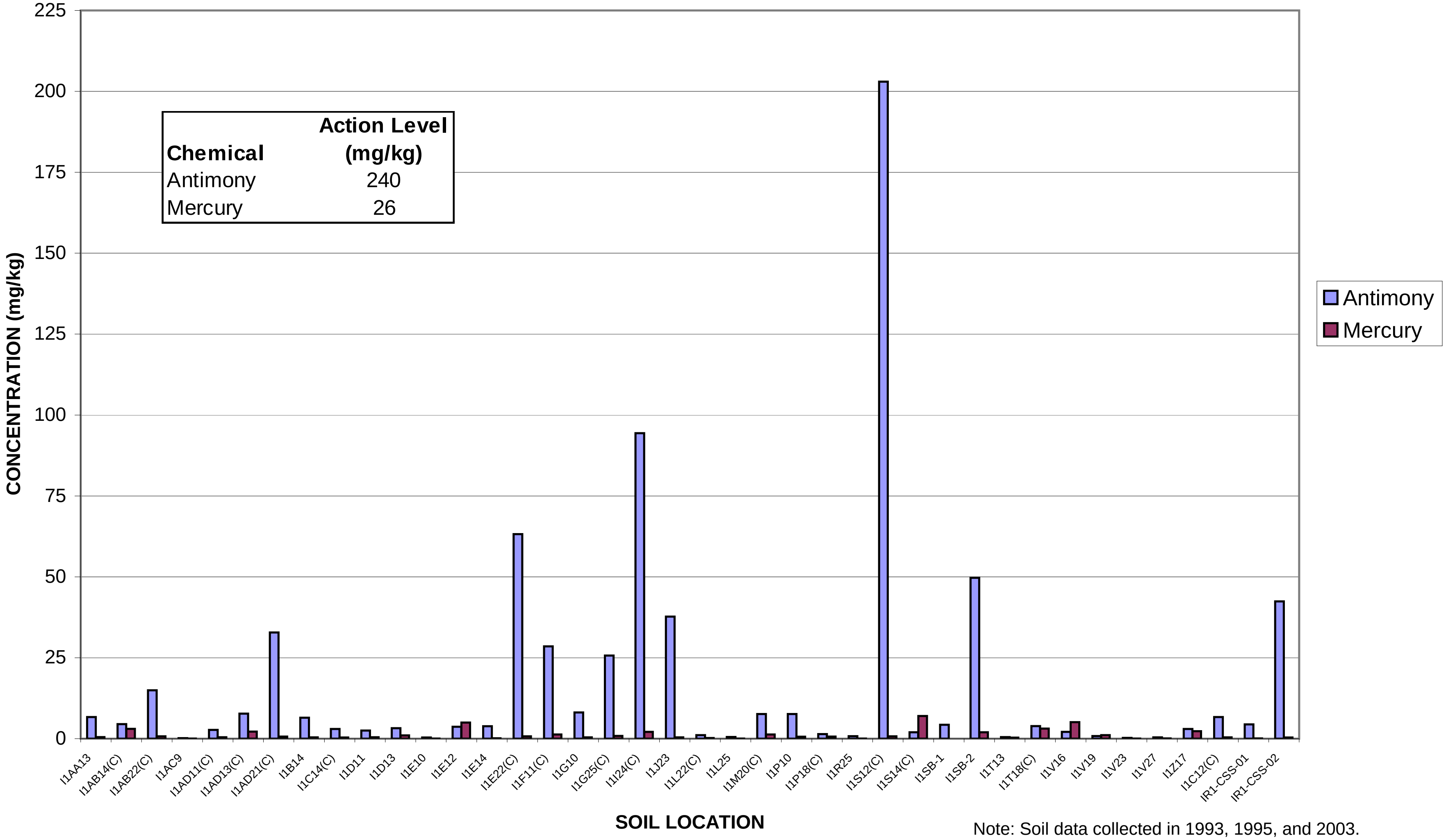
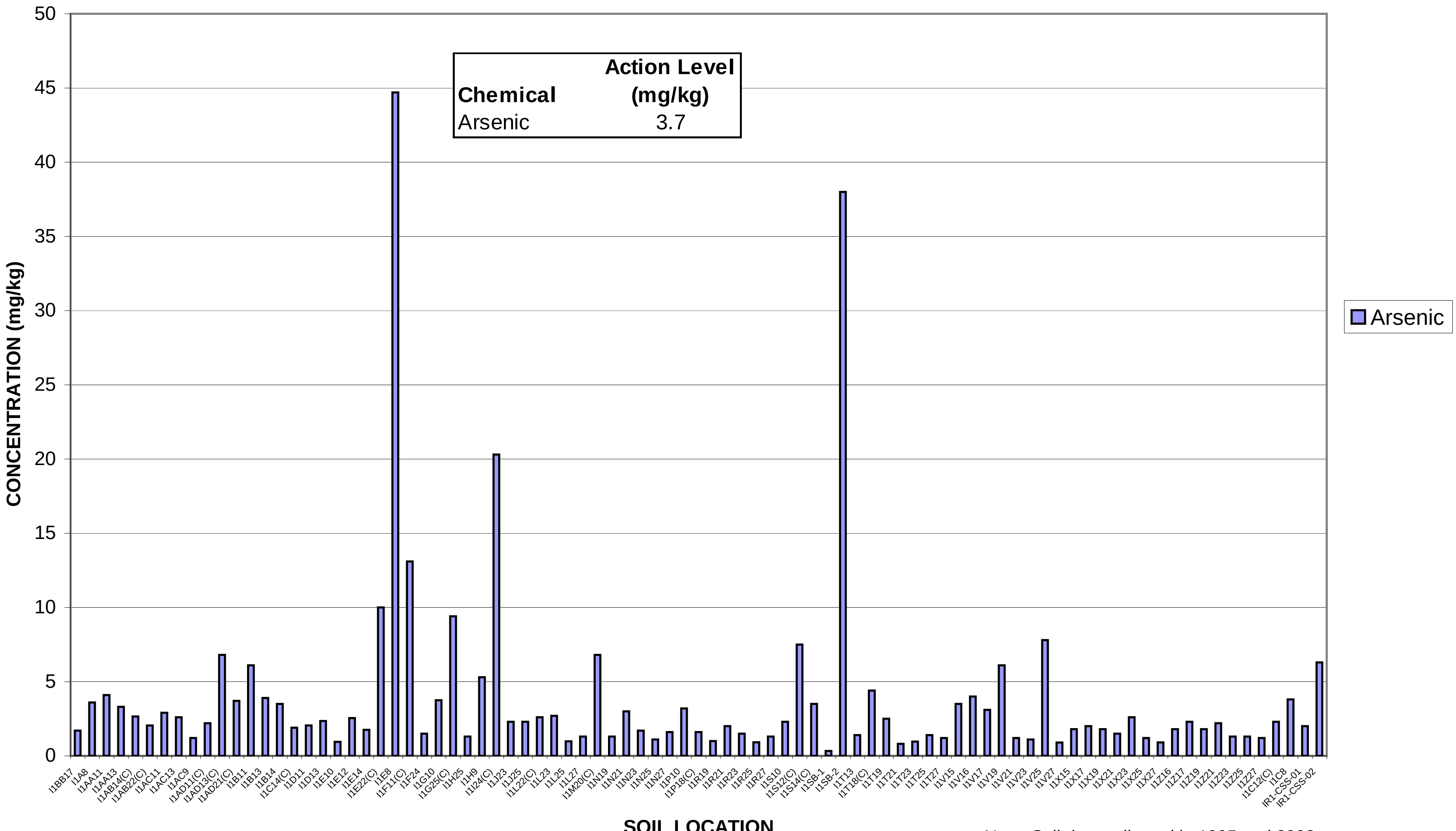


FIGURE 10-7

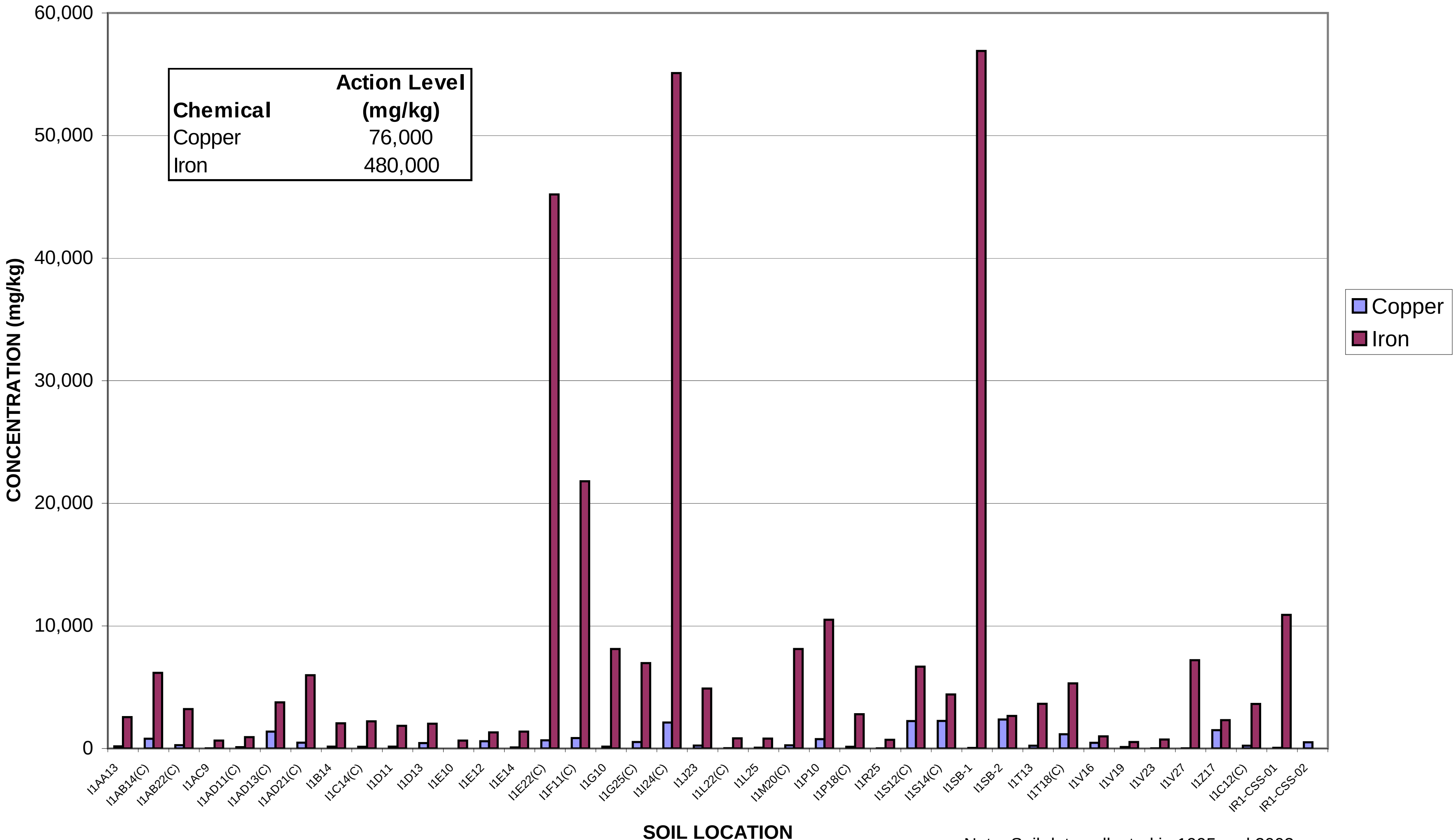
ARSENIC IN SOIL
IR 1
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA



Note: Soil data collected in 1995 and 2003.

FIGURE 10-8

INORGANIC COCS IN SOIL
IR 1
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA



Note: Soil data collected in 1995 and 2003.

FIGURE 10-9

ORGANIC COCS IN TURTLEGRASS
IR 1
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

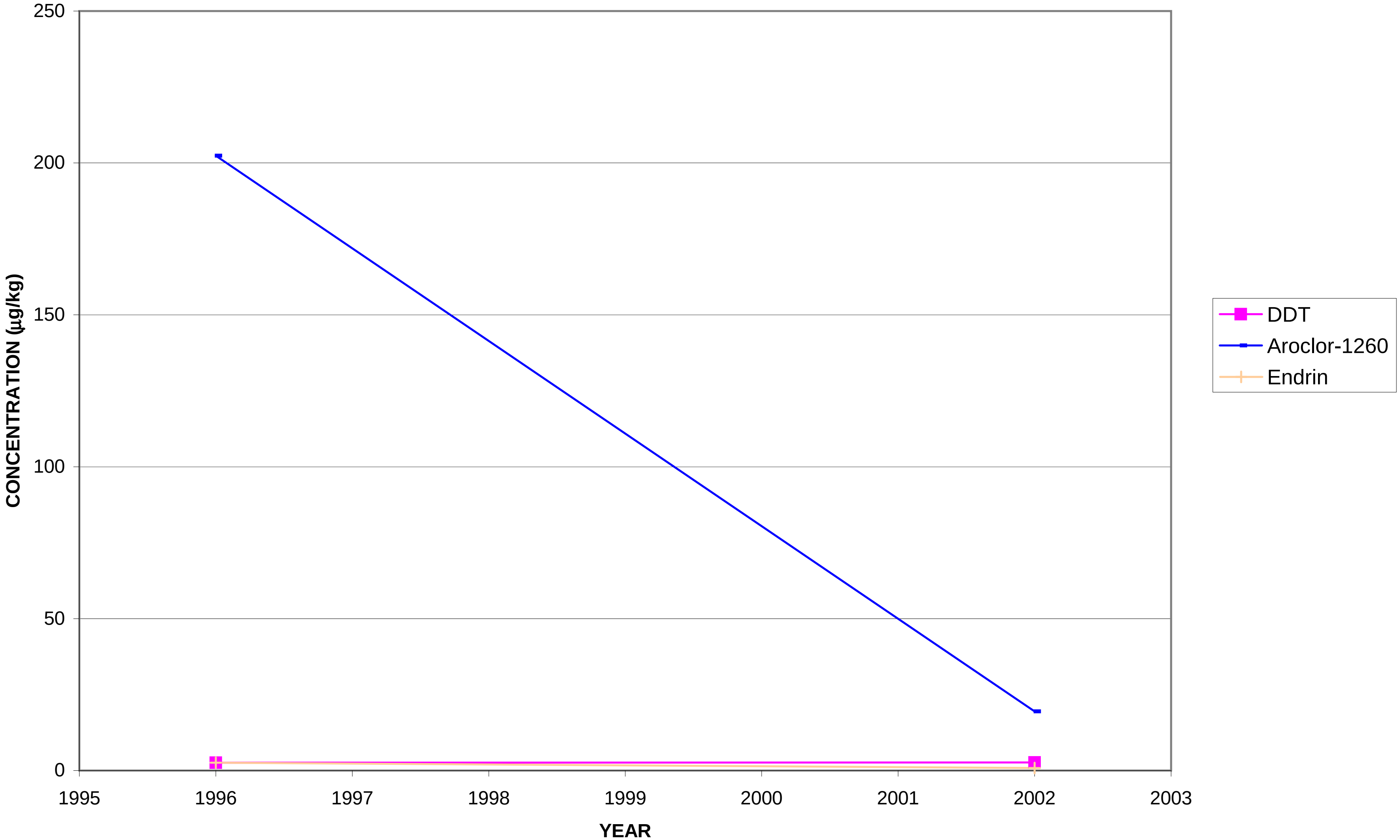
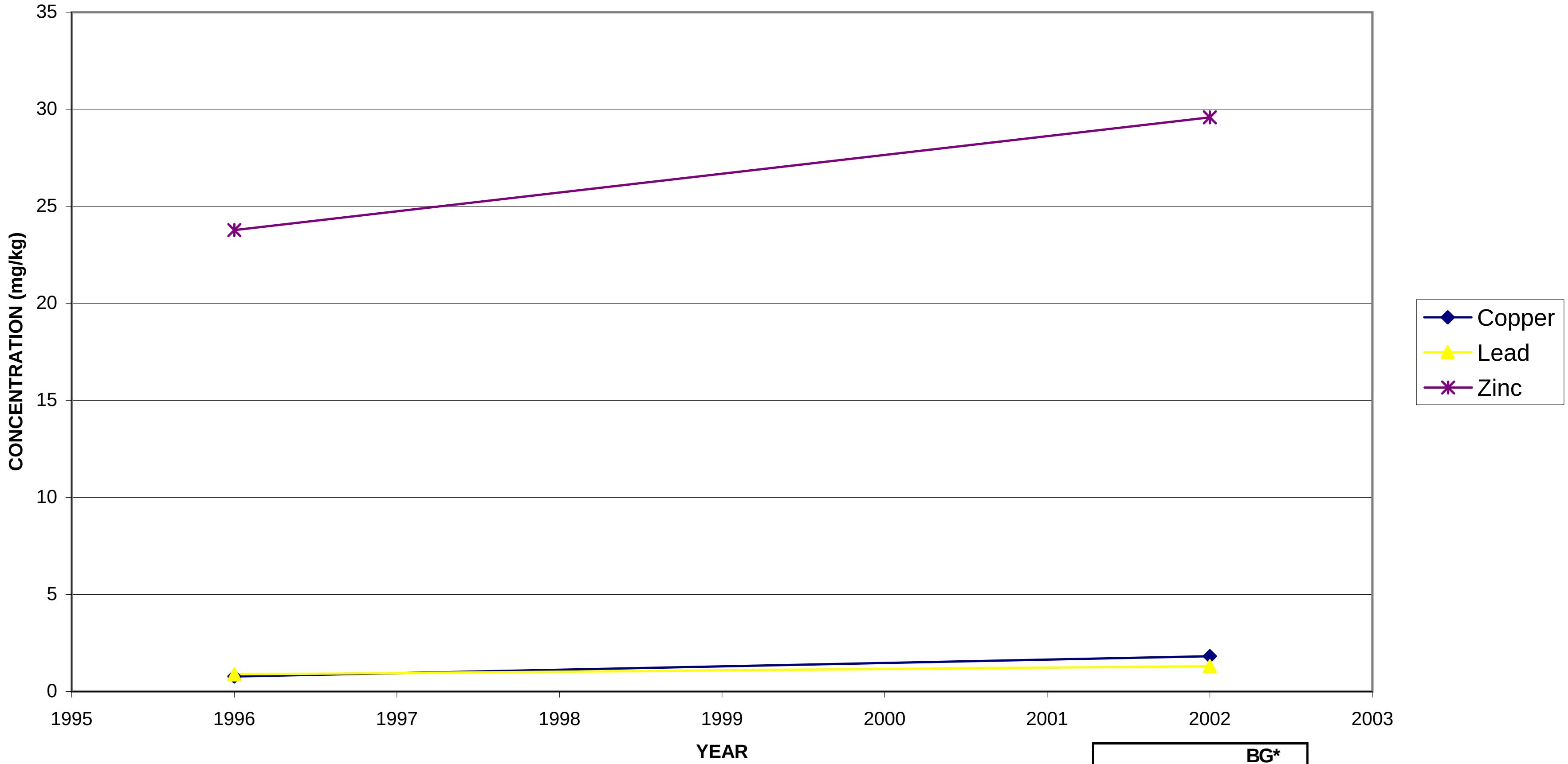


FIGURE 10-10

INORGANIC COCS IN TURTLEGRASS
IR 1
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA



Chemical	BG* (mg/kg)
Copper	0.83
Lead	0.415
Zinc	9.5

*Mean background concentration as listed in Appendix B, Table B-3

11.0 IR 3 - TRUMAN ANNEX DDT MIXING AREA

This section describes the five-year review for IR 3, the Truman Annex DDT Mixing Area.

11.1 HISTORY AND SITE CHRONOLOGY

A list of important IR 3 historical events and relevant dates in the site chronology is shown below. The identified events are intended to be illustrative, rather than comprehensive.

Investigation/Activity	Date
DDT mixing operations	1940s to early 1970s
IAS Report produced by Envirodyne Engineers	May 1985
Verification Study Assessment produced by G&M	March1987
Preliminary RI Report issued by IT	January 1991
RFI/RI Report issued by IT	June 1994
IRA completed by BEI	October 1995
Supplemental RFI/RI Report for Eight Sites issued by TtNUS	January 1998
Decision Document for IR 3, IR 7, and AOC B issued by TtNUS	April 1999

11.2 BACKGROUND

11.2.1 Site Description

The Truman Annex DDT Mixing Area (IR 3) is located at the former site of NAS Key West Building 265. The site covers an area of about 0.25 acre, and is located approximately 1,100 feet from the coastline in an area that is currently paved and is restricted to vehicular and pedestrian traffic (Figure 11-1). Fort Street, which is the westernmost street of an adjacent residential area, is located opposite the chain-link fence that marks the Navy property boundary to the northeast of the site. The topography of the site is flat and turf grass covers most of the soil. The site is underlain by highly permeable soil with no surface water drainage or holding features present. The water table occurs at approximately 5 ft below land surface (bls). From the 1940s to the early 1970s, the location was used as a DDT mixing area. Powdered DDT concentrate was mixed with water and temporarily stored in 55-gallon drums both inside and outside the former building. The mixed solution was then transferred to trucks for dispersal. Discharges at the site were from accidental spills. The soil and groundwater at the site have been impacted with pesticides, primarily DDT, DDE, and DDD (B&RE, 1998a).

11.2.2 Summary of Sampling Results

In 1986, G&M conducted an initial investigation of IR 3. Surface soil samples were analyzed for pesticides. All the samples were collected from the area that was later excavated by BEI. Analytical results indicated that DDT and other pesticides, such as BHC, were present (G&M, 1987). In 1991, IT conducted a Preliminary RI. Analysis of groundwater samples from the site indicated that cadmium and seven different pesticide compounds were present in concentrations above established standards. The pesticide concentrations in the groundwater suggested that leaching could be occurring at the site (IT, 1991).

In 1993, IT conducted soil and groundwater sampling during the RFI/RI at this site. Characterization of contamination at the site indicated that surface soil and groundwater appeared to be impacted by metals (i.e., lead and arsenic) and pesticides. The source of groundwater contamination appeared to be the leaching of metals and pesticides from the soil. The Final RFI/RI prepared by IT recommended installing new monitoring wells and additional soil sampling to further delineate the extent of contamination; conducting an IRA to remove or cap contaminated surface soils; and performing a preliminary feasibility study to determine appropriate remedial actions to prevent further migration of contaminants (IT, 1994).

11.2.3 1995 IRA

The IRA objective for IR 3 was contaminant source removal to prevent further migration of waste into other media. To accomplish this objective, the scope of work for IR 3 consisted of the following elements: excavation of pesticide, lead, and arsenic-contaminated soils; transportation of waste to a RCRA-permitted treatment/disposal facility; backfilling with clean fill; and stabilizing with topsoil and sod (BEI, 1998).

In 1995, the IRA removed 735 cubic yards of DDT-contaminated soil from the site for treatment and disposal. The remediated area was then backfilled. Confirmatory samples were collected from locations on the excavation floor and sidewalls. There were small areas of IR 3 that were not excavated because of the presence of permanent structures such as sidewalks, fences and utility poles. As a result, there were locations that remained with elevated pesticide levels (BEI, 1998).

11.2.4 Summary of Risk

Following completion of the IRA, a BRA and an ecological risk assessment were performed as part of the Supplemental RFI/RI for Eight Sites (B&RE, 1998a). The BRA indicated that contaminants were not present at sufficient concentrations to cause adverse non-carcinogenic or carcinogenic health effects to any current potential receptors. However, contaminants were present in surface soil at concentrations indicating adverse health effects may occur for the hypothetical future resident and occupational worker. Arsenic, DDD, DDE, and DDT were the main contributors to the carcinogenic risk, and arsenic and DDT were the main contributors to the non-carcinogenic risk (B&RE, 1998a).

The ecological risk assessment indicated the absence of a complete exposure pathway for ecological receptors at IR 3. Although groundwater contamination was present at IR 3, it was considered unlikely that the contaminant plume could travel the distance necessary to reach the coastline. The Supplemental RFI/RI for Eight Sites concluded that the potential for ecological impacts did not exist at IR 3 (B&RE, 1998a).

11.3 REMEDIAL ACTIONS

11.3.1 Remedy Selection

The NAS Key West Partnering Team agreed on September 30, 1997 that a presumptive remedy using an asphalt cap was the most appropriate action for IR 3 (B&RE, 1998a). The selected remedy for IR 3, first presented in the Proposed Plan (TtNUS, 1998f) and documented in the Decision Document and Responsiveness Summary for IR 3, IR 7, and AOC B (TtNUS, 1999f), was to install an asphalt cap to decrease direct exposure to remaining soil contamination and migration of contaminants to groundwater, and to institute LUCs. The asphalt cap provides sound engineering controls in accordance with Section 62-785.680(2)(b) 4 of the FAC. The asphalt cap addressed FAC requirements to prevent human exposure and limit water infiltration by cutting off potential contact exposure to contaminated soil at the site reducing the percolation of precipitation through the soil that could mobilize the contaminants (TtNUS, 1999f).

11.3.2 Remedy Implementation

IR 3 is located on active military base with no planned change in site usage for the foreseeable future. The IRA conducted in 1995 removed the majority of the contaminated soil from the site. The asphalt cap installed provides engineering controls, preventing human exposure and limiting water infiltration. LUCs were developed through LUCIPs, and were designed to ensure protection of human health and the environment by restricting future site use and accessibility, educating NAS Key West personnel, and maintaining records of contamination. The LUCs documented in the NAS Master Plan prevent future residential use at IR 3. The LUCIP for IR 3 includes maintenance of the asphalt cap over the site. Personnel from the NAS Key West Public Works Department are required to visually inspect IR 3 at least once every three months to ensure that all LUCs are being implemented and properly maintained. The

NAS Key West Public Works Department submits an annual report to FDEP describing the results of the quarterly inspections.

11.3.3 System Operations and Maintenance

No cost information is available for installation of the asphalt cap. According to cost estimates obtained from the NAS Key West Public Works Environmental Department, the cost associated with maintaining the LUCs at the site is approximately $1,500 per year.

11.4 FIVE YEAR REVIEW PROCESS

11.4.1 Document Review

Reports and data from investigations conducted from 1985 through 1998 were reviewed for this five year review, as discussed in Section 11.2.

11.4.2 Data Review

No analytical data have been generated since the Supplemental RFI/RI for Eight Sites. However, COCs identified for soil in the Supplemental RFI/RI were reviewed and compared to current action levels. The action levels are concentrations that have been selected by the NAS Key West Partnering Team below which there is no potential for unacceptable risk to human health or the environment. The action levels were selected from several sources, and are included in Appendix C.

11.4.3 Site Inspection

The site has been inspected on numerous occasions since the asphalt cap was installed. No significant issues have been identified at any time regarding the site.

11.5 TECHNICAL ASSESSMENT

The Comprehensive Five-Year Review Guidance (EPA, 2001) states that the technical assessment section should answer three primary questions, each of which is presented below.

11.5.1 <u>Question A</u>

Is the remedy functioning as intended by the decision documents?

The remedy is functioning as intended by the Decision Document and Responsiveness Summary for IR 3 (TtNUS, 1999f). NAS Key West personnel perform quarterly inspections to ensure that the asphalt cap is being maintained, and an annual report is submitted to FDEP describing the results. There is no planned change in site usage for the foreseeable future.

11.5.2 <u>Question B</u>

Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of the remedy selection still valid?

There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. There have been no significant changes to the standardized risk assessment methodology or toxicity data that could affect the protectiveness of the remedy. However, subsequent to completion of the Supplemental RFI/RI Report, the action level selection process was revised by the NAS Key West Partnering Team as presented in the Site Investigation Work Plan for Ten BRAC Parcels (B&RE, 1998). The current ARARs are included in Appendix C, along with the dates of the latest revisions and method of selection for each medium. Values evaluated for each medium are listed in tables, along with the selected action level.

The current industrial soil action levels in Appendix C were compared to concentrations of COCs detected in IR 3 soil samples evaluated in the Supplemental RFI/RI Report. Figures 11-2 through 11-4 present COC concentrations in soil, along with the current action levels. For DDD, DDE, and DDT, action levels have increased significantly since completion of the Supplemental RFI/RI resulting in fewer exceedances of action levels for these pesticides, as shown on Figure 11-2. However, DDT and DDE still exceeded their action levels at one location each. All DDD detections were below the updated action level.

Inorganic COCs for soil at IR 3 include arsenic, beryllium, and iron. When compared to updated action levels, beryllium and iron concentrations in soil no longer exhibit any exceedances, as shown on Figures 11-3 and 11-4, respectively. Figure 11-3 demonstrates that arsenic concentrations in soil at IR 3 continue to exceed the action level.

Based on the above information, DDD, beryllium, and iron should be eliminated as soil COCs at IR 3.

11.5.3 <u>Question C</u>

Has any other information come to light that could call into question the protectiveness of the remedy?

No new receptors have been identified for IR 3. No weather related events have affected the protectiveness of the remedy. There is no known information that calls into question the protectiveness of the remedy.

11.5.4 <u>Technical Assessment Summary</u>

Based on the data reviewed and the site inspections, the remedy is functioning as intended by the Decision Document. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. There have been no significant changes to the standardized risk assessment methodology that could affect the protectiveness of the remedy. There is no other information that calls into question the protectiveness of the remedy.

11.6 ISSUES

There are no unresolved issues that could impact the remedy.

11.7 RECOMMENDATIONS AND FOLLOW UP ACTIONS

The selected remedy (asphalt cap and LUCs) should be maintained. There are no other applicable recommendations or follow-up actions for IR 3.

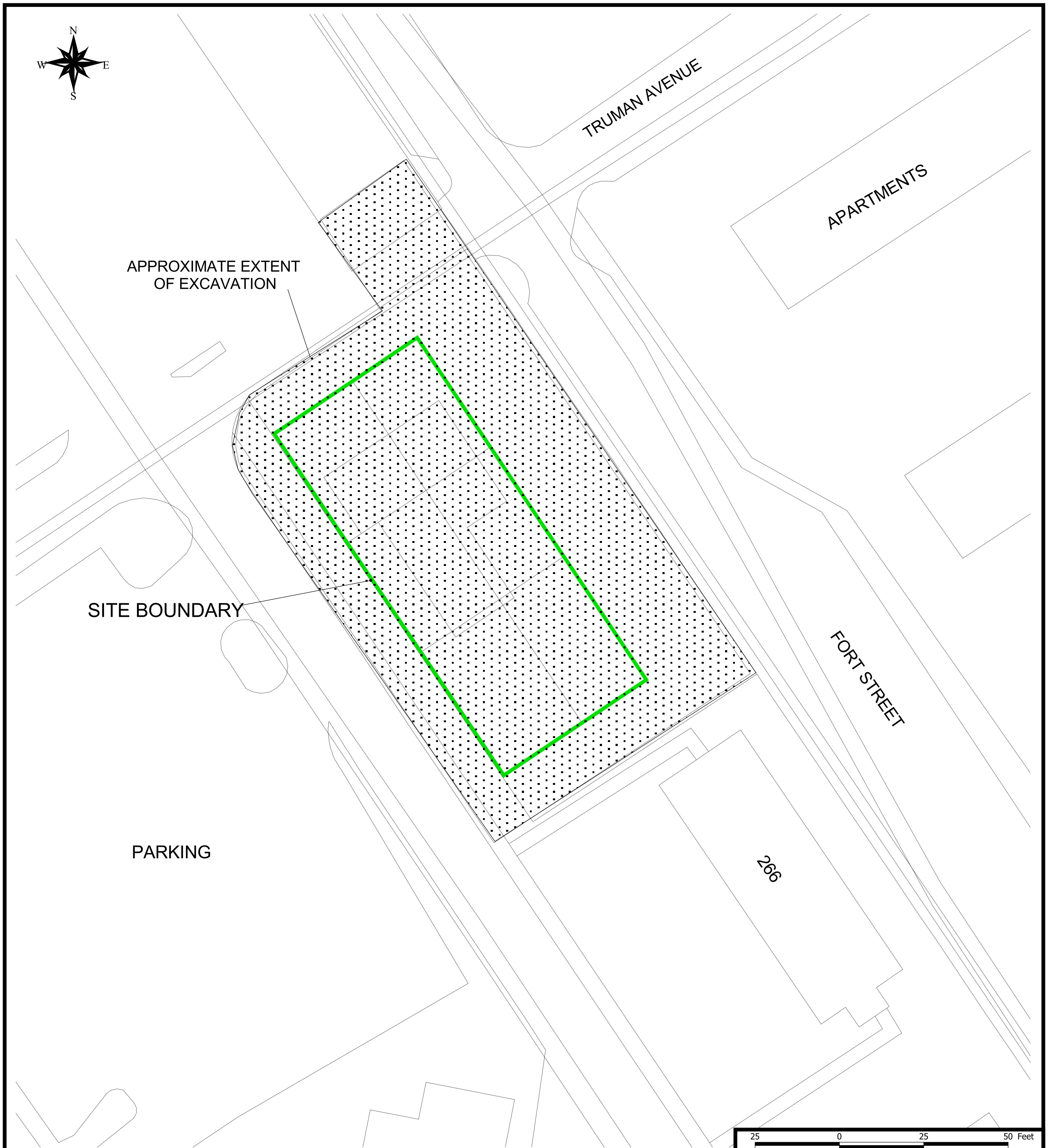
11.8 PROTECTIVENESS STATEMENT

The remedy is expected to continue to be protective of human health and the environment.

11.9 NEXT REVIEW

The next five-year review for IR 3 is required by May 2009.

Rev. 0
12/10/04



NO.	DATE	REVISIONS

DRAWN BY: EHM — DATE: 11/17/2004
CHECKED BY: SH — DATE: 11/18/2004
COST/SCHED-AREA
SCALE: AS NOTED

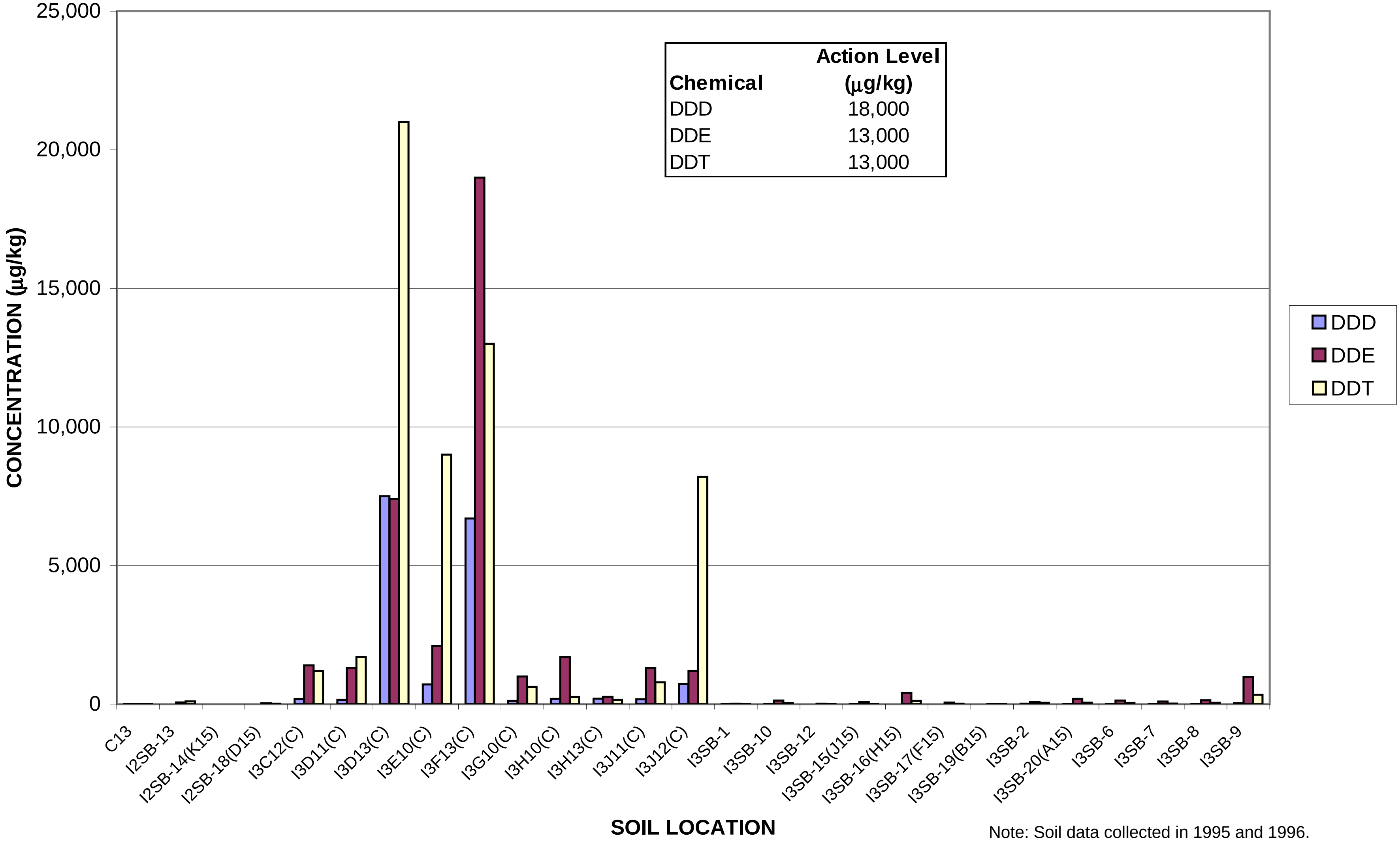
IR 3 SITE LAYOUT
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

CONTRACT NO. 5327
APPROVED BY: CMB — DATE: 11/23/2004
APPROVED BY — DATE
FIGURE NO. 11-1 — REV. 0

FILE: K:\FIVE YEAR REVIEW.APR LAYOUT: FIGURE 11-1 IR 3 SITE LAYOUT DATE: 11/22/2004 BY: EHM

FIGURE 11-2

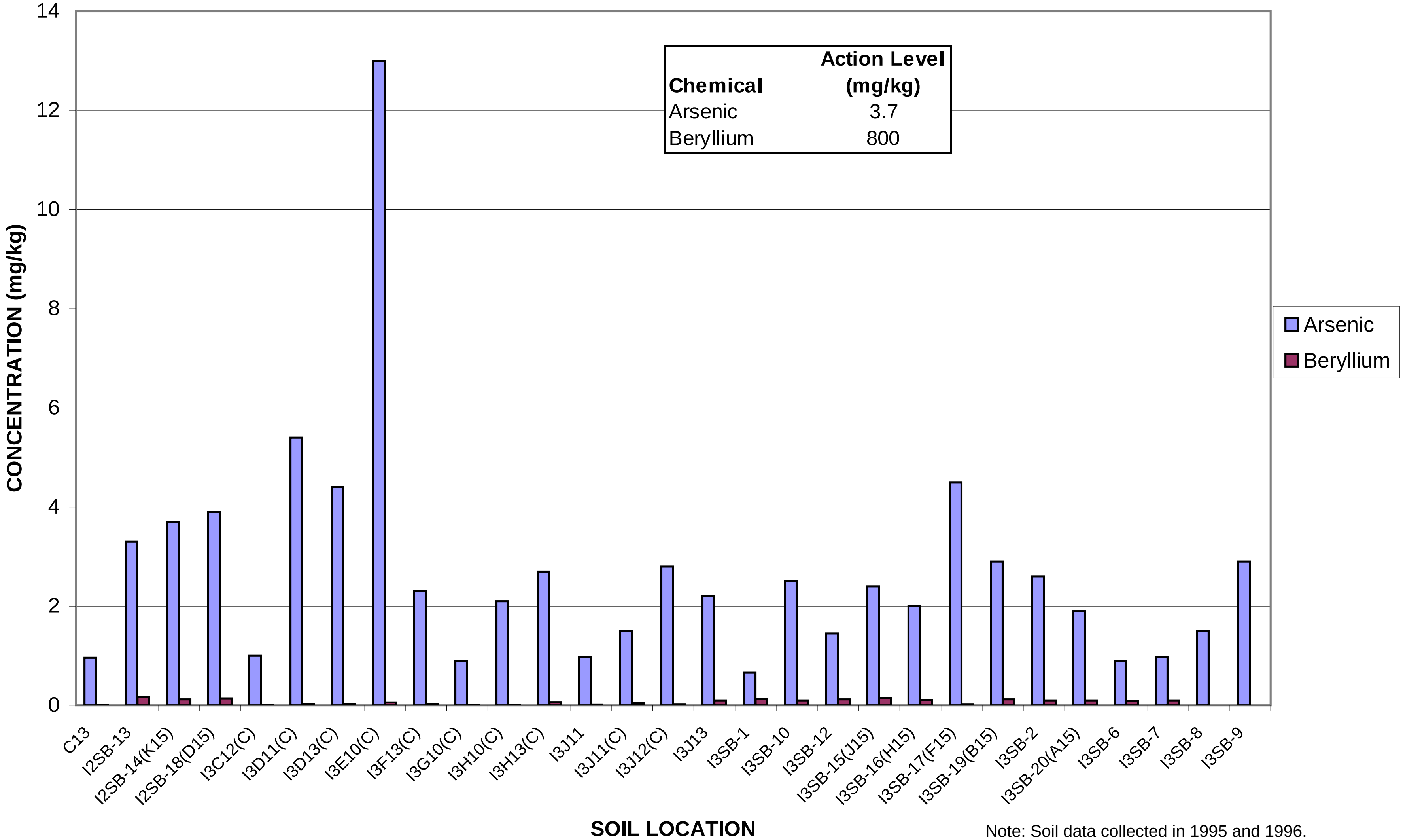
PESTICIDES IN SOIL
IR 3
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA



Note: Soil data collected in 1995 and 1996.

FIGURE 11-3

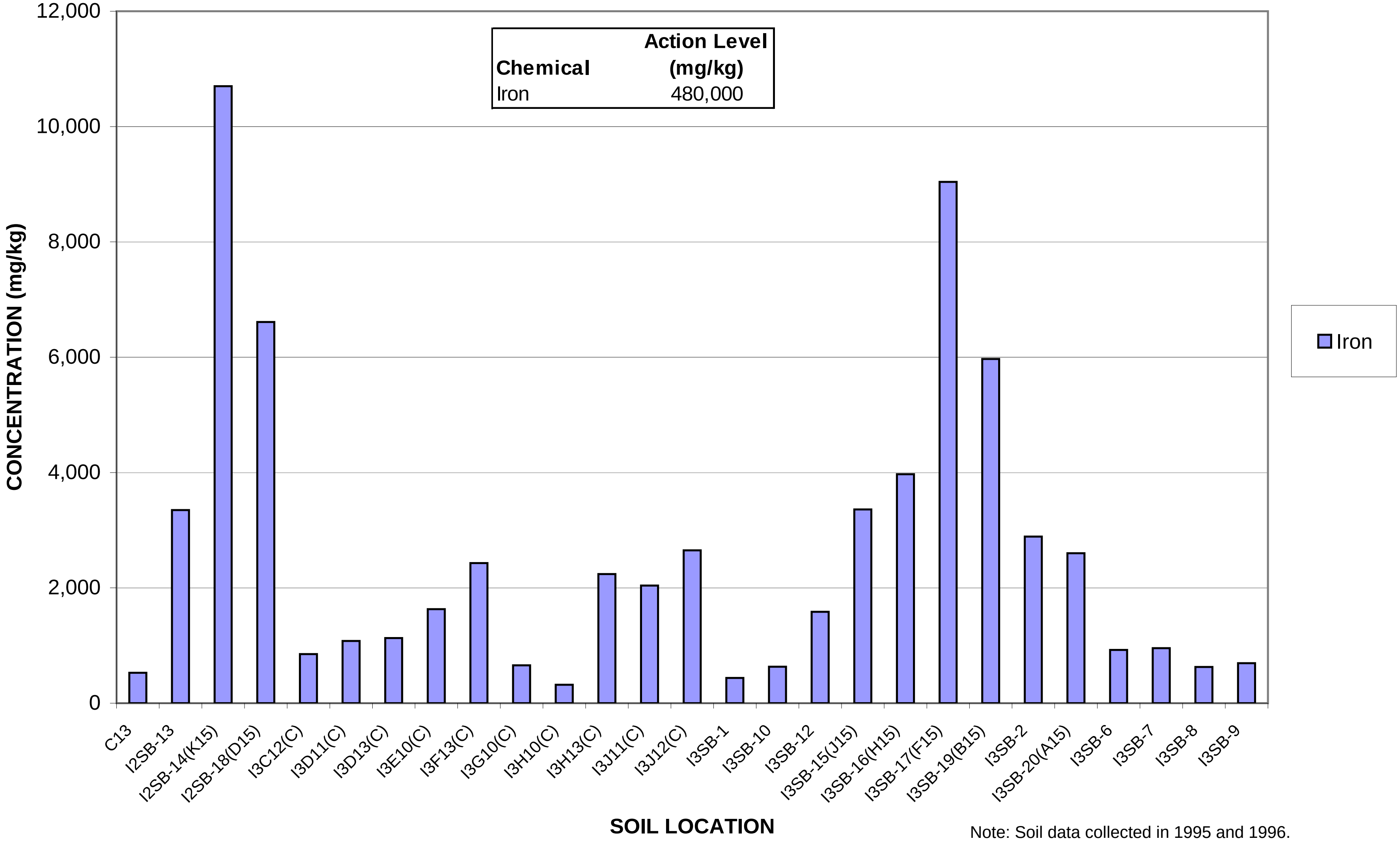
INORGANIC COCS IN SOIL
IR 3
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA



Note: Soil data collected in 1995 and 1996.

FIGURE 11-4

IRON IN SOIL
IR 3
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA



Note: Soil data collected in 1995 and 1996.

12.0 IR 7 - FORMER FLEMING KEY NORTH LANDFILL

This section describes the five-year review for IR 7, the Former Fleming Key North Landfill.

12.1 HISTORY AND SITE CHRONOLOGY

A list of IR 7 important historical events and relevant dates in the site chronology is shown below. The identified events are intended to be illustrative, rather than comprehensive.

Investigation/Activity	Date
Fleming Key North Landfill, Navy and City of Key West operations	1952 to 1962
USDA Animal Import Center operations	1979 to 1999
IAS Report produced by Envirodyne Engineers	May 1985
Verification Study Assessment produced by G&M	March 1987
Preliminary RI Report issued by IT	January 1991
RFI/RI Report issued by IT	June 1994
IRA completed by BEI	October 1995
Supplemental RFI/RI Report for Eight Sites issued by B&RE	January 1998
Proposed Plan for IR 7 issued by TtNUS	October 1998
Decision Document and Responsiveness Summary for IR 3, IR 7, and AOC B issued by TtNUS	April 1999
First Year of Quarterly Performance Monitoring implemented by TtNUS	April 2000
Annual Performance Monitoring conducted by TtNUS	January 2002
Environmental Baseline Survey conducted by TtNUS at Harry S. Truman Animal Import Center.	2002
Annual Performance Monitoring conducted by TtNUS	January 2003
Annual Performance Monitoring conducted by REA	January 2004

12.2 BACKGROUND

12.2.1 Site Description

IR 7, the former Fleming Key North Landfill, is located on the north portion of Fleming Key, north of the island of Key West (Figure 12-1). The site, a relatively flat area of approximately 30 acres in size, was used from 1952 to 1962 as a landfill for NAS Key West and the City of Key West. In 1979, the U.S. Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS) constructed the Harry S. Truman Animal Import Center over 18.4 acres of the landfill. During the construction phase, wastes were excavated and transferred to an area immediately to the west of the construction site and buried under a soil/rock cover. The Animal Import Center operated as a livestock quarantine facility from 1979 until 1999. Currently, the entire landfill area is covered with soil and is vegetated by grass, weeds, or trees. Approximately 4,000 to 5,000 tons of unknown wastes were disposed of annually at the site. The open trench and fill method was used during landfill operations; trenches were approximately 25 feet wide, 10 feet deep, and 500 to 1,000 feet in length and typically contained about 3 feet of sea water in the bottom. Wastes disposed of in the trenches were covered at the end of each working day with soil. Malathion, DDT, and diesel oil were sprayed on the landfill to control pests and insects. The soil, sediment, groundwater and surface water have been impacted by organic and inorganic contaminants that exceed action levels. Fill material placed on site has created a topographic high around the Animal Import Center. The area surrounding this feature slopes gradually toward Man of War Harbor to the west and the Gulf of Mexico to the east. Lining the shore of the Gulf are large concrete boulders to prevent shoreline erosion. Along the shore of North Fleming Key and to the northwest are woods and mangroves. To the west are mangroves and small dirt roads. South of the site is an ammunitions storage area for the Navy. North of the site is a U.S. Army Special Forces training facility (B&RE, 1998a).

12.2.2 Summary of Sampling Results

In 1986, G&M conducted an initial investigation of IR 7. This investigation involved the installation of four shallow monitoring wells. Several organic compounds including SVOCs and VOCs were found in samples from the wells. Analyses for metals detected concentrations of copper, mercury, and arsenic (G&M, 1987). In 1990, IT conducted a preliminary RI, which included the installation of five soil borings (converted to monitoring wells) and the excavation of 21 test pits to characterize the waste types and distribution patterns. Waste consisted of household, construction, and electrical debris, and scrap metal. The majority of the waste was household debris, including tires, glass, plastic, and basic household trash. Construction debris included concrete slabs, steel cables, and piping. Electrical debris consisted of electrical conduit, wire, and low-voltage batteries. Scrap metal waste included sheet metal and refrigerator parts. Groundwater samples from the site indicated metals (i.e., antimony, chromium, cadmium, mercury, and lead) were present in concentrations above established standards. Wells located downgradient along the shoreline within the landfill area had the highest concentrations of metals (IT, 1991).

In 1993, IT Corporation conducted soil, sediment, surface water, and groundwater sampling during the RFI/RI at this site. Characterization of contamination at the site indicated that groundwater appeared to be impacted by cyanide, metals (i.e., arsenic, cadmium, lead, and mercury), and pesticides. Mercury and cyanide also were detected in surface water at concentrations exceeding surface water quality standards. The Final RFI/RI prepared by IT recommended continued monitoring of the site for possible migration of contaminants, grading the west side of the site to provide drainage and prevent ponding of water over the waste material, maintaining the soil and vegetative cover for the site, performing a preliminary ecological risk assessment, and conducting a BRA based on monitoring data (IT, 1994).

12.2.3 1995 IRA

In September 1995, BEI performed an IRA at IR 7 to prevent ponding of rainwater and minimize infiltration through the waste. Clean topsoil was imported to fill low areas and promote runoff. A vegetative cover was established to prevent erosion. BEI mowed the non-wooded surface of IR 7 to visually identify low spots to be filled with clean topsoil. Forty (40) cubic yards of topsoil were put in place and sodded with grass to meet the objectives of the IRA. The IRA achieved the goal of preventing rainwater ponding at the site (BEI, 1998).

12.2.4 Summary of Risk

A BRA and an ecological risk assessment were performed as part of the Supplemental RFI/RI for Eight Sites. Contaminants were not present at sufficient concentrations to cause adverse non-carcinogenic health effects to any current potential receptors or future excavation workers. Although some cancer risks exceeded FDEP's target risk, the cancer risks estimated for the current potential or future receptors were below EPA's target risk range that is often used in setting standards and criteria, and in evaluating the need for environmental remediation. Adverse non-carcinogenic health effects may occur for the hypothetical future resident. Antimony was the main contributor to the non-carcinogenic risk (B&RE, 1998a).

The ecological risk assessment at IR 7 indicated that site-related contaminants have not accumulated in vegetation, crabs, or lobsters, and potential ecological risk from contaminants in groundwater, surface water, soil, and sediment are negligible (B&RE, 1998a).

12.3 REMEDIAL ACTIONS

12.3.1 Remedy Selection

The remedy for IR 7 was presented in the Proposed Plan (TtNUS, 1998g) and is documented in the Decision Document and Responsiveness Summary for IR 3, IR 7, and AOC B (TtNUS, 1999f). The selected remedy includes groundwater monitoring to detect any contaminant migration from the landfill. In addition, LUCs were implemented to reduce the potential risk to human health and the environment associated with the remaining wastes in the landfill (TtNUS, 1999f).

12.3.2 Remedy Implementation

IR 7 is on an active military base with no planned change in site usage for the foreseeable future. LUCs were developed through LUCIPs. These controls were designed to ensure protection of human health and the environment by restricting future site use and accessibility, educating NAS Key West personnel, and maintaining records of contamination. The LUCs documented in the NAS Key West Base Master Plan prevent future residential use at this site. The LUCIP for IR 7 includes the placement and maintenance of signs along the perimeter of the site warning against dumping and trespassing. Personnel from the NAS Key West Public Works Department are required to visually inspect IR 7 at least once every three months to ensure that all LUCs are being implemented and properly maintained. The NAS Key West Public Works Department submits an annual report to FDEP describing the results of the quarterly inspections.

To implement the monitoring program for this corrective measure, groundwater samples were collected quarterly for the first year and annually thereafter. The quarterly monitoring began in April 2000 and was completed in January 2001 (TtNUS, 2001a). Additional annual events were performed in January 2002 and 2003 (TtNUS; 2002a, 2003a).

12.3.3 System Operations and Maintenance

Six sampling events involving the monitoring of groundwater have been conducted since April 2000. Four sampling events were conducted quarterly during the first year. Subsequent annual events were conducted in January 2002 and 2003. According to cost estimates obtained from the NAS Key West Public Works Environmental Department, the approximate annual cost for the long term monitoring and LUCs associated with the remedy at IR 7is $1570.

12.4 FIVE-YEAR REVIEW PROCESS

12.4.1 Document Review

Reports and data from investigations conducted from 1985 through 2003 were reviewed for this five-year review, as discussed in Section 12.2.

12.4.2 Data Review

Concentrations of media-specific COCs identified in the Supplemental RFI/RI were plotted to identify and evaluate trends across various investigations. Antimony in soil and surface water was the only COC

(B&RE, 1998a). Surface water sampling is not part of performance monitoring at IR 7, so no trends are available for antimony in surface water. However, concentrations of antimony in historical sample data do not exceed the current action level for antimony in surface water. Therefore, antimony should be eliminated as a COC in surface water.

The Performance Monitoring Plan for IR 7 recommended the collection and analyses of groundwater samples from four locations quarterly for the first year of monitoring and annually for the next nine years, and groundwater samples were to be analyzed for Appendix IX VOCs, SVOCs, pesticides, and TAL metals (TtNUS, 2000e). However, analyses of selected chemical fractions were reduced and the sampling of three monitoring wells was discontinued due to few action level exceedances during the first year of monitoring (TtNUS, 2001a). Arsenic has been the only analyte that exceeded its current action level (10 µg/L) after the first year of performance monitoring; at 91.7 µg/L in 2002 (TtNUS, 2002a) and 45.7 µg/L in 2003 (TtNUS, 2003a).

Soil sampling is not part of performance monitoring at IR 7, but soil samples were collected and analyzed in 2002 as part of an Environmental Baseline Survey (EBS) for the Animal Import Center (TtNUS, 2002e), which is located within IR 1 (Figure 12-1). Figure 12-2 presents antimony data for individual soil samples collected at IR 7 in 1993 and 2002. Antimony did not exceed the action level in any sample collected, and should therefore be eliminated as a soil COC. Arsenic, iron, benzo(a)pyrene, aroclor-1254, aroclor-1260, and dioxins exeeded FDEP industrial Soil Cleanup Target Levels in a few samples located in a former sludge drying bed and a former ash pile (TtNUS, 2002e). The contaminated soil was excavated and removed (TN&A, 2003), and the EBS data are not evaluated in this report.

12.4.3 <u>Site Inspection</u>

The site has been inspected on numerous occasions during routine monitoring events. No significant issues have been identified at any time regarding the site. Since access to the base is restricted, potential access by trespassers is minimal. In addition, signs are in place around the site perimeter, warning that dangerous material may be present below ground surface.

12.5 TECHNICAL ASSESSMENT

The Comprehensive Five-Year Review Guidance (EPA, 2001) states that the technical assessment section should answer three primary questions, each of which is presented below.

12.5.1 Question A

Is the remedy functioning as intended in the decision documents?

The remedy to protect human health and the environment is functioning as intended in the Decision Document. IR 7 is located on an active military base, and access to the base is restricted. NAS Key West personnel perform quarterly monitoring to ensure adherence to LUCs, and an annual report is submitted to FDEP describing the results of the quarterly monitoring. In addition, warning signs are in place around the site perimeter, reducing the chance of potential exposure to base personnel. There is no planned change in site usage for the foreseeable future.

12.5.2 Question B

Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of the remedy selection still valid?

There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. There have been no significant changes to the standardized risk assessment methodology or toxicity data that affect the protectiveness of the remedy. However, following conclusions presented in the Supplemental RFI/RI Report, the action level selection process was revised by the NAS Key West Partnering Team as presented in the Site Investigation Work Plan for Ten BRAC Parcels (B&RE, 1998). The current ARARs are include in Appendix C, along with the dates of the latest revisions and the method of selection for each medium. Values evaluated for each medium are listed in tables, along with the selected action level.

Antimony in surface water and soil was the only COC identified in the Supplemental RFI/RI (B&RE, 1998a). Subsequent to the 1998 RFI/RI, the surface water action level for antimony was increased from 67 to 4,300 μg/L, and the soil action level was increased from 0.79 to 240 mg/kg. Antimony concentrations in surface water and soil do not exceed the current action levels. Therefore, antimony should no longer be considered a COC in surface water or soil at IR 7. There are no new soil COCs.

12.5.3 Question C

Has any other information come to light that could call into question the protectiveness of the remedy?

No new ecological receptors or human usage of the site were identified during performance monitoring or during the five-year review. No weather related events have affected the protectiveness of the remedy. Hurricane Georges passed directly over the Key West area in September 1998, with maximum sustained winds near 100 mph, but no erosion or other effects were visible at IR 7 as a result of the storm. There is no known information that calls into question the protectiveness of the remedy.

12.5.4 Technical Assessment Summary

Based on the data reviewed and the site inspections, the remedy is functioning as intended by the Decision Document. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. There have been no significant changes to the standardized risk assessment methodology that could affect the protectiveness of the remedy. There is no other information that calls into question the protectiveness of the remedy.

12.6 ISSUES

There are no unresolved issues that could impact the remedy.

12.7 RECOMMENDATIONS AND FOLLOW UP ACTIONS

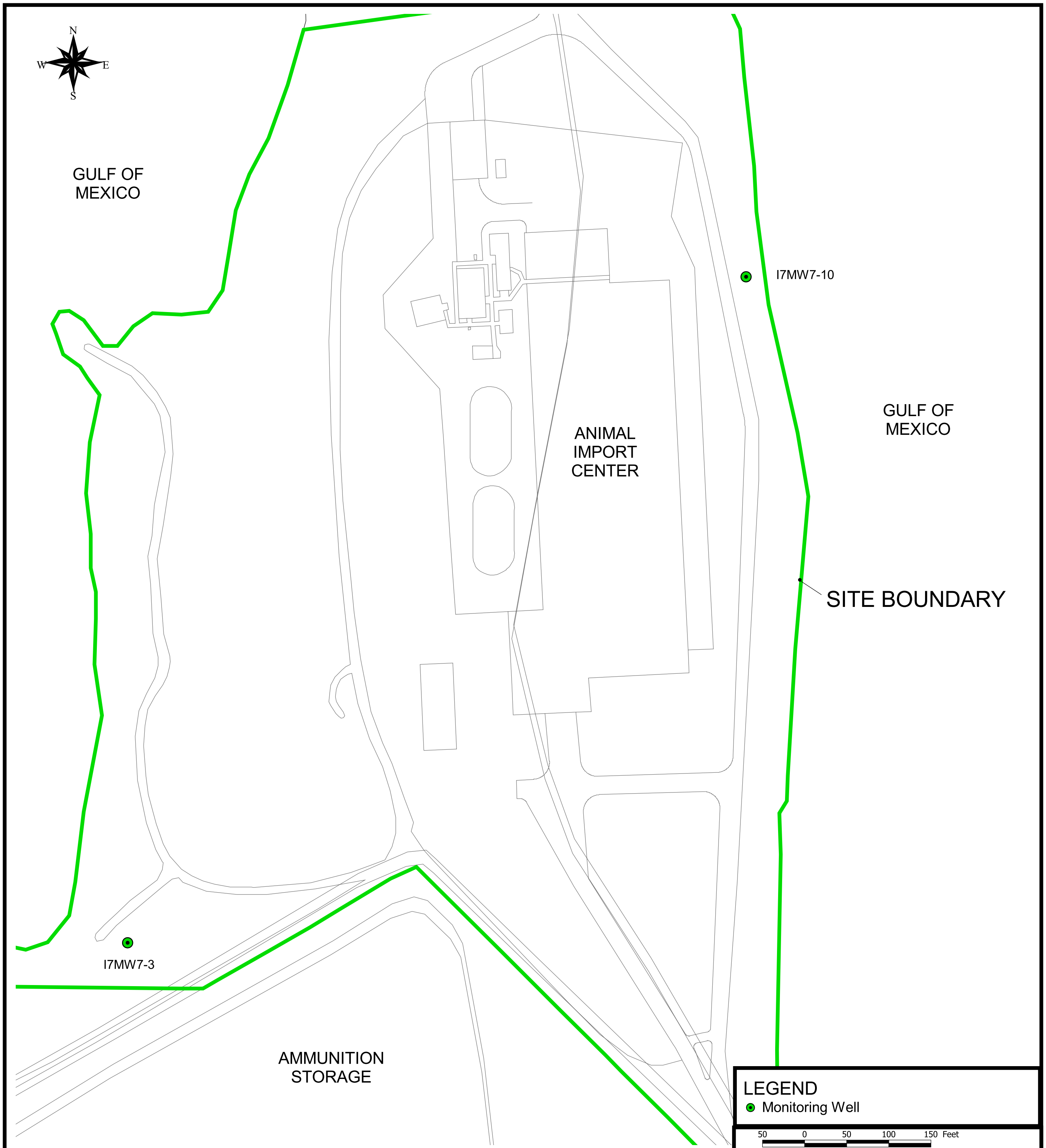
The remedy (LUCs and groundwater monitoring) should continue to be implemented as is. Groundwater should continue to be monitored annually as required by landfill regulations to ensure that landfill contamination is not leaching to other media.

12.8 PROTECTIVENESS STATEMENT

The remedy is expected to continue to be protective of human health and the environment.

12.9 NEXT REVIEW

The next five-year review for IR 7 is required by May 2009.



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IR 7 SITE LAYOUT
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

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APPROVED BY CMB	DATE 11/23/2004
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FIGURE NO. 12-1	REV. 0

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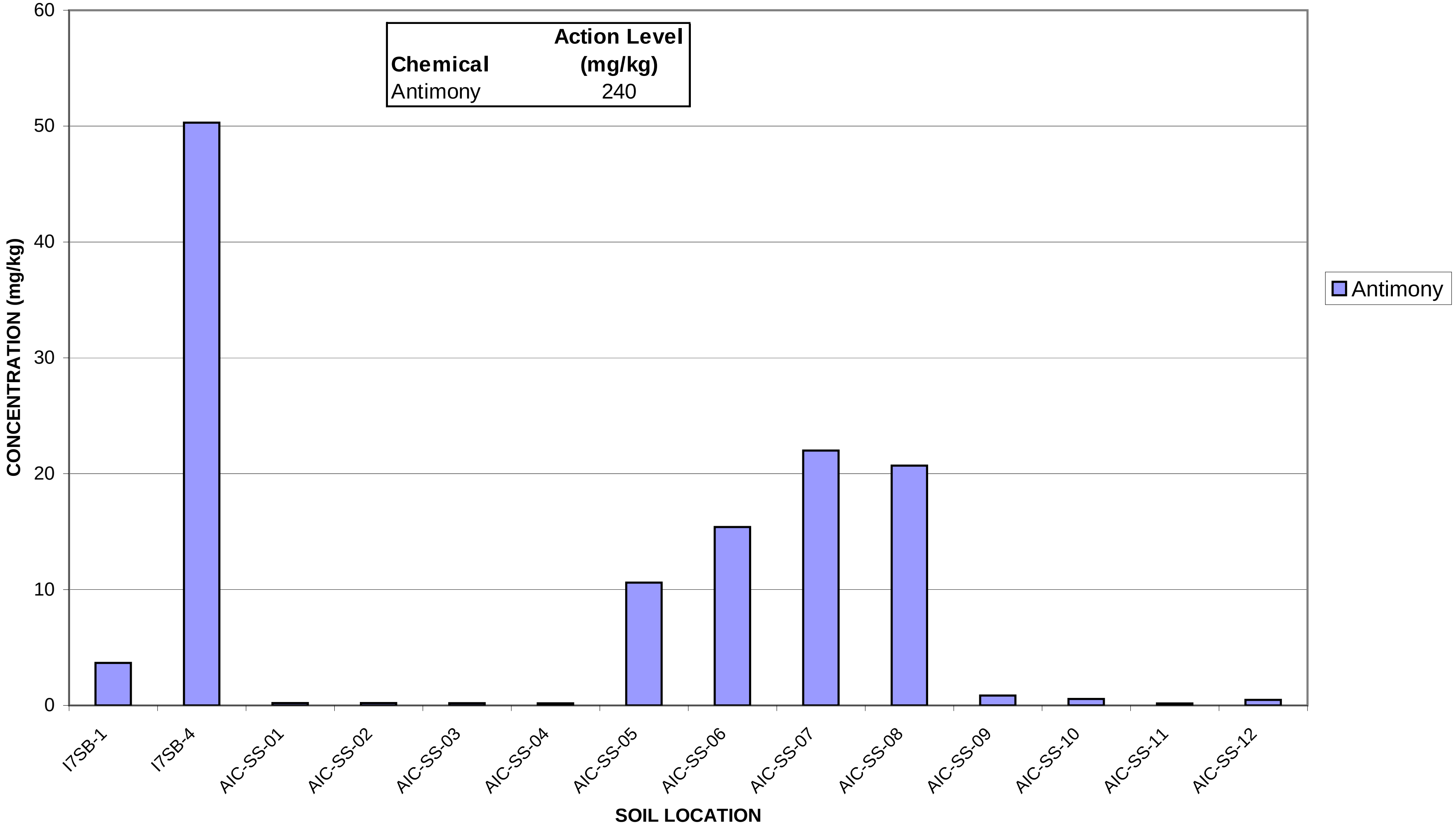
FIGURE 12-2

ANTIMONY IN SOIL
IR 7
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA



Note: Soil data collected in 1993 and 2002.

13.0 IR 8 - FORMER FLEMING KEY SOUTH LANDFILL

This section describes the five-year review for IR 8, the Former Fleming Key South Landfill.

13.1 HISTORY AND SITE CHRONOLOGY

A list of IR 8 important historical events and relevant dates in the site chronology is shown below. The identified events are intended to be illustrative, rather than comprehensive.

Investigation/Activity	Date
Fleming Key South Landfill, Dredgers Key operations	1948 to 1951
Fleming Key South Landfill, Navy operations	1962 to 1982
Fleming Key South Landfill, Navy and City of Key West operations	1968 to 1982
IAS Report issued by Envirodyne Engineers, Inc.	May 1985
Verification Study Assessment produced by G&M	March 1987
Preliminary RI Report issued by IT	January 1991
RFI/RI Report issued by IT	June 1994
Shoreline Protection System installation completed by BEI	August 1997
Supplemental RFI/RI Report for Eight Sites issued by B&RE	January 1998
Sediment Toxicity Study Report produced by TtNUS	August 1999
Proposed Plan for IR 8 issued by TtNUS	March 2000
Decision Document for IR 1 and IR 8 issued by TtNUS	September 2000
First year of Quarterly Performance Monitoring implemented by TtNUS	July 2001
Annual Performance Monitoring performed by TtNUS	January 2003
Annual Performance Monitoring conducted by REA	January 2004

13.2 BACKGROUND

13.2.1 Site Description

The Fleming Key South Landfill (IR 8) covers approximately 45 acres in the southwest portion of Fleming Key. The southeast portion of the site is bordered by the City of Key West Sewage Treatment Plant. An ammunitions storage area is located along the east boundary of the site. The remainder of the site is bordered by the Man of War Harbor and Fleming Key Cut. A closed canopy of Australian pines covers most of the site. The west portion of the site contains piles of metal debris (heavy equipment, desks, marine equipment, etc.) (B&RE, 1998a).

Waste materials and fill from Sigsbee Key (formerly Dredgers Key) were disposed at the site between 1948 and 1951. As much as 8,000 tons of unknown wastes were reportedly disposed annually at the landfill between 1962 and 1982. Waste disposal activities of the City of Key West were combined with those of the Navy from 1968 to 1982 at this site. The open trench disposal method was practiced at this site, with the trenches being constructed in a manner similar to that used at Fleming Key North Landfill (IR 7). The trenches were partly full of seawater when the wastes were disposed. Wet garbage was placed directly into one end of the trench and combustible wastes were taken to the west portion of the site and burned. The ashes and unburned wastes were then placed in the rest of the trench (B&RE, 1998a).

13.2.2 Summary of Sampling Results

G&M performed an initial investigation at IR 8 in 1986 involving the installation of five shallow monitoring wells (G&M, 1987). Based on the results of this investigation, IT conducted a preliminary RI in 1990 that included soil and groundwater sampling (IT, 1991). In 1993, an RFI/RI was performed for characterization of contamination at the site. The RFI/RI indicated that groundwater and sediment appeared to be extensively impacted by metals. The Final RFI/RI Report recommended that: receptor identification and tissue analysis be performed to confirm uptake of contaminants; an IRA be performed to prevent further contact between the surface water and the waste materials along the shoreline; a preliminary FS be conducted; and a BRA be performed based on post-IRA data (IT, 1994).

13.2.3 Summary of Risk

In 1996, the Supplemental RFI/RI was performed by B&RE (B&RE, 1998a). Metals and pesticides were found to be the most widespread contaminants detected at the site. VOCs were detected in sediment and groundwater. SVOCs were detected in sediment, surface water, and groundwater. PCBs were detected, to a limited extent, in sediment and surface water. A BRA and ecological risk assessment were performed at IR 8. Two scenarios (residential and trespasser adolescent) were calculated to be above the hazard index threshold for non-carcinogenic risk. The results of the ecological risk assessment concluded that risks at IR 8 were primarily confined to benthic organisms from contamination in sediment. The Supplemental RFI/RI recommended that an FS be conducted at IR 8, and include toxicity tests to determine whether the concentration of chemicals detected in sediments were toxic to benthic organisms (B&RE, 1998a).

Because of low human health risks, the NAS Key West Partnering Team decided to perform a Sediment Toxicity Study at IR 8 instead of an FS. The bioavailability and toxicity of IR 8 sediment contamination to benthos was not assessed during the ecological risk assessment. The Sediment Toxicity Report for Sites IR 1 and IR 8 (TtNUS, 1999g) concluded that potential ecological risks from site-related contaminants appeared to be negligible.

13.2.4 Shoreline Protection System

In February 1997, BEI began installation of a shoreline protection system to establish a stable shoreline along the landfill perimeter to prevent debris from being washed into the harbor by erosion. By August 1997, the shoreline structure had been fully installed (BEI, 1998).

13.3 REMEDIAL ACTIONS

13.3.1 Remedy Selection

The Proposed Plan for Fleming Key South Landfill (TtNUS, 2000f) summarizes and the Decision Document for IR 1 and IR 8 documents the selected remedy for IR 8 (TtNUS, 2000d). The remedy involves LUCs with performance monitoring of groundwater. The remedy addresses remaining contamination in groundwater, and the LUCs are designed to eliminate or reduce exposure pathways by limiting site access (TtNUS, 2000d).

13.3.2 Remedy Implementation

IR 8 is located on an active military base with no planned change in site usage for the foreseeable future. LUCs were developed through LUCIPs. These controls were designed to ensure protection of human health and the environment by restricting future site use and accessibility, educating NAS Key West personnel, and maintaining records of contamination. The LUCs documented in the NAS Key West Base Master Plan prevent future residential use at this site. The LUCIP for IR 8 includes the placement and maintenance of signs around the site perimeter warning against dumping and trespassing. Personnel from the NAS Key West Public Works Department are required to visually inspect IR 8 at least once every three months to ensure that all LUCS are being implemented and properly maintained. The NAS Key West Public Works Department submits an annual report to FDEP describing the results of the quarterly inspections.

To implement the monitoring program for this corrective measure, groundwater samples were collected quarterly for the first year and annually thereafter. The quarterly monitoring began in July 2001 and was completed in April 2002 (TtNUS, 2002c). The first annual event was performed in January 2003 (TtNUS, 2003a).

13.3.3 System Operations and Maintenance

Five sampling events involving the monitoring of groundwater have been conducted since July 2001. Four sampling events were conducted quarterly during the first year. A subsequent annual event was conducted in January 2003. According to cost estimates obtained from the NAS Key West Public Works Environmental Department, the approximate annual cost for the long term monitoring and LUCs associated with the remedy at IR 8 is $1,900.

13.4 FIVE YEAR REVIEW PROCESS

13.4.1 Document Review

Reports and data from investigations conducted from 1985 through 2003 were reviewed for this five-year review, as discussed in Section 13.2.

13.4.2 Data Review

Concentrations of media-specific COCs identified in the Supplemental RFI/RI were plotted to identify and evaluate trends across various investigations. COCs were identified in sediment and surface water for IR 8, and concentrations over time were plotted for sampling locations. The plots also show the media-specific action level for each COC. The action levels are concentrations that have been selected by the NAS Key West Partnering Team as representing concentrations below which there is no potential for unacceptable risk to human health or the environment. The action levels were selected from several sources, and are included in Appendix C.

13.4.2.1 Groundwater

Although there were no COCs in groundwater (B&RE, 1998a), the selected remedy includes groundwater monitoring in order to detect any contaminant migration from the landfill. Groundwater samples were initially collected and analyzed from three monitoring wells, but one well has been deleted from long term monitoring due to consistently low concentrations of analytes (TtNUS, 2002c). Since that time, arsenic has been the only analyte that exceeded its current action level (10 µg/L); at 60.6 µg/L in the third quarterly sample of I8MW8-2 (TtNUS, 2002c) and 53.1 µg/L in 2003 (TtNUS, 2003a).

13.4.2.2 Surface Water

Antimony, arsenic, and iron were identified as COCs in surface water at IR 8. However, no trends are available for surface water data because no location was sampled more than once. When compared to updated action levels, no exceedances of the action levels were observed for antimony or arsenic in 1990 or 1993 data. One exceedance was observed for iron in surface water, but this occurred in 1990, and no exceedances occurred in the subsequent sampling event in 1993. Because IR 8 borders the Gulf of Mexico, surface water contamination, when present, might be the result of regional local (non-site) conditions rather than site-related inputs. Nevertheless, concentrations of metals in surface water were low relative to current action levels. Therefore, antimony, arsenic, and iron should be eliminated as COCs in surface water at IR 8.

13.4.2.3 Sediment

COCs identified in sediment include antimony, arsenic, iron, and thallium. Figures 13-2 through 13-5 present concentrations over time for these chemicals in sediment. Antimony was detected above the action level of 12 mg/kg in two samples collected in 1990 (Figure 13-2). However, no exceedances have been observed in samples collected in 1993, 1997, or 1998. Arsenic has exhibited multiple exceedances at several sample locations during various investigations as shown in Figure 13-3. In particular, arsenic has exceeded the action level in samples collected from IR8-SD-4 each time it has been sampled. For iron, although limited data are available as presented in Figure 13-4, exceedances of the action level were observed during the most recent sampling event, the Sediment Toxicity Study for IR 1 and IR 8 (TtNUS, 1999g). Thallium concentrations in sediment were plotted on Figure 13-5. No action level exists for thallium in sediment, but the chemical has not been detected since 1990.

Due to lack of exceedances and/or detections, it is recommended that antimony and thallium be eliminated as COCs in sediment at IR 8.

13.5 TECHNICAL ASSESSMENT

The Comprehensive Five-Year Review Guidance (EPA, 2001) states that the technical assessment section should answer three primary questions, each of which is presented below.

13.5.1 Question A

Is the remedy functioning as intended by the decision documents?

The remedy to protect human health and the environment is functioning as intended. IR 8 is located on an active military base, and access to the base is restricted. NAS Key West personnel perform quarterly monitoring to inspect the shoreline protection structure and to ensure adherence to LUCs, and an annual report is submitted to FDEP describing the results of the quarterly monitoring. In addition, warning signs are in place around the site perimeter, reducing the chance of trespassing and potential exposure to base personnel. There is no planned change in site usage for the foreseeable future.

13.5.2 Question B

Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of the remedy selection still valid?

There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. There have been no significant changes to the standardized risk assessment methodology or toxicity data that could affect the protectiveness of the remedy. However, following conclusions presented in the Supplemental RFI/RI Report, the action level selection process was revised by the NAS Key West Partnering Team as presented in the Site Investigation Work Plan for Ten BRAC Parcels (B&RE, 1998b). The current ARARs are included in Appendix C, along with the dates of the latest revisions and method of selection for each medium. Values evaluated for each medium are listed in tables, along with the selected action level.

Updated action levels were compared to analytes in groundwater, surface water, and sediment. Antimony, which was previously identified as a COC in sediment, does not exceed current action levels. Similarly, antimony and arsenic no longer exceed action levels in surface water. Arsenic in groundwater has exceeded its action level.

13.5.3 Question C

Has any other information come to light that could call into question the protectiveness of the remedy?

No new ecological receptors or human usage of the site were identified during performance monitoring or during the five-year review. No weather related events have affected the protectiveness of the remedy.

Hurricane Georges passed directly over the Key West area in September 1998, with maximum sustained winds near 100 mph, but no erosion or other effects were visible at IR 8 as a result of the storm. There is no known information that calls into question the protectiveness of the remedy.

13.5.4 Technical Assessment Summary

Based on the data reviewed and the site inspections, the remedy is functioning as intended by the Decision Document for IR 1 and IR 8 (TtNUS, 2000d). There have been no physical changes to the site that would affect the protectiveness of the remedy. There have been no changes to the standardized risk assessment methodology that could affect the protectiveness of the remedy. There is no other information that calls into question the protectiveness of the remedy.

13.6 ISSUES

There are no unresolved issues that could impact the remedy.

13.7 RECOMMENDATIONS AND FOLLOW UP ACTIONS

The remedy should continue to be implemented as is. Groundwater should continue to be monitored annually as required by landfill regulations and the LUCIP should be continued.

13.8 PROTECTIVENESS STATEMENT

The remedy is expected to continue to be protective of human health and the environment.

13.9 NEXT REVIEW

The next five-year review for IR 8 is required by May 2009.

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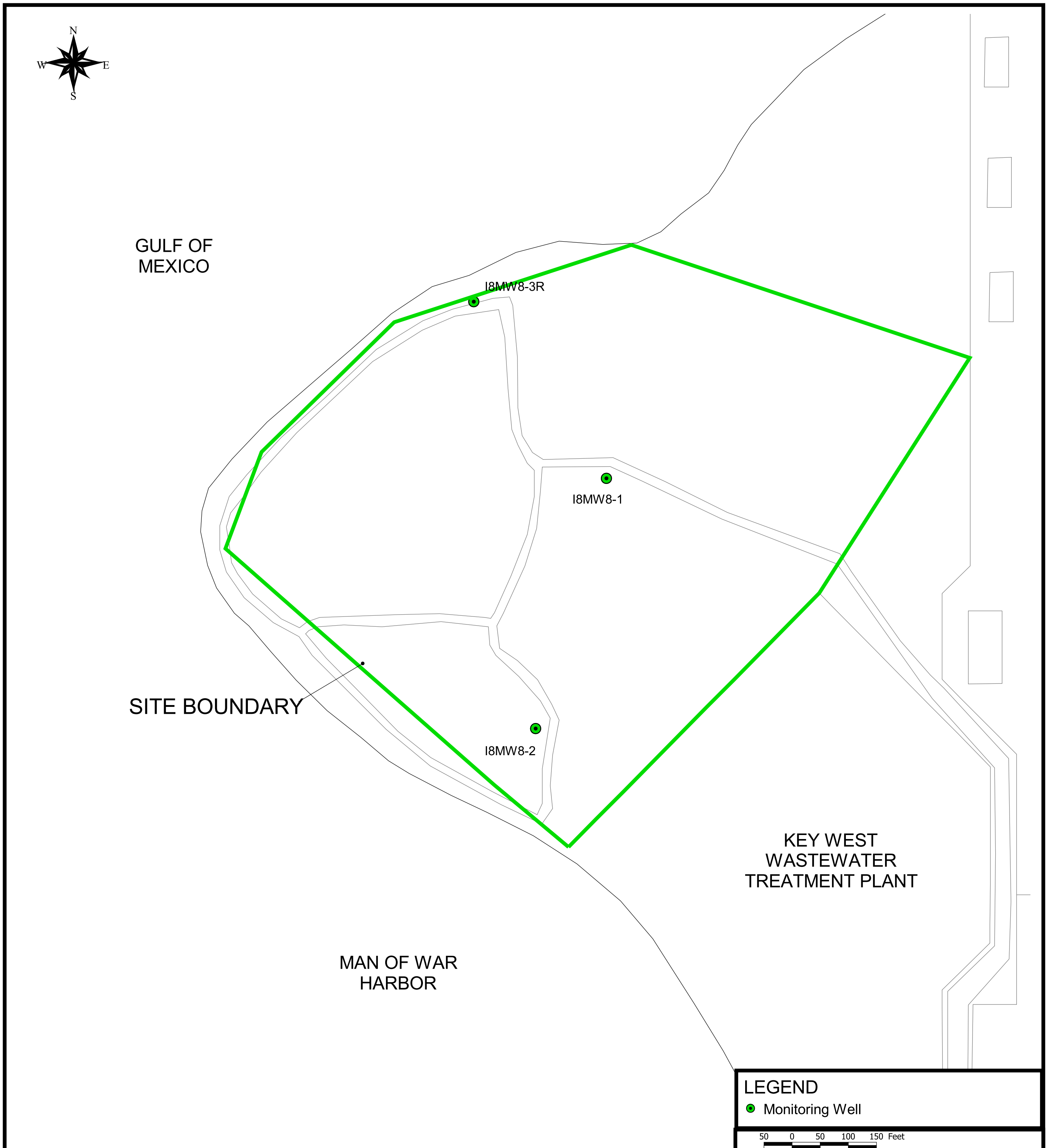

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			CHECKED BY SH	DATE 11/18/2004		FIVE YEAR REVIEW REPORT	APPROVED BY CMB	DATE 11/23/2004
			COST/SCHED-AREA			NAVAL AIR STATION	APPROVED BY	DATE
			SCALE AS NOTED			KEY WEST, FLORIDA	FIGURE NO. 13-1	REV. 0

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FIGURE 13-2

ANTIMONY IN SEDIMENT
IR 8
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

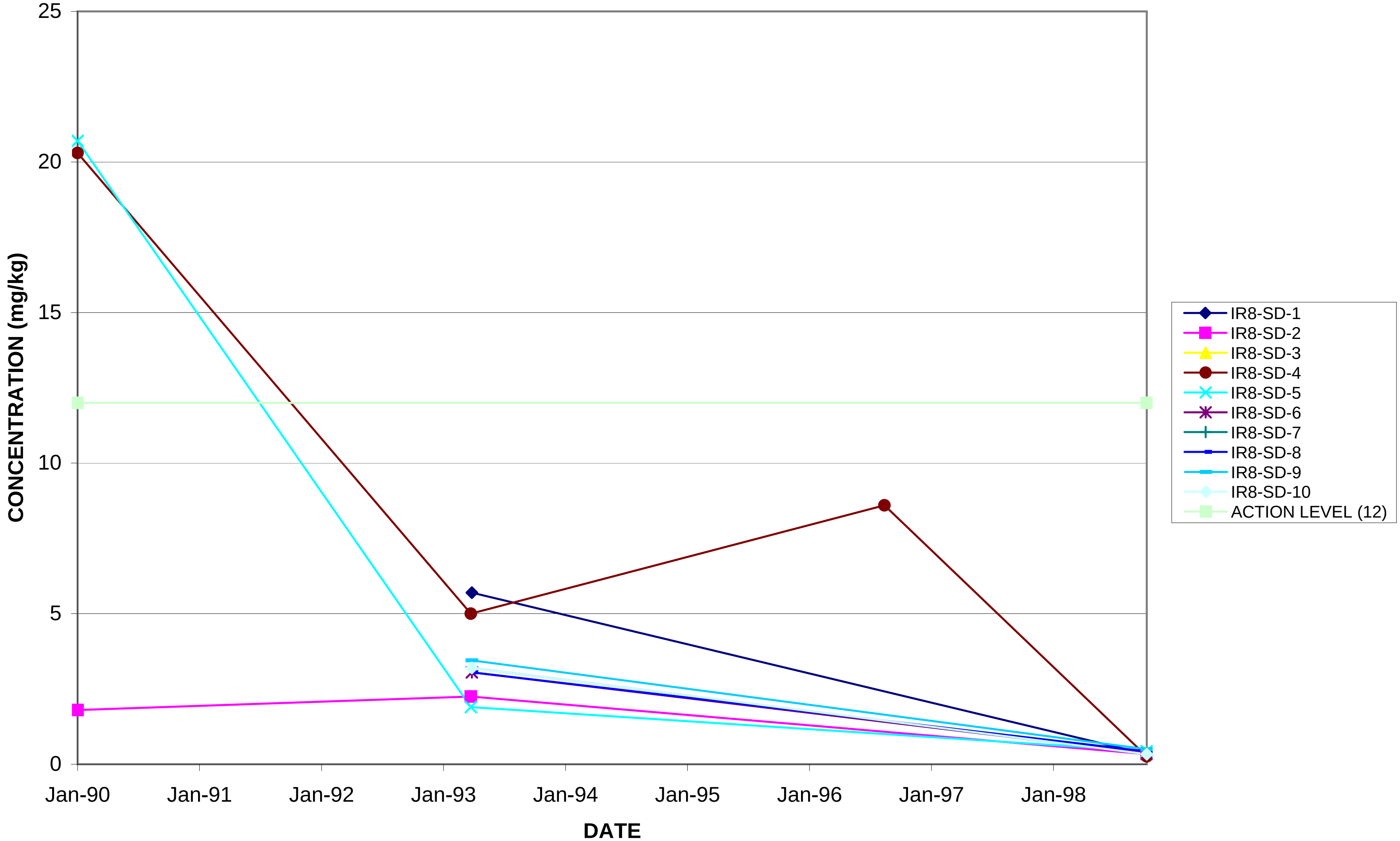


FIGURE 13-3

ARSENIC IN SEDIMENT
IR 8
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

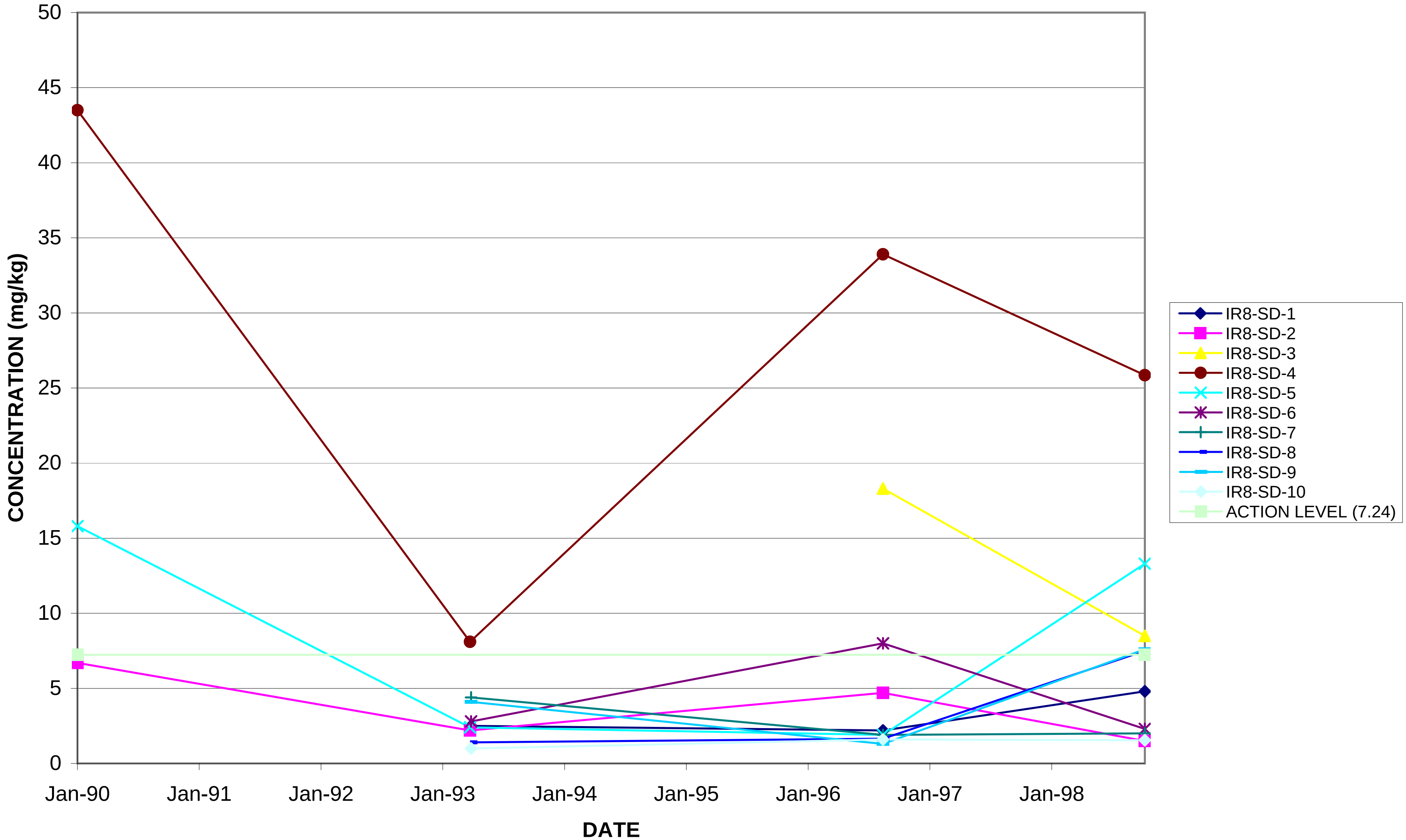


FIGURE 13-4

IRON IN SEDIMENT
IR 8
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

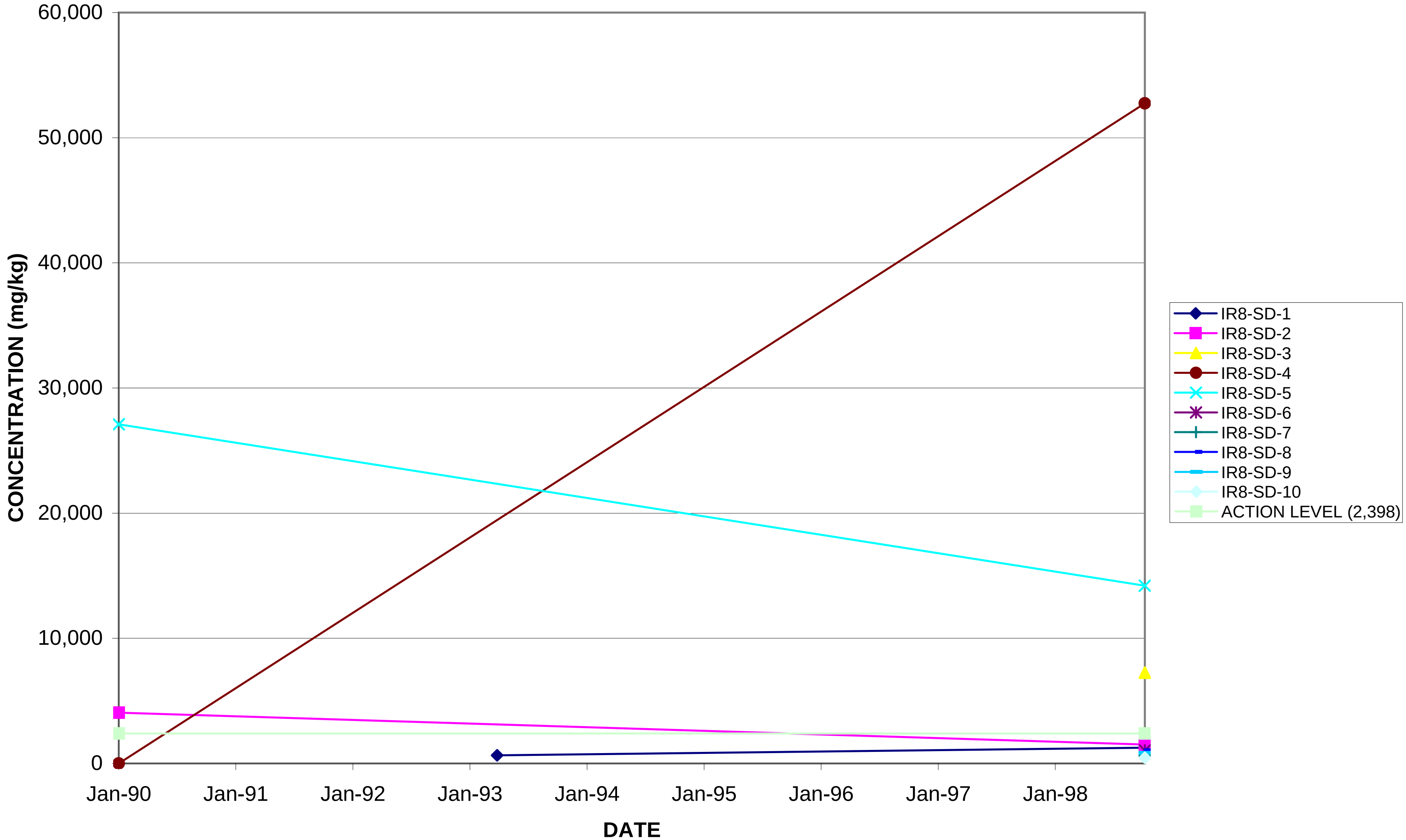
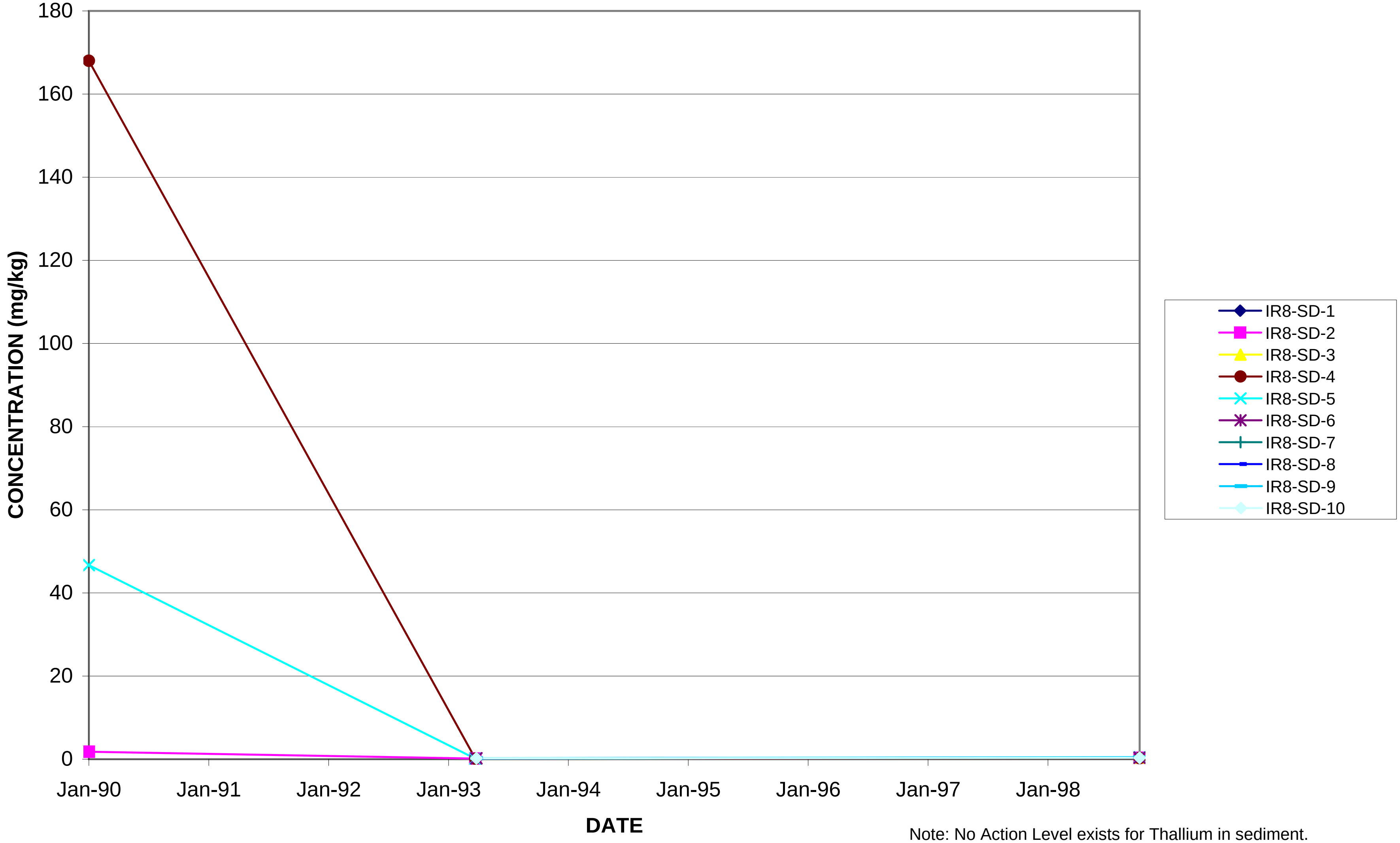


FIGURE 13-5

THALLIUM IN SEDIMENT
IR 8
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA



Note: No Action Level exists for Thallium in sediment.

14.0 IR 21 – TRUMAN ANNEX SEMINOLE BATTERY

This section describes the five-year review for IR 21, the Truman Annex Seminole Battery.

14.1 HISTORY AND SITE CHRONOLOGY

A list of important IR 21 historical events and relevant dates in the site chronology is shown below. The identified events are intended to be illustrative, rather than comprehensive.

Investigation/Activity	Date
Seminole Battery constructed	Early 1860s
Area adjacent to Battery used for fueling & grease rack	1940s to 1950s
Modern battery additions made	1950s
UST removal by Omega Environmental Services, Inc. (OES)	August 1995
Site Inspection Report for Nine BRAC Parcels issued by TtNUS	February 1999
Supplemental Site Inspection Report issued by TtNUS	September 1999
IRA excavation completed by BEI	March 1999
Decision Document for IR 21 issued by TtNUS	September 2000

14.2 BACKGROUND

14.2.1 <u>Site Description</u>

The Truman Annex Seminole Battery was constructed during the Civil War. A modern battery addition was constructed in the 1950s. The structure is currently unused and entry is restricted. Little is known about materials used while the Battery was in operation. The oldest portion of the Battery has remnants of a power generator exhaust system (TtNUS, 1999h).

Fueling tanks, known as Tanks 248A and 248B, were located west of the Truman Annex Seminole Battery near Building 248 (Figure 14-1). The tanks were constructed of plate steel and had a capacity of 5,000 gallons each. The tanks were used for gasoline storage and were located under a concrete slab with fuel islands. The fueling island and tanks were removed in August 1995. Soil screening and groundwater samples were analyzed during the closure of the USTs. The UST Closure Report concluded that the tanks were closed in accordance with FDEP guidelines. The area is now covered with asphalt. The UST Closure Report recommended a study of groundwater in the area (OES, 1995). To the northwest of the former tank location, concrete slabs are present from former grease racks used to lubricate and service vehicles. No stains are visible on or near the slabs (TtNUS, 1999h).

14.2.2 Summary of Sampling Results

In 1997, TtNUS performed sampling at IR 21 as part of a Site Inspection (SI). Arsenic, benzo(a)pyrene, and benzo(b)fluoranthene were detected in excess of action levels at one surface soil sample location. Further action was recommended in the SI Report (TtNUS, 1999h).

14.2.3 1999 IRA

In March 1999, BEI completed an IRA at IR 21, excavating 61.5 cubic yards of soil from IR 21 to a depth of 2 feet (BEI, 1999). Confirmation sampling results presented in the Supplemental Site Inspection (SSI) Report revealed that benzo(a)pyrene concentrations remained in excess of its action level at two sidewall sample locations adjacent to the battery foundation. Clean fill was placed in the excavation to reduce the possibility of exposure to potential contaminants remaining below 2 feet (TtNUS, 1999i).

14.3 REMEDIAL ACTIONS

14.3.1 Remedial Selection

As described in the Decision Document for Seminole Battery (IR 21), LUCs, including institutional and engineering controls, were selected as the remedy for the site since contamination was left in place above levels that allow for unlimited exposure (TtNUS, 2000g).

14.3.2 Remedial Implementation

The selected remedy for IR 21 is LUCs, consisting of institutional and engineering controls. Institutional controls at Truman Annex Seminole Battery include the development of a LUCIP and documentation in the Base Master Plan preventing future residential use at this site. The plan also requires that anyone who disturbs structures identified as a permanent cover and/or containment material to comply with appropriate laws and regulations. LUCs are considered to be protective of human health and the environment under current industrial uses at IR 21, comply with state and federal requirements, and are cost effective (TtNUS, 2000g).

14.3.3 System Operations and Maintenance

Engineering controls are in place at the site (battery foundation). According to cost estimates obtained from the NAS Key West Public Works Environmental Department, the cost associated with the selected remedy is approximately $1,500 per year.

14.4 FIVE YEAR REVIEW PROCESS

14.4.1 Document Review

Because the selected remedy is LUCs, a document review for IR 21 is not applicable.

14.4.2 Data Review

Because the selected remedy is LUCs, no analytical data have been generated since the 1999 SSI. However, soil data evaluated in the SSI were reviewed and compared to current action levels (see Section 14.5.2). The action levels are concentrations that have been selected by the NAS Key West Partnering Team as representing concentrations below which there is no potential for unacceptable risk to human health or the environment. The action levels were selected from several sources, and are included in Appendix C.

As discussed in the SSI Report (TtNUS, 1999i) and the Decision Document (TtNUS, 2000g), benzo(a)pyrene was detected above its action level of 100 μg/kg during confirmation sampling at two locations adjacent to the battery foundation. The action level has not changed since issuance of the Decision Document, and therefore, these detections are still considered exceedances. However, an engineering control is in place at IR 21, limiting access to the remaining soil contamination and preventing exposure.

14.4.3 Site Inspection

The site has been inspected on numerous occasions since the last sampling in 1999. No significant issues have been identified at any time regarding the site. Since access to the base is restricted, trespassing is minimal.

14.5 TECHNICAL ASSESSMENT

The Comprehensive Five-Year Review Guidance (EPA, 2001) states that the technical assessment section should answer three primary questions, each of which is presented below.

14.5.1 Question A

Is the remedy functioning as intended by the decision documents?

The remedy to protect human health and the environment is functioning as intended. IR 21 is located on an active military base, and access to the base is restricted. NAS Key West personnel perform quarterly inspections to ensure adherence to LUCs, and an annual report is submitted to FDEP describing the results of the quarterly monitoring. There is no planned change in site usage for the foreseeable future.

14.5.2 Question B

Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of the remedy selection still valid?

There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. There have been no changes to the action level selection process that have affected exceedances identified in the SSI Report (TtNUS, 1999i).

14.5.3 Question C

Has any other information come to light that could call into question the protectiveness of the remedy?

No new human usage of the site has been identified for IR 21. No weather related events have affected the protectiveness of the remedy. There is no known information that calls into question the protectiveness of the remedy.

14.5.4 Technical Assessment Summary

Based on the data reviewed and the site inspections, the remedy is functioning as intended by the Decision Document (TtNUS, 2000g). There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. There is no other information that calls into question the protectiveness of the remedy.

14.6 ISSUES

There are no unresolved issues that could impact the remedy.

14.7 RECOMMENDATIONS AND FOLLOW UP ACTIONS

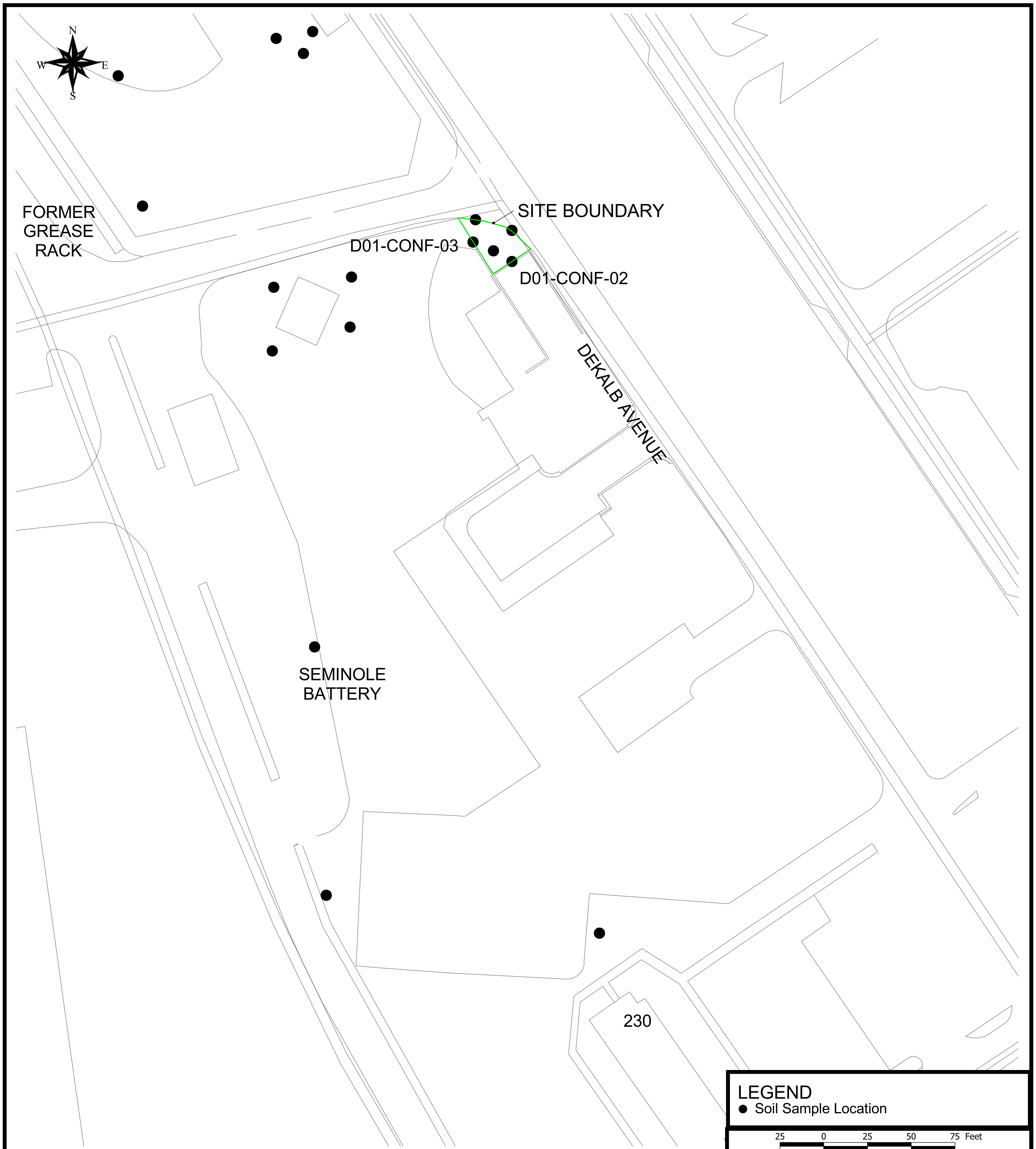
LUCs should remain in place at the site. There are no other applicable recommendations or follow-up actions for IR 21.

14.8 PROTECTIVENESS STATEMENT

The remedy is expected to continue to be protective of human health and the environment.

14.9 NEXT REVIEW

The next five-year review for IR 21 is required by May 2009.



NO.	DATE	REVISIONS

DRAWN BY: EHM — DATE: 11/17/2004
CHECKED BY: SH — DATE: 11/18/2004
COST/SCHED-AREA
SCALE: AS NOTED

IR 21 SITE LAYOUT
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

CONTRACT NO. 5327
APPROVED BY: CMB — DATE: 11/23/2004
APPROVED BY — DATE
FIGURE NO. 14-1
REV. 0

FILE: K:\FIVE YEAR REVIEW.APR LAYOUT: FIGURE 14-1 IR 21 SITE LAYOUT DATE: 11/23/2004 BY: EHM

15.0 BASEWIDE CONCLUSIONS AND RECOMMENDATIONS

The basewide conclusions and recommendations are presented below. These conclusions and recommendations are provided in the form of a basewide protectiveness statement and a summary of the requirements of the next five-year review.

15.1 PROTECTIVENESS STATEMENT

The remedies in place at the NAS Key West sites are expected to be protective of human health and the environment, with the exception of SWMU 9. Additional investigation at SWMU 9, the Jet Engine Test Cell Site, is planned for the immediate future as described in the RCRA Focused Site Investigation Strawman for SWMU 9, the Jet Engine Test Cell Site (TtNUS, 2004). Remediation options will be discussed by the NAS Key West Partnering Team following the completion of this focused site investigation.

This five-year review demonstrates that the Navy is meeting or exceeding the requirements of the HSWA permit and the Decision Documents for sites at NAS Key West and is constantly re-evaluating the utilization of alternative treatment technology options and more permanent remedies.

15.2 NEXT REVIEW

The next five-year review for NAS Key West sites will be required within five years of the signature date of this review, May 2009.

REFERENCES

ABB (ABB Environmental Services, Inc.), 1995. Supplemental RFI/RI Work Plan for NAS Key West, Florida. Prepared for prepared for the Department of the Navy, Southern Division, Naval Facilities Engineering Command. Tallahassee, Florida, December.

BEI (Bechtel Environmental, Inc.), 1995a. Delineation Sampling Report for SWMU-1, SWMU-2, SWMU-3, SWMU-7, AOC-A, AOC-B, IR-1, and IR-3 at the Naval Air Station Key West, Florida, Delivery Order 0004. Prepared for the Department of the Navy, Southern Division, Naval Facilities Engineering Command. Oak Ridge, Tennessee, November.

BEI, 1995b. Remediation Work Plan Delivery Order No. 0004, Rev. 1. Prepared for Department of the Navy, Southern Division, Naval Facilities Engineering Command. Oak Ridge, Tennessee, May.

BEI, 1998. Project Completion Report for Delivery Order No. 0004, Rev. 1. Prepared for Department of the Navy, Southern Division, Naval Facilities Engineering Command. Oak Ridge, Tennessee, August.

BEI, 1999. Project Completion Report for BRAC Parcels Fast Track Soil Removal, Delivery Order No. 0101. Prepared for Department of the Navy, Southern Division, Naval Facilities Engineering Command. Oak Ridge, Tennessee, June.

B&RE (Brown and Root Environmental, Inc.), 1997. Supplemental RFI/RI High-Priority Sites, Rev. 2. Prepared for Department of the Navy, Southern Division, Naval Facilities Engineering Command. Aiken, South Carolina, July.

B&RE, 1998a. Supplemental RFI/RI for Eight Sites, Naval Air Station Key West, Florida. Prepared for Department of the Navy, Southern Division, Naval Facilities Engineering Command. Aiken, South Carolina, January.

B&RE, 1998b. Site Investigation Work Plan for Ten BRAC Properties, Rev. 2. Prepared for Department of the Navy, Southern Division, Naval Facilities Engineering Command. Aiken, South Carolina. January.

B&RE, 1998c. Corrective Measures Study for SWMU 1, Naval Air Station Key West, Boca Chica Key, Florida. Prepared for Southern Division, Naval Facilities Engineering Command. Pittsburgh, Pennsylvania, March.

B&RE, 1998d. Corrective Measures Study for SWMU 2, Naval Air Station Key West, Boca Chica Key, Florida. Prepared for Southern Division, Naval Facilities Engineering Command. Pittsburgh, Pennsylvania, March.

CCI (CH2MHill Constructors, Inc.), 2001. Task Completion Report SWMU 1 Field Sampling Delineation Activities, Rev. 0. Prepared for Department of the Navy, Southern Division, Naval Facilities Engineering Command. Atlanta, Georgia. May

CCI, 2003. Source Removal Report, Excavation of Petroleum Contaminated Soil at SWMU 1 and Removal of Remediation System at SWMU 9. Rev. 0. Prepared for Department of the Navy, Southern Division, Naval Facilities Engineering Command. Atlanta, Georgia. December.

Envirodyne Engineers, Inc., 1985. Initial Assessment Study of Naval Air Station, Key West, Florida. Prepared for the Naval Energy and Environmental Support Activity. St. Louis, Missouri, May.

EPA (U.S. Environmental Protection Agency), 1988. RCRA Facility Assessment Report, Draft.

EPA, 2001. Comprehensive Five-Year Review Guidance. Office of emergency and Remedial Response. EPA 540-R-01-007. OSWER No. 9355.7-03B-P. June.

Geraghty and Miller, Inc. (G&M), 1987. Verification Study Assessment of Potential Ground-Water Pollution at the Naval Air Station Key West, Florida. Prepared for Naval Facilities Engineering command, Southern Division. Tampa, Florida, March.

IT (IT Corporation, Inc.), 1991. Remedial Investigation Report, Naval Air Station Key West, Florida, Final Draft. Prepared for Southern Division, Naval Facilities Engineering Command, Tampa, Florida, January.

IT, 1994. RCRA Facility Investigation/Remedial Investigation, Final Report, NAS Key West, Florida. Prepared for Southern Division, Naval Facilities Engineering command, Tamp, Florida, June.

Long E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. Incidence of Adverse Biological Effects within Ranges of Chemical Concentrations in Marine and Estuarine Sediments. Environmental Management. 19:81-97.

MacDonald, D.D. 1994. Approach to the Assessment of Sediment Quality in Florida Coastal Waters: Volume 1 - Development and Evaluation of Sediment Quality Assessment Guidelines. Prepared for Florida Department of Environmental Protection. Tallahassee, Florida.

OES (Omega Environmental Services, Inc.), 1995. UST Closure Report, Tanks 248A and 248B. Prepared for Department of the Navy, Southern Division, Naval Facilities Engineering Command. September.

REA (REA Remedial Solutions, Inc.), 2004. Annual Performance Monitoring Report for SWMU 1, 2, 5, 7, 8, and Poinciana Housing, Naval Air Field, Key West, Florida. Prepared for Naval Air Facilities Southern Division. Valrico, Florida, April.

TN&A (T N & Associates, Inc.), 2003. Remedial Action Completion Report, Ash Pile Are/ Sludge Drying Bed Remediation, Harry S. Truman Animal Import Center, Fleming Key, Naval Air Station, Key West, Florida, prepared for Naval Facilities Engineering Command, Southern Division, Raleigh, NC. June.

TtNUS (Tetra Tech NUS, Inc.), 1998a. Statement of Basis for SWMU 1, NAS Key West, Florida. Prepared for Department of the Navy, Southern Division, Naval Facilities Engineering Command. Aiken, South Carolina, July.

TtNUS, 1998b. Statement of Basis for SWMU 2, NAS Key West, Florida. Prepared for Department of the Navy, Southern Division, Naval Facilities Engineering Command. Aiken, South Carolina, July.

TtNUS, 1998c. Statement of Basis for SWMU 3, NAS Key West, Florida. Prepared for Department of the Navy, Southern Division, Naval Facilities Engineering Command. Aiken, South Carolina, July.

TtNUS, 1998d. Statement of Basis for SWMU 4, NAS Key West, Florida. Prepared for Department of the Navy, Southern Division, Naval Facilities Engineering Command. Aiken, South Carolina, July.

TtNUS, 1998e. Proposed Plan for Big Coppitt Key Abandoned Civilian Disposal Area (AOC B), NAS Key West, Florida. Prepared for Department of the Navy, Southern Division, Naval Facilities Engineering Command. Aiken, South Carolina, October.

TtNUS, 1998f. Proposed Plan for Truman annex DDT Mixing Area (IR 3), Naval Air Station Key West, Florida. Prepared for Department of the Navy, Southern Division, Naval Facilities Engineering Command. Aiken, South Carolina, October.

TtNUS, 1998g. Proposed Plan for Former Fleming Key North Landfill (IR 7), Naval Air Station Key West, Florida. Prepared for Department of the Navy, Southern Division, Naval Facilities Engineering Command. Aiken, South Carolina, October.

TtNUS, 1999a. Corrective Measures Study Report for SWMU 5, NAS Key West, Boca Chica Key, Florida. Prepared for Department of the Navy, Southern Division, Naval Facilities Engineering Command. Aiken, South Carolina, March.

TtNUS, 1999b. Statement of Basis for SWMU 5, NAS Key West, Florida. Prepared for Department of the Navy, Southern Division, Naval Facilities Engineering Command. Aiken, South Carolina, February.

TtNUS, 1999c. Corrective Measures Study Report for SWMU 7, NAS Key West, Boca Chica Key, Florida. Prepared for Department of the Navy, Southern Division, Naval Facilities Engineering Command. Aiken, South Carolina, March.

TtNUS, 1999d. Statement of Basis for SWMU 7, NAS Key West, Florida. Prepared for Department of the Navy, Southern Division, Naval Facilities Engineering Command. Aiken, South Carolina, February.

TtNUS, 1999e. Corrective Measures Study Report for SWMU 9, NAS Key West, Boca Chica Key, Florida. Prepared for Department of the Navy, Southern Division, Naval Facilities Engineering Command. Aiken, South Carolina, October.

TtNUS, 1999f. Decision Document and Responsiveness Summary for IR 3, IR 7, and AOC B, Naval Air Station Key West, Florida. Prepared for Department of the Navy, Southern Division, Naval Facilities Engineering Command. Aiken, South Carolina, April.

TtNUS, 1999g. Sediment Toxicity Report for IR 1 and IR 8, Naval Air Station Key West, Florida. Prepared for Department of the Navy, Southern Division, Naval Facilities Engineering Command. Aiken, South Carolina, August.

TtNUS, 1999h. Site Inspection Report for Nine BRAC Parcels, Naval Air Station Key West, Florida. Prepared for Department of the Navy, Southern Division, Naval Facilities Engineering Command. Aiken, South Carolina, February.

TtNUS, 1999i. Supplemental Site Inspection Report for BRAC Parcels, Naval Air Station Key West, Florida. Prepared for Department of the Navy, Southern Division, Naval Facilities Engineering Command. Aiken, South Carolina, September.

TtNUS, 2000a. Statement of Basis for the Jet Engine Test Cell Site, NAS Key West, Florida. Prepared for Department of the Navy, Southern Division, Naval Facilities Engineering Command. Aiken, South Carolina, February.

TtNUS, 2000b. Enhanced Biodegradation Treatability Study Work Plan for SWMU 9, NAS Key West, Florida. Prepared for Department of the Navy, Southern Division, Naval Facilities Engineering Command. Aiken, South Carolina, December.

TtNUS, 2000c. Proposed Plan for Truman Annex Refuse Disposal Area (IR 1), Naval Air Station Key West, Florida. Prepared for Department of the Navy, Southern Division, Naval Facilities Engineering Command. Aiken, South Carolina, February.

TtNUS, 2000d. Decision Document for IR 1 and IR 8, Naval Air Station Key West, Florida. Prepared for Department of the Navy, Southern Division, Naval Facilities Engineering Command. Aiken, South Carolina, September.

TtNUS, 2000e. Performance Monitoring Plan, Naval Air Station Key West, Florida. Prepared for Department of the Navy, Southern Division, Naval Facilities Engineering Command. Aiken, South Carolina, September.

TtNUS, 2000f. Proposed Plan for Fleming Key South Landfill (IR 8), Naval Air Station Key West, Florida. Prepared for Department of the Navy, Southern Division, Naval Facilities Engineering Command. Aiken, South Carolina, March.

TtNUS, 2000g. Decision Document for Seminole Battery (IR 21), Naval Air Station Key West, Florida. Prepared for Department of the Navy, Southern Division, Naval Facilities Engineering Command. Aiken, South Carolina, September.

TtNUS, 2001a. Performance Monitoring Annual Report, Naval Air Station Key West, Florida. Prepared for the Department of the Navy, Southern Division, Naval Facilities Engineering Comman. Aiken, South Carolina. April.

TtNUS, 2001b. Performance Monitoring Quarterly Report, Fall 2000, Naval Air Station Key West, Florida. Prepared for the Department of the Navy, Southern Division, Naval Facilities Engineering Comman. Aiken, South Carolina. January.

TtNUS, 2001c. Treatability Study Installation Report for SWMU 9, Naval Air Station Key West, Florida. Prepared for the Department of the Navy, Southern Division, Naval Facilities Engineering Comman. Aiken, South Carolina. March.

TtNUS, 2002a. Performance Monitoring Second Annual Report, Naval Air Facility Key West, Florida. Prepared for the Department of the Navy, Southern Division, Naval Facilities Engineering Comman. Aiken, South Carolina. April.

TtNUS, 2002b. SWMU 9 Treatability Study Annual Monitoring Report, Naval Air Facility Key West, Florida. Prepared for the Department of the Navy, Southern Division, Naval Facilities Engineering Comman. Aiken, South Carolina. July.

TtNUS, 2002c. IR 1 and IR 8 Annual Performance Monitoring Report, Naval Air Facility, Key West, Florida. Prepared for the Department of the Navy, Southern Division, Naval Facilities Engineering Command. Aiken, South Carolina. August.

TtNUS, 2002d. IR 1 and IR 8 Third Quarter Performance Monitoring Report, Naval Air Facility, Key West, Florida. Prepared for the Department of the Navy, Southern Division, Naval Facilities Engineering Command. Aiken, South Carolina. April.

TtNUS, 2002e. Environmental Baseline Survey Report for Harry S. Truman Animal Import Center, Naval Air Facility, Key West, Florida. Prepared for the Department of the Navy, Southern Division, Naval Facilities Engineering Command. Aiken, South Carolina. October.

TtNUS, 2003a. Annual Performance Monitoring Report, Naval Air Station Key West, Florida, prepared for the Department of the Navy, Southern Division, Naval Facilities Engineering Command. Aiken, South Carolina. April.

TtNUS, 2003b. SWMU 1 Groundwater Monitoring Report, Naval Air Station Key West, Florida. Prepared for the Department of the Navy, Southern Division, Naval Facilities Engineering Command. Aiken, South Carolina. October.

TtNUS, 2004. RCRA Focused Site Investigation Strawman for SWMU 9, the Jet Engine Test Cell Site, Naval Air Station Key West, Florida. Prepared for the Department of the Navy, Southern Division, Naval Facilities Engineering Command. Aiken, South Carolina. June.

APPENDIX A

RESPONSE TO COMMENTS

APPENDIX A. RESPONSE TO COMMENTS

Note: Responses to comments on Rev. 0 will be included in Rev. 1

APPENDIX B

BACKGROUND TISSUE REPORT

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1.0 INTRODUCTION

This report was prepared by Tetra Tech NUS, Inc (TTNUS) on behalf of the Department of the Navy, Southern Division, Naval Facilities Engineering Command (NAVFAC EFD SOUTH), and was completed under Comprehensive Long-term Environmental Action Navy (CLEAN) Contract Number N62467-94-D-0888, Contract Task Order (CTO) Number 300.

This report discusses the development of the comprehensive data set used to characterize background conditions in selected flora and fauna at Naval Air Station (NAS) Key West. This characterization is necessary to support long-term monitoring being conducted at Solid Waste Management Units (SWMUs) 1 and 2, and at Installation Restoration (IR) Site 1 at NAS Key West. The background tissue data set can also be used to evaluate the nature and extent of contamination in possible future investigations at NAS Key West. This report includes recommendations for future sampling of biological tissues.

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2.0 DEVELOPMENT OF THE BACKGROUND TISSUE DATA SET

NAS Key West is in southern Monroe County, Florida, approximately 150 miles southwest of Miami. The air station encompasses 3,250 acres on Boca Chica Key and 260 acres on Key West. The geology and hydrology of the lower Florida Keys have been described in previous reports and are not discussed here.

Background sampling and analysis are conducted to ensure that site-related contamination can be distinguished from naturally occurring or nonsite-related anthropogenic compounds. Background biological samples are collected at locations where habitats and physical conditions are similar to those at sites being investigated, but are unlikely to have received chemical releases from site activities. This section describes how the background tissue data set for NAS Key West was developed.

2.1 SAMPLING HISTORY

Background biological samples have been collected during five field efforts. Biological samples were initially collected from background sites on Boca Chica Key in January 1996 in order to establish a representative background data set for use with four Boca Chica Key Resource Conservation and Recovery Act (RCRA) sites under investigation at the time (SWMUs 1, 2, 3, and 9). That background tissue data set was presented and discussed in Appendix J of the *Final Supplemental RFI/RI Report for NAS Key West High Priority Sites, Boca Chica Key, Florida* (B&RE, 1997).

The second background tissue sampling effort was conducted during August-October 1996 as part of the investigation of eight additional RCRA and Comprehensive Environmental Restoration, Compensation, and Liability Act (CERCLA) sites. These eight sites were geographically widespread across four islands (Boca Chica Key, Fleming Key, Key West, and Big Coppitt Key), and habitat types as well as flora and fauna at some of the eight sites were unlike those at the initial four SMMU sites. Thus, additional background tissue samples were collected to expand the geographical extent of the background data and create a data set representative of general NAS Key West background conditions, rather than those specific to inland sites on Boca Chica Key. The second background tissue sampling effort was presented and discussed in Appendix F of the *Final Supplemental RFI/RI Report for Eight Sites, NAS Key West, Florida* (B&RE, 1998).

Based on risk assessments that were part of the aforementioned investigations (B&RE, 1997; 1998), several sites were placed in a long-term monitoring status. The long-term monitoring plan for three sites (SWMU 1, SWMU 2, and IR 1) incorporates biennial collection and analysis of biological samples (TtNUS, 2000). The initial biennial monitoring at SWMUs 1 and 2 was conducted in October 2000, and included the collection of biological samples from three background locations (TtNUS, 2001). The initial biennial monitoring at IR 1 was conducted in January 2002, and included the collection of biological samples from two background locations (TtNUS, 2002). The second biennial monitoring at SWMUs 1 and 2 was conducted in January 2003, and included the collection of biological samples from two background locations (TtNUS, 2003).

The five background tissue sampling efforts are referred to in this report as round 1 (January 1996), round 2 (August-October 1996), round 3 (October 2000), round 4 (January 2002) and round 5 (January 2003).

2.2 SAMPLE COLLECTION AND LABORATORY ANALYSIS

The species collected at background sites, sampling methodology, and laboratory analyses are described in this section.

2.2.1 Species Collected

The species targeted for collection at background sites were determined by the species collected at the RCRA/CERCLA sites under investigation, and are described below.

2.2.1.1 Aquatic Biota

Aquatic habitat at the RCRA/CERCLA sites and background sites consisted either of water bodies with little or no connection to marine waters (designated inland sites), or sites that are adjacent to the Gulf of Mexico or the Atlantic Ocean (designated shoreline sites). The species collected at RCRA/CERCLA sites (and consequently, at background sites) depended on which of these two habitats was present. For example, fish were not collected from shoreline sites since it was assumed that fish in marine waters are highly mobile, and therefore are not good indicators of source-specific contamination.

Fish

Small, minnow-like fish species collected at inland background sites included the sheepshead minnow (*Cyprinodon variegatus*), sailfin molly (*Poecilia latipinna*), crested goby (*Lophogobius cyprinoides*), and killifish (*Fundulus* spp. and *Floridicthys carpio*). Sheepshead minnows feed on vascular plant material, algae, detritus, amphipods, copepods, and mosquito larvae (Pattillo et al., 1997). Sailfin mollies feed primarily on algae, vascular plants, detritus, and mosquito larvae (Lee et al., 1980). Crested gobies feed primarily on small crustaceans and insect larvae, but also consume algae and detritus (Odum et al., 1982). Small crustaceans and insects comprise a large portion of the killifish diet, but killifish also consume vascular plants and algae (Pattillo et al., 1997). All of these species are relatively short lived, typically less than two years. For brevity, the minnow-sized fish described above will be referred to as minnows.

Larger-bodied fish such as tarpon (*Megalops atlanticus*), ladyfish *(Elops saurus)*, yellowfin mojarra *(Gerres cinereus)*, and striped mullet *(Mugil cephalus*) were collected from two background sites. Tarpon and ladyfish feed on crustaceans and small fish. Yellowfin mojarra are bottom feeders, and forage primarily on invertebrates (Odum et al., 1982). Striped mullet are also bottom feeders, and feed on detritus, diatoms, algae, and various small organisms (Odum et al., 1982; Pattillo et al., 1997). These larger-bodied fish are much longer-lived than minnow-like fish. Tarpon, for example, live as long as 50 years or more (Pattillo et al., 1997).

Because the larger-bodied fish live typically longer and have different feeding strategies than minnow-sized fish, the fish were divided into two groups for data analyses: minnows and large fish.

Mollusks

Four species of gastropods and one species of bivalve were collected for tissue analyses from background sites: milk conch (*Strombus costatus*), Caribbean vase conch (*Vasum muricatum*), true tulip snail (*Fasciolaria tulipa*), Florida horse conch (*Pleuroploca gigantea*), and mangrove oyster (*Isognomon alatus*). The gastropods inhabit seagrass beds and sand flats. The milk conch and vase conch are herbivorous and feed primarily on algae and algal detritus. The true tulip and Florida horse conch are carnivorous, preying upon other mollusks (Kaplan, 1988). Mangrove oysters are filter feeders that grow in colonies on rocks and red mangrove roots.

Crustaceans

Four crab and one lobster species were collected for tissue analyses from background sites. Crab species consisted of the stone crab (*Menippe mercenaria*), spiny spider crab (*Mithrax spinosissimus*), red hermit crab (*Petrochirus diogenes*), and mud fiddler crab (*Uca pugnaxi*). Stone crabs, spiny spider crabs, and red hermit crabs are marine species found in coastal waters and prey primarily on larvae, small crustaceans, worms, etc. Mud fiddler crabs are more terrestrial, and they are found along the edges of salt marshes and mangrove swamps, where they feed on detritus and live in burrows above low water (Kaplan, 1988). The Florida spiny lobster (*Panulirus argus*) feeds on a variety of slow-moving animals including gastropod and bivalve mollusks, crustaceans, and echinoderms (Marx and Herrnkind, 1986).

Turtle Grass

Seagrass communities are among the most productive of all coastal ecosystems, and several species of seagrasses are found in the Florida Keys. Turtle grass (*Thalassia testudinum*) was collected for tissue analyses from background sites. Green sea turtles, manatees, parrot fish, and sea urchins consume turtle grass, and numerous fish species consume seagrass epiphytes.

2.2.1.2 Terrestrial Vegetation

Terrestrial vegetation was collected for tissue analyses at background sites because of its use as a food item by the endangered Lower Keys marsh rabbit (*Sylvilagus palustris hefneri*) at some RCRA sites under investigation. Three species of terrestrial vegetation have been collected at background sites: seashore dropseed (*Sporobolus virginicus*), red mangrove (*Rhizophora mangle*), and sea oxeye daisy *(Borrichia frutescens*); each of these species is known to be used as a food item by the Lower Keys marsh rabbit (USFWS, 1994). Although red mangrove trees are found in tidal areas that are often inundated, the species is included here as “terrestrial vegetation” for convenience.

2.2.2 Sample Collection

Minnows were collected in baited minnow traps. Larger fish were collected in gill nets. Crabs and lobsters were collected by hand nets and baited traps. Mollusks and vegetation samples were collected by hand.

All fish samples except killifish were pooled by species so that each sample consisted of a single species. Several killifish species are found in the Florida Keys. Most killifish appeared to be Gulf killifish (Fundulus grandis), but field identification of Fundulus to the species level is difficult due to differences in appearance from area to area and population to population. Thus, all killifish species were grouped together and are referred to as killifish in this report.

Minnow samples typically consisted of 20 to 50 individuals per sample, and weighed at least 30 grams. Samples of mangrove oysters and mud fiddler crabs consisted of several individuals per sample. Caribbean vase conch samples consisted of 1 to 3 individuals per sample. Samples of other mollusks and crustaceans, as well as samples of large fish, consisted of a single individual per sample. Sea oxeye daisy samples consisted of at least 70 grams of foliage; other vegetation samples consisted of at least 100 grams of foliage.

2.2.3 Laboratory Analysis

Chemical analyses were performed on whole-body samples of fish and crabs. Analyses were performed on soft tissue (muscle and viscera) of lobsters and mollusks. The soft tissues were removed from these organisms at the testing laboratory. Tissue concentrations reported by the analytical laboratory and used in this report are wet weight (also known as fresh weight) values. Tissue concentrations of organic compounds were reported by the analytical laboratory in units of µg/kg, and metals were reported in units of mg/kg. These units are retained for this report.

Tissue samples collected during all five rounds were analyzed for pesticides and metals. Tissue samples were also analyzed during round 1 for volatile organic compounds. No volatile organic compounds were detected in tissue samples collected during round 1 from background sites or from RCRA/CERCLA sites. With the concurrence of the NAS Key West Partnering Team, tissue samples in subsequent sampling rounds were not conducted for volatile compounds. Tissue analyses during rounds 1 and 2 included semivolatile organic compounds. These compounds were rarely detected in tissues from background and RCRA/CERCLA sites, and the risk assessments indicated that semivolatile organic compounds were not contaminants of concern in tissue. Therefore, with the concurrence of the NAS Key West Partnering Team, tissue samples in subsequent sampling rounds were not conducted for semivolatile organic compounds. PCB analyses were conducted on tissue samples collected during rounds 1, 2, and 4.

Tissue samples collected during round 1 were analyzed by Environmental Science and Engineering Inc., Gainesville, Florida. Tissue samples collected during round 2 were analyzed by Savannah Laboratories, in Savannah, Georgia. Tissue samples collected during round 3 were analyzed by Severn Trent Laboratories of North Canton, Ohio. Tissue samples collected during rounds 4 and 5 were analyzed by GPL Laboratories of Gaithersburg, Maryland. Quality assurance and quality control procedures were described in the reports in which the background tissue data were originally presented (B&RE, 1997; 1998; TtNUS, 2001; 2002; 2003) and are not described in this report.

2.3 BACKGROUND SAMPLING LOCATIONS

During the field investigations for the RFI/RI sites mentioned above (B&RE, 1997; 1998), eight locations were selected to represent background conditions (Figure B-1). The selection of background locations was based on a review of aerial photographs, historical maps, and site inspections. Abiotic media (surface water, sediment, soil) were collected and analyzed at each background location to evaluate the appropriateness of the location as a background site (B&RE, 1997; 1998). The analytical data indicated that the locations adequately represented background conditions, and with the concurrence of the NAS Key West Partnering Team, all subsequent background tissue samples were collected from these sites.

Brief descriptions of the background sites follow. Table B-1 lists the species collected during each of the five sampling rounds.

2.3.1 Background 1 (Northeastern Boca Chica Key)

Site BG 1 is located in the northeastern portion of Boca Chica Key between Perimeter Road and the intersection of the air station's three major runways (Figure B-2). It consists of a water-filled borrow pit, apparently excavated to provide fill material for other areas. Scattered red mangrove trees occur along the water's edge. Terrestrial habitat surrounding the borrow pit consists of various grasses and herbaceous species interspersed with areas of bare rock.

The borrow pit is V-shaped when viewed from above, with one segment parallel to and approximately 300 feet from Runway 3/21 and the other segment parallel to and approximately 300 feet from Runway 7/25. The northern ponded area is approximately 100 feet wide and 10 feet deep, while the southern ponded area is approximately 40 feet wide and 3 to 6 feet deep. The pond is normally isolated from other surface waters, but after heavy rainfall, water in the pond drains to a channel north of the site through a ditch at the north end of the borrow pit.

BG 1 is distant from any RCRA or CERCLA site, but about 300 feet from an aircraft taxiway and runway. BG 1 does not represent pristine conditions, but pristine inland water bodies do not exist in the lower Florida Keys. This site reflects existing conditions at Boca Chica Key, those associated with historic military operations and development. Conditions at BG1 are similar to those at SWMU 2, which is also located near an aircraft taxiway and runway.

Seven species of fish have been collected for chemical analysis from the borrow pit at BG 1, while sea oxeye daisy (a small shrubby terrestrial plant), has been collected from the grassy area near the borrow pit.

2.3.2 Background 2 (Southern Boca Chica Key)

Site BG 2 is located in the southern portion of Boca Chica Key and consists of a large lagoon east of runway 3/21 (Figure B-3). Water in most portions of the lagoon is 3 feet deep or less. Much of the lagoon extends into a mangrove swamp dominated by red mangrove, black mangrove (*Avicennia germinans*), white mangrove (*Laguncularia racemosa*), and buttonwood (*Conocarpus erectus*). Five species of fish were collected from the lagoon in January 1996 (the first sampling effort). The site was originally selected as a background fish location because maps suggested that the lagoon was landlocked. During sampling, however, the lagoon was observed to be connected by narrow channels to the Atlantic Ocean. As a result, most fish species collected at BG 2 were different from those collected at the inland RCRA/CERCLA sites being investigated, and BG 2 has not been used as a background tissue sampling location since that time.

2.3.3 Background 3 (Northwestern Boca Chica Key)

Site BG 3 is in the northwestern portion of Boca Chica Key north of U.S. Highway 1, and consists of a shallow 8-acre lagoon (Figure B-4). The lagoon is isolated from marine waters. Mangroves occur along the lagoon shoreline. A rockland hammock dominated by the exotic Australian pine (*Casuarina equisetifolia*) is located to the west and north of the lagoon. Water depth throughout the lagoon is approximately 18 inches. Three species of fish have been collected from the shallow lagoon at BG 3 for tissue analysis. In addition, mangrove oysters (*Isognomon alatus*) have been collected for analysis from an excavated channel approximately 650 feet west of the lagoon, and sea oxeye daisy has been collected in the rockland hammock northwest of the lagoon.

2.3.4 Background 4 (Dredgers Key)

Site BG 4 is located approximately 0.5 mile north of Key West (Figure B-5), encompassing the eastern end of Dredgers Key (known as Sigsbee Park on some maps) and the near-shore waters. Various U.S. Navy facilities, including the Navy Exchange and Commissary, are found on the island. The eastern portion of Dredgers Key is relatively undeveloped, and is covered by Australian pines. Red mangroves dominate the southeastern shoreline of Dredgers Key, while the northeastern shoreline is dominated by Australian pines and scattered red mangroves. There is a small island approximately 150 yards south of the eastern tip of Dredgers Key that has no structures or other signs of development and is covered by an extensive red mangrove closed canopy forest. Submerged aquatic vegetation around Dredgers Key consists primarily of seagrasses such as turtle grass, manatee grass (*Cymodocea filiforme*), and shoal grass (*Halodule wrightii*).

Caribbean vase conch, milk conch, and turtle grass samples have been collected in shallow water along the northeastern shoreline of Dredgers Key for tissue analysis. Stone crab, spiny spider crab, Florida spiny lobster, and turtle grass samples have been collected from the area between Dredgers Key and the small island to the south.

2.3.5 Background 5 (Bluefish Channel to Bay Keys)

Site BG 5, approximately 5 miles north of Key West, consists of the open-water area between Bluefish Channel and Bay Keys (Figure B-6). Bay Keys are a group of three small mangrove-covered islands that appear to be pristine and are approximately 1.5 miles east of Bluefish Channel. Aquatic habitat in the vicinity of BG 5 consists of large areas dominated by turtle grass. Manatee grass, shoal grass, and other submerged aquatic plants also occur in the shallow water (3 to 6 ft deep) in this area.

Biological samples collected for tissue analysis at BG 5 consist of Florida spiny lobster, spiny spider crab, milk conch, Florida horse conch, and turtle grass.

2.3.6 Background 6 (Geiger Key)

Site BG 6 is located on Geiger Key, east of Boca Chica Key (Figure B-7). The site consists of a water-filled borrow pit and a weedy area surrounded primarily by red mangroves, black mangroves, and buttonwood trees. The borrow pit is isolated from the Atlantic Ocean by a 500 foot wide mangrove swamp. The surface water in the borrow pit does not have an outlet to any other body of water, but presumably receives water from the ocean during high tides in major storms. The site was selected primarily as a location for background fish collection, but minnow traps initially placed in the borrow pit were vandalized, and no fish were collected. No further attempts were made to collect fish from this location.

Biological samples collected from BG 6 have consisted of mud fiddler crabs and three plant species: red mangrove, sea oxeye daisy, and seashore dropseed.

2.3.7 Background 7 (Eastern Key West)

Site BG 7 is in a lagoon and mangrove swamp near the eastern end of Key West (Figure B-8). The lagoon is hydrologically connected by narrow, shallow channels to Cow Key Channel, and thus, the depth of the lagoon fluctuates slightly with the tides. However, the water depth in most portions of the site is typically about 1 to 2 feet.

Red mangroves are the dominant vegetation throughout most of the lagoon and mangrove swamp. Black mangroves and buttonwood are common along the edges of the lagoon. Biological tissues were collected from BG 7 during August-October 1996 (the second sampling round). At that time, Australian pines and various grasses and weeds were common in the upland portions of the site. Between the second and third sampling rounds, the area adjacent to the lagoon was developed and now consists of condominiums, parking lots, etc. As a result, no further samples were collected at this background site.

Minnows, red mangrove, sea oxeye daisy, and seashore dropseed were collected at BG 7.

2.3.8 Background 8 (Wisteria Island)

Wisteria Island (BG 8) is approximately 0.5 mile northwest of Key West (Figure B-9). There is no development on the island, which is covered by a dense canopy of Australian pines. The shoreline consists largely of crushed limestone and coral fragments. Submerged aquatic vegetation surrounding the island is dominated by turtle grass.

Biological samples collected at BG 8 have included lobster, spiny spider crab, Florida horse conch, red hermit crab, true tulip snail, and turtle grass.

TABLE B-1

**SPECIES COLLECTED FOR CHEMICAL ANALYSIS FROM BACKGROUND SITES
NAVAL AIR STATION
KEY WEST, FLORIDA**

Species[1]	Background Site Where Species was Collected [2]				
	January 1996	August-October 1996	October 2000	January 2002	January 2003
Minnow-Sized Fish					
Sheepshead minnow	BG 1, BG 3	BG 7	BG 3		BG 1
Killifish	BG 3	BG 7	BG 3		
Crested goby	BG 1		BG 1		BG 1
Sailfin molly	BG 1, BG 2, BG 3	BG 7			BG 1
Larger Fish					
Tarpon			BG 1		
Ladyfish	BG 1				
Yellowfin mojarra	BG 1		BG 1		
Striped mullet	BG 1				
Pinfish	BG 2				
Gray snapper	BG 2				
Bluestriped grunt	BG 2				
Sea robin	BG 2				
Crustacean					
Mud fiddler crab			BG 6		
Stone crab		BG 4			
Spiny spider crab		BG 4, BG 5, BG 8			
Red hermit crab		BG 8			
Spiny lobster		BG 4, BG 5, BG 8			
Mollusk					
Caribbean vase conch		BG 4		BG 4	
True tulip snail		BG 8		BG 4	
Mangrove oyster	BG 3				
Florida horse conch		BG 5, BG 8			
Milk conch		BG 4, BG 5			
Vegetation					
Turtle grass		BG 4, BG 5, BG 8		BG 4, BG 8	
Sea oxeye daisy		BG 6, BG 7	BG 3, BG 6		BG 1, BG 6
Seashore dropseed		BG 6, BG 7			
Red mangrove		BG 6, BG 7			

Notes:
[1] See Section 2.2 for scientific names of species collected.
[2] See Section 2.3 for descriptions of sampling locations BG 1 through BG 8.

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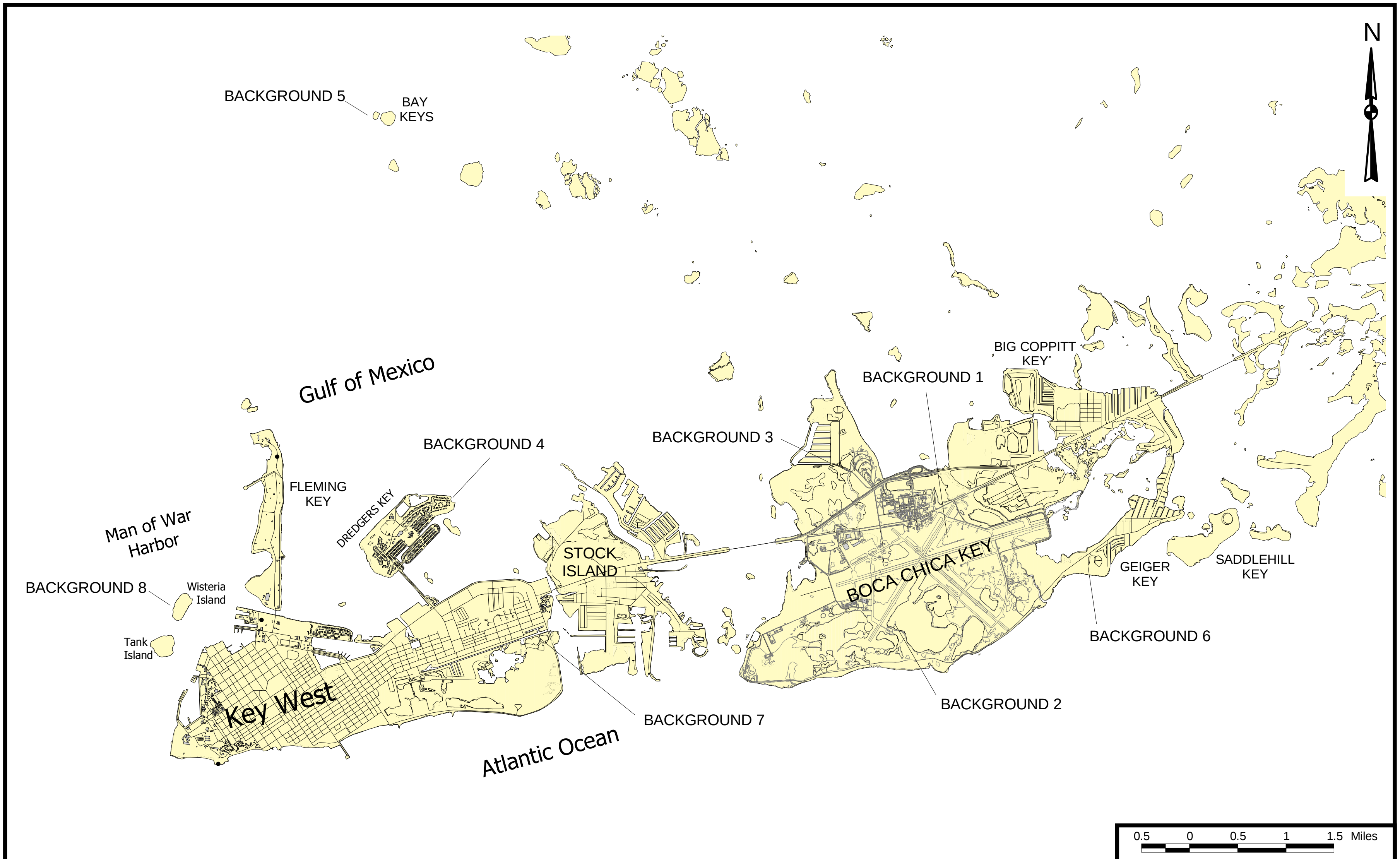

NO.	DATE	REVISIONS

DRAWN BY: EHM — DATE: 03/30/2004

CHECKED BY: MLW — DATE: 04/02/2004

COST/SCHEDULE-AREA

SCALE: AS NOTED

BACKGROUND SITES
NAVAL AIR STATION
KEY WEST, FLORIDA

CONTRACT NUMBER: 5327

APPROVED BY: __ — DATE: __

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FIGURE: B-1 — REV: 0

Rev. 0
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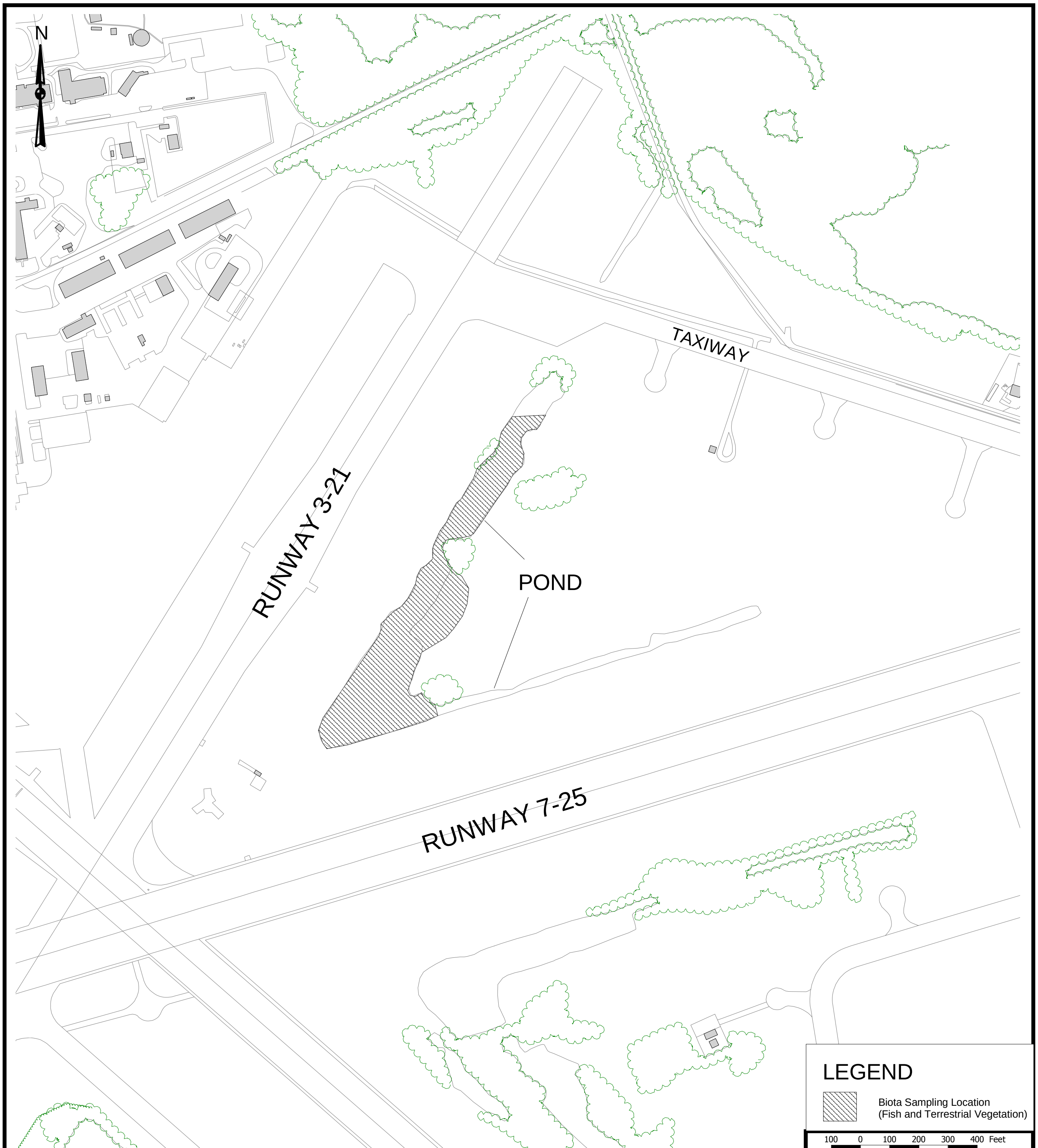

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DRAWN BY: EHM | DATE: 03/29/2004
CHECKED BY: MLW | DATE: 04/02/2004
COST/SCHED-AREA
SCALE: AS NOTED

NORTHEASTERN BOCA CHICA KEY
BACKGROUND 1 SAMPLING LOCATIONS
NAVAL AIR STATION
KEY WEST, FLORIDA

CONTRACT NO. 5327
APPROVED BY | DATE
APPROVED BY | DATE
FIGURE B-2 | REV. 0

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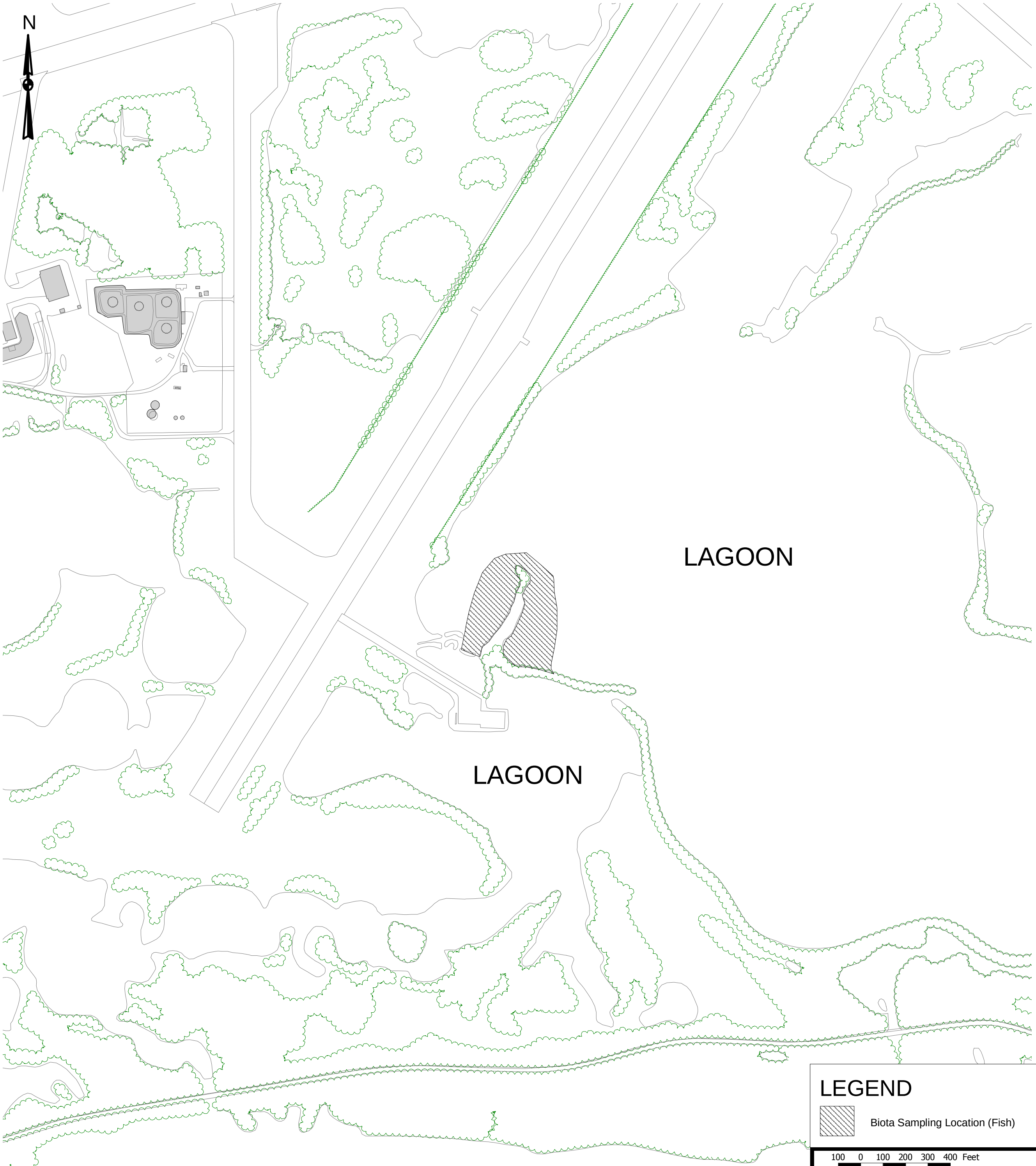

NO.	DATE	REVISIONS	DRAWN BY EHM DATE 03/30/2004		SOUTHEASTERN BOCA CHICA KEY	CONTRACT NO. 5327
			CHECKED BY MLW DATE 04/02/2004		BACKGROUND 2 SAMPLING LOCATION	APPROVED BY DATE
			COST/SCHED-AREA		NAVAL AIR STATION	APPROVED BY DATE
			SCALE AS NOTED		KEY WEST, FLORIDA	FIGURE B-3 REV. 0

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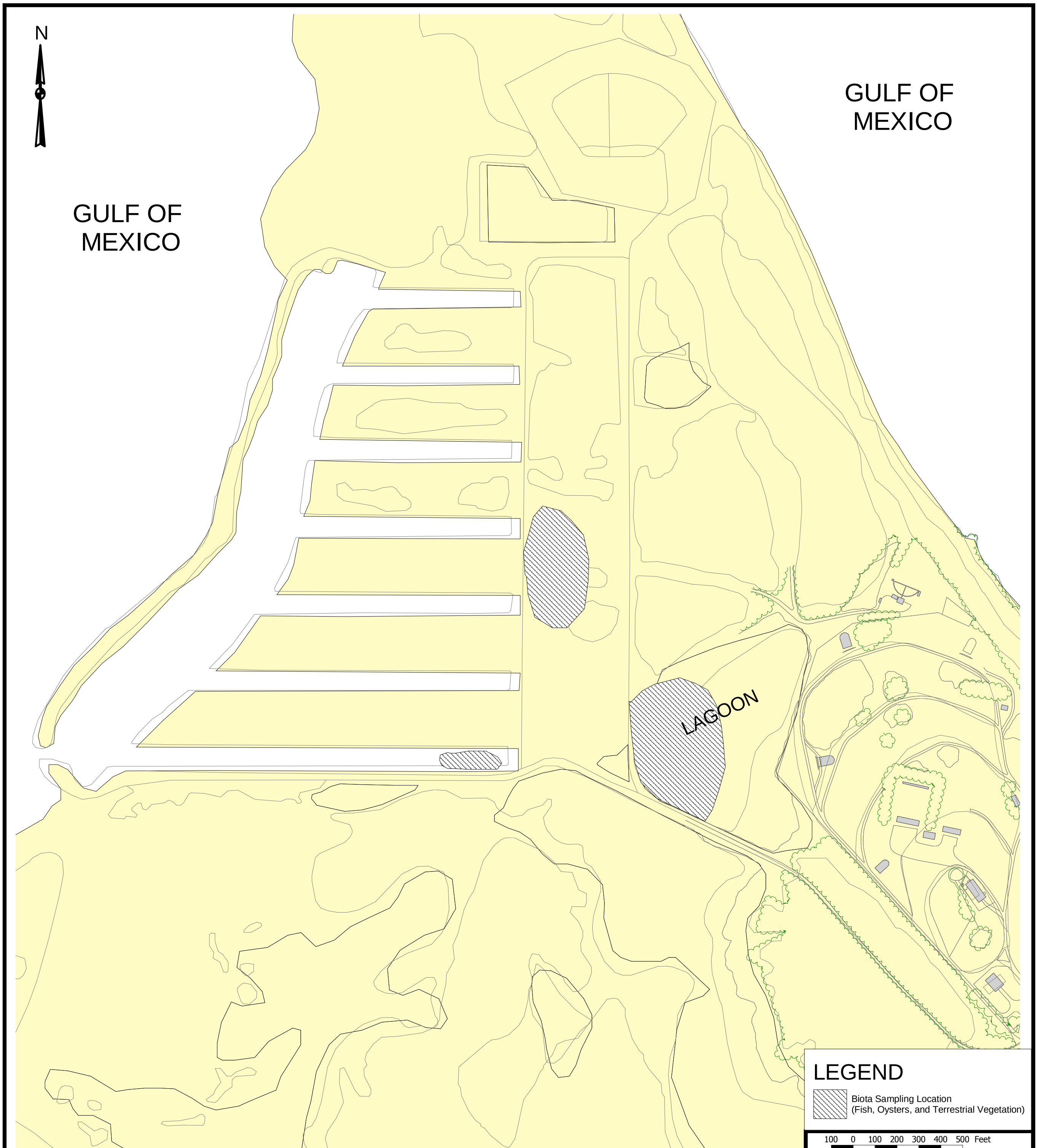

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COST/SCHED-AREA
SCALE AS NOTED

NAVAL AIR STATION KEY WEST FLORIDA

NORTHWESTERN BOCA CHICA KEY
BACKGROUND 3 SAMPLING LOCATIONS
NAVAL AIR STATION
KEY WEST, FLORIDA

CONTRACT NO. 5327
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FIGURE B-4
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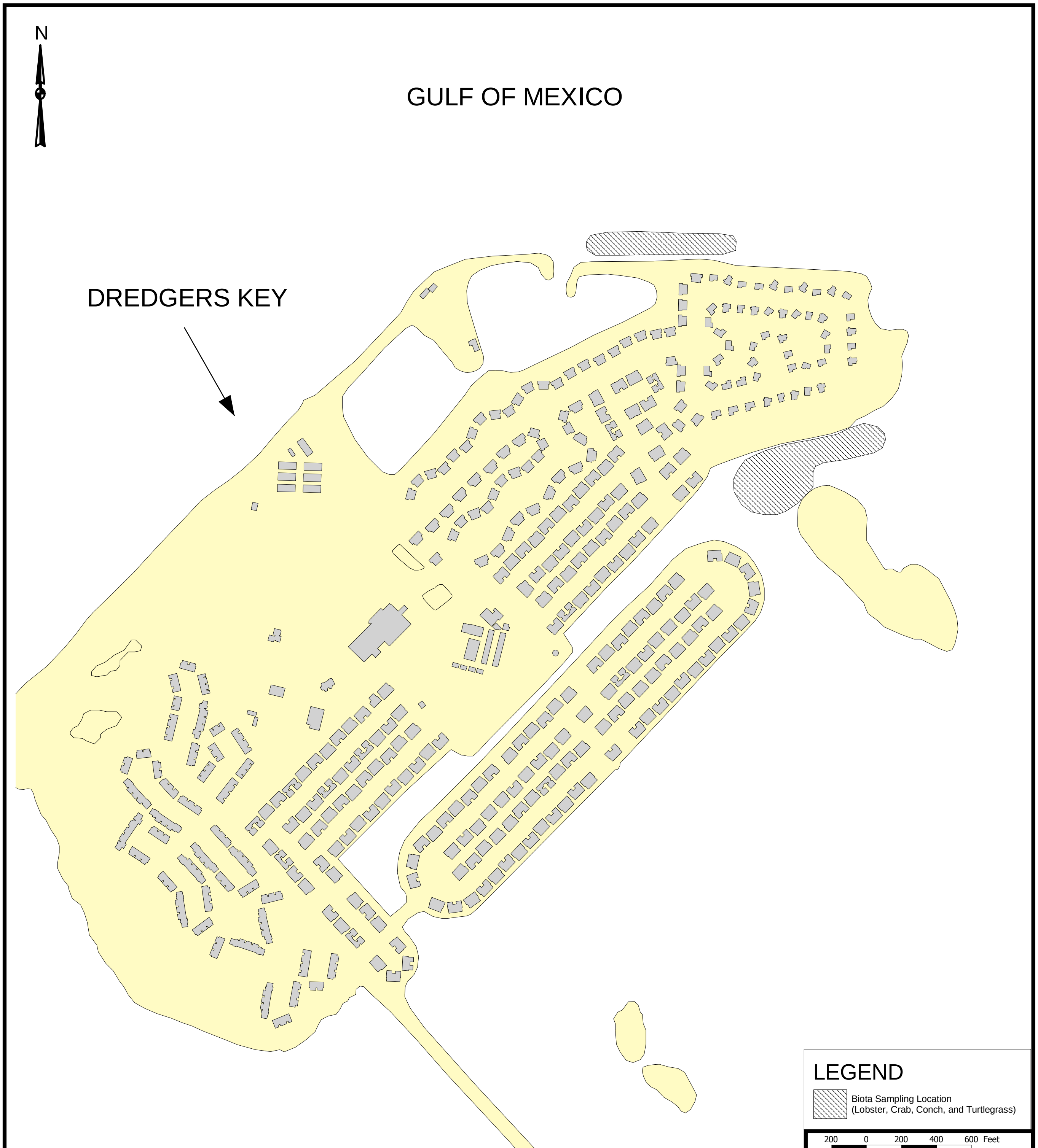

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SCALE AS NOTED

DREDGERS KEY
BACKGROUND 4 SAMPLING LOCATIONS
NAVAL AIR STATION
KEY WEST, FLORIDA

CONTRACT NO. 5327
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FIGURE B-5
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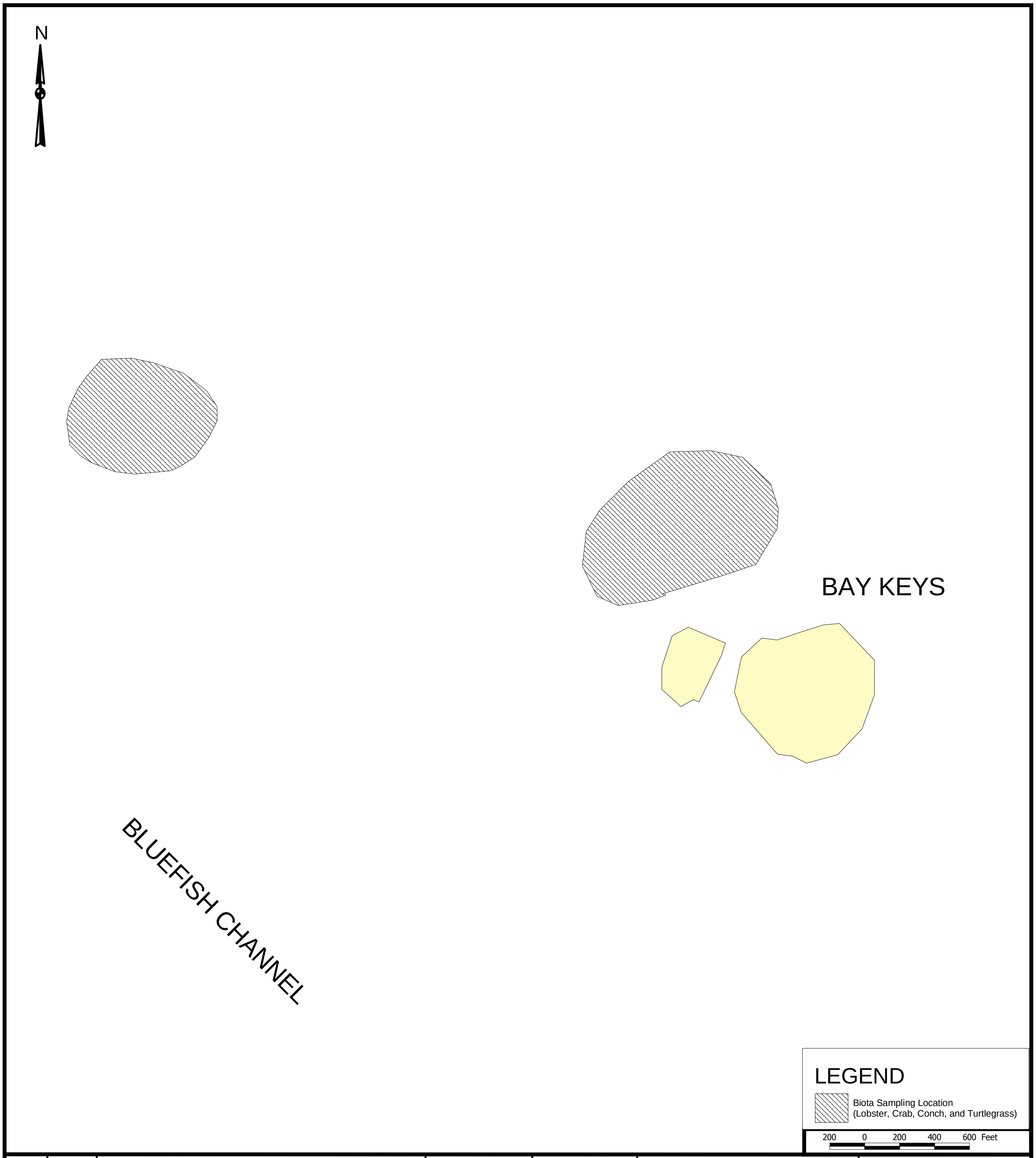

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BLUEFISH CHANNEL AREA
BACKGROUND 5 SAMPLING LOCATIONS
NAVAL AIR STATION
KEY WEST, FLORIDA

CONTRACT NO. 5327
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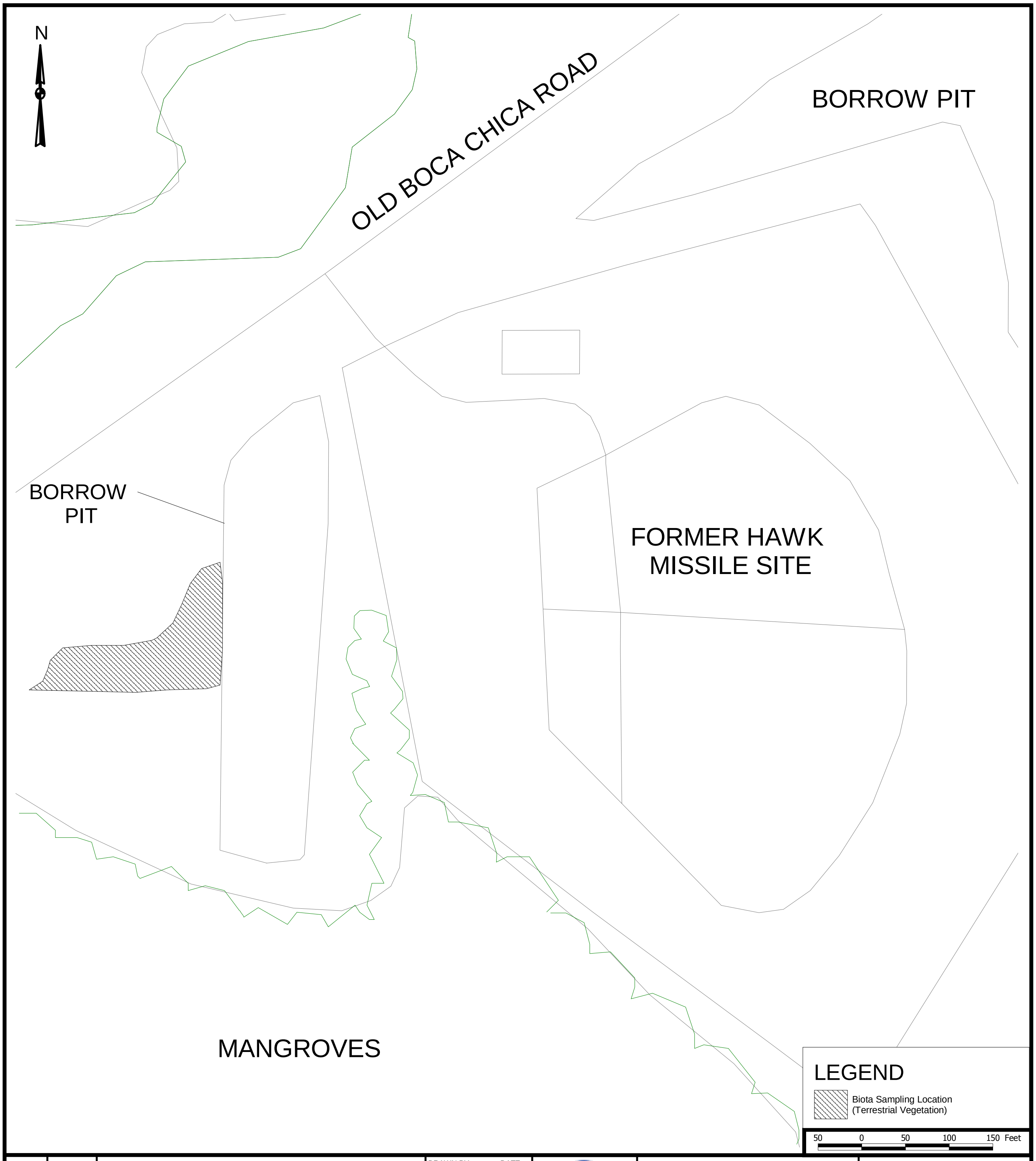
FIGURE B-6 REV. 0

FILE: K:\FIVE YEAR REVIEW.APR LAYOUT: FIGURE B-6 DATE: 03/31/2004 BY: EHM



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GEIGER KEY
BACKGROUND 6 SAMPLING LOCATIONS
NAVAL AIR STATION
KEY WEST, FLORIDA

CONTRACT NO. 5327	
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FIGURE B-7	REV. 0

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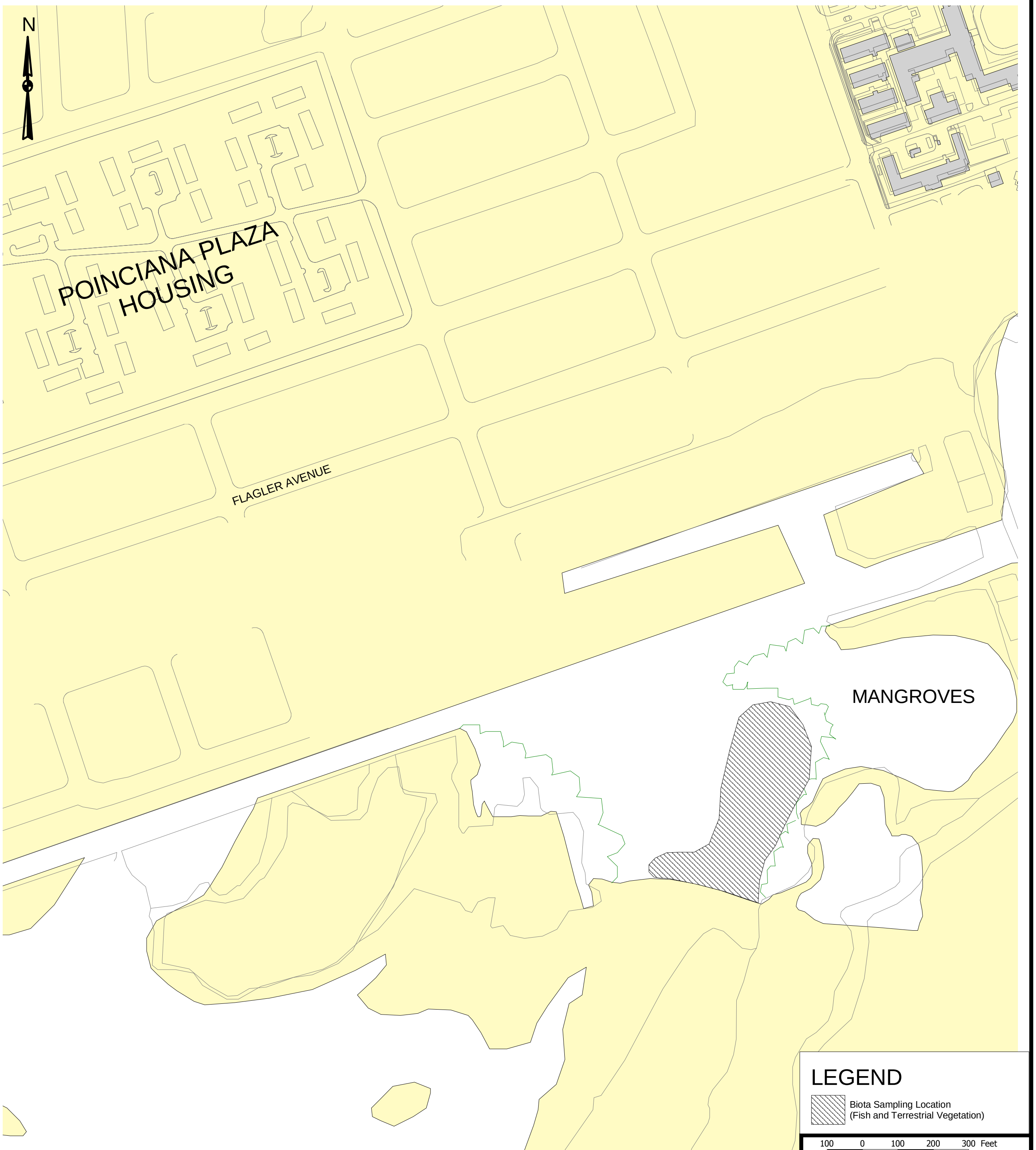

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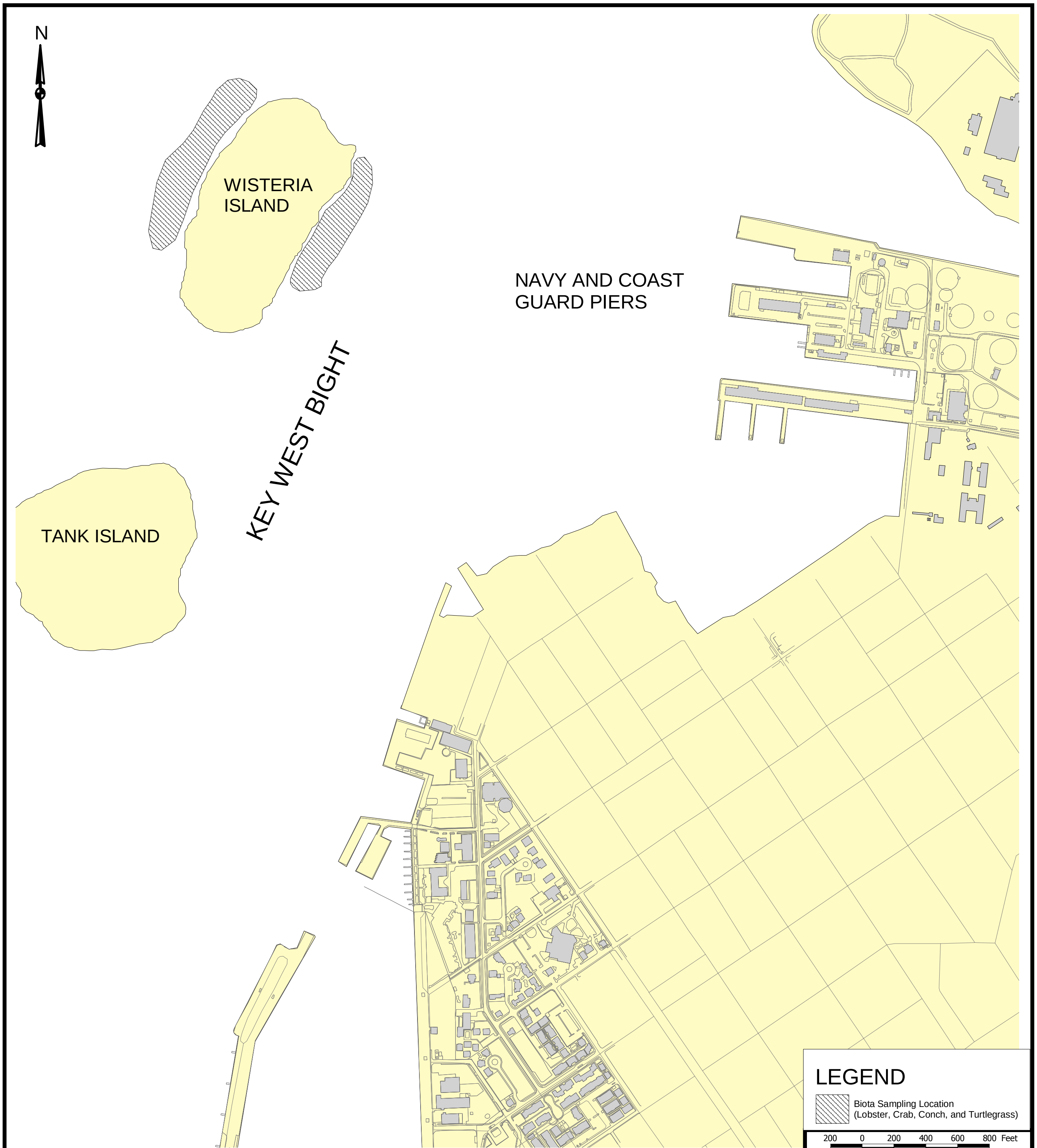
			COST/SCHED-AREA		APPROVED BY / DATE
			SCALE: AS NOTED		FIGURE: B-8 / REV.: 0

EASTERN KEY WEST
BACKGROUND 7 SAMPLING LOCATIONS
NAVAL AIR STATION
KEY WEST, FLORIDA

FILE: K:\FIVE YEAR REVIEW.APR LAYOUT: FIGURE B-8 DATE: 03/31/2004 BY: EHM



NO.	DATE	REVISIONS	DRAWN BY EHM	DATE 03/31/2004		WISTERIA ISLAND	CONTRACT NO. 5327
			CHECKED BY MLW	DATE 04/02/2004		BACKGROUND 8 SAMPLING LOCATIONS	APPROVED BY / DATE
			COST/SCHED-AREA			NAVAL AIR STATION	APPROVED BY / DATE
			SCALE AS NOTED			KEY WEST, FLORIDA	DRAWING NO. B-9 / REV. 0

FILE: K:\FIVE YEAR REVIEW.APR LAYOUT: FIGURE B-9 DATE: 03/31/2004 BY: EHM

3.0 RESULTS AND DISCUSSION

This report focuses on three types of background biological samples: minnows, aquatic vegetation (turtle grass), and terrestrial vegetation (sea oxeye daisy). These sample types are of particular interest because minnows and terrestrial vegetation have been used in the long-term monitoring of SWMUs 1 and 2, and aquatic vegetation has been used in the long-term monitoring of IR 1. Background tissue data for minnows, aquatic vegetation, and terrestrial vegetation were examined to determine if existing data are adequate to establish background conditions. If so, then the collection of additional background tissue samples is not necessary. For each pesticide, PCB, and metal (except macronutrients) detected in each tissue type, the data were examined for differences between background sites, between sampling rounds, and between species to determine whether the data could be combined to create one overall background data set. Calcium, magnesium, potassium, and sodium are macronutrients that are not evaluated in this report.

The complete analytical data set is too voluminous to include in this report but can be made available to interested parties by NAVFAC EFD SOUTH.

Section 3.1 describes how the tissue data were evaluated. Section 3.2 presents and discusses the minnow tissue data, while Sections 3.3 and 3.4 present and discuss the aquatic vegetation and terrestrial vegetation data, respectively. Section 3.5 briefly summarizes the data for large fish, mollusks, crustaceans, red mangrove, and seashore dropseed.

3.1 DATA EVALUATION

Box and whisker plots were employed to provide a graphical representation of analytes detected in minnows (Appendix B.A-1), turtle grass (Appendix B.A-2), and sea oxeye daisy (Appendix B.A-3). An explanation of how to interpret the box and whisker plots is provided at the beginning of Appendix B.A -1. The plots were examined to identify trends in the data between sampling events, and conclusions were then drawn regarding whether the sampling events could be combined to create one background data set. The term “sampling event” as used in this report, refers to a discrete combination of species, location, and round for a particular tissue type. For example, the background minnow data set represents four minnow species (crested goby, killifish, sailfin molly, and sheepshead minnow) collected at four locations (BG 1, BG 2, BG 3, and BG 7) in four sampling rounds (rounds 1, 2, 3, and 5). The different combinations of species, location and round resulted in 16 distinct “sampling events” for minnow data (see Table A-1 of Appendix B.A-1). The turtle grass data set represents a single species collected at three locations (BG 4, BG 5, and BG 8) in two sampling rounds (rounds 2 and 4), resulting in five “sampling events” for turtle grass data (see Table A-2 of Appendix B.A-2). The sea oxeye daisy data set represents a single species collected at four locations (BG 1, BG 3, BG 6, and BG 7) in three sampling rounds (rounds 2, 3, and 5), resulting in six “sampling events” for sea oxeye daisy data (see Table A-3 of Appendix B.A-3).

The background tissue data were evaluated using graphical presentations (box and whisker plots) rather than statistical tests (e.g., analysis of variance). As mentioned in the previous paragraph, the data were collected over multiple rounds and at multiple locations, and for minnows, the data represented multiple species. Statistical comparisons among data sets were hindered by low sample sizes in many sampling events, with some sampling events consisting of only one sample. Some data sets had few values greater than detection limits. Due to these factors, the statistical power was often insufficient to determine differences between sampling events. A review of the graphical representations, however, was generally sufficient to distinguish similarities and differences among sampling events.

Non-detected samples are represented in the box and whisker plots by substituting one-half the contract required detection limit (CRDL) for the sample. Non-detect values in the laboratory analytical data contain a “U” flag after the concentration; in such cases, the reported concentration is the CRDL, which is referred to in this report as the “detection limit.” Concentrations less than the detection limit are reported to be “not detected” at the detection limit value. Because of this data censoring, the actual concentration for “non-detects” could fall anywhere between zero and the detection limit. For various reasons, detection limits can vary from one analysis to another for the same analyte. The presence of non-detected values, and especially large variations in non-detected values, can confound comparisons between data sets because the actual concentrations are unknown for the non-detects. The effects of the non-detects and variations in detection limits are discussed below when these factors significantly affected data set comparisons.

3.2 MINNOWS

Minnows have been collected during rounds 1, 2, 3, and 5. Minnows were collected at background sites during rounds 1 and 2 for use in ecological risk assessments at SWMUs 1, 2, 3, 4, 5, and AOC B. Minnows were collected at background sites during rounds 3 and 5 for use in long-term monitoring of SWMUs 1 and 2. Round 4 sampling was conducted only at shoreline sites, and as mentioned in Section 2.2.1.1, fish were not collected from shoreline sites. Thus, minnows were not collected during round 4. Sixteen metals (excluding calcium, magnesium, potassium, and sodium), 17 pesticides, and two PCBs have been detected in minnow samples (Table B-2).

One sailfin molly sample collected at BG 1 during round 5 (B303-F-14) was deleted from the background tissue data set. The concentration of the pesticide 4,4’-DDD was 920 µg/kg in this sample; the next highest 4,4'-DDD concentration in the same sampling event was 7.6 µg/kg and the next highest minnow concentration for this analyte among all sampling events was 100 µg/kg. The same sample was also responsible for the maximum concentrations of 4,4'-DDE and 4,4'-DDT. An occasional value outside the expected range of concentrations (i.e., an outlier) is not uncommon in a collection of biological samples, especially when the samples consist of individual specimens, but all minnow samples were aggregates of 20 to 50 fish. Sample B303-F-14 was comprised of more than 20 sailfin mollies and was collected from the same BG 1 location as other minnow samples. With this in mind, it is difficult to accept the 4,4'-DDD concentration as valid, and yet the data validation process identified no problems with the laboratory analysis. Analytical data that fall outside the expected distribution can be the result of sampling error, laboratory error, or unusual conditions that existed at the location during collection. The degree to which these or other circumstances are responsible for the reported high pesticide concentrations in sample B303-F-14 is unknown. Nevertheless, the pesticide data from this sample do not appear to be representative of background conditions, and all analytical data for this sample were excluded from the background tissue data set, from Table B-2, and from the following discussion and associated box and whisker plots.

There are few promulgated standards for chemical concentrations in fish tissue that are protective of fish and fish-eating animals. Instead, tissue toxicity thresholds cover a wide range of values depending on species, water and sediment conditions, and other factors. Establishing toxicity thresholds for each chemical detected in fish tissue was beyond the scope of this report. Nevertheless, tissue toxicity thresholds from available literature sources are discussed herein, where pertinent, in order to differentiate tissue data that accurately represent background conditions from tissue data that might be elevated due to local contaminant sources.

3.2.1 Detected Metals

Aluminum

Laboratory analyses for metals during round 1 did not include aluminum, but aluminum was analyzed in subsequent sampling rounds. Two sheepshead minnow concentrations are noteworthy in the box and whisker plot for aluminum (Appendix B.A-1). First, the maximum detected aluminum concentration (62.5 mg/kg) was in a sheepshead minnow sample collected at BG 3 in round 3, and was the only detection among eight samples from that sampling event. Detection limits in the seven non-detect samples from that sampling event ranged from 12.2 to 28.5 mg/kg. The 62.5 mg/kg value was considerably greater than the next highest detected value in any minnow sample (37.7 mg/kg in a killifish sample from BG 7). Second, the box and whisker plot shows one non-detect sample at a concentration of 50 mg/kg. The detection limit in this sample (100 mg/kg) was considerably higher than detection limits in other samples (1.9 to 28.5 mg/kg). This sample (B303-F-03), collected from BG 1 during round 5, consisted of only 10 sheepshead minnows and weighed only 11.2 grams. The analytical lab had requested at least 30 grams per sample, but additional sheepshead minnows were not collected during round 5. The low sample weight in B303-F-03 resulted in an elevated detection limit for aluminum (and several other metals) in this sample relative to other samples.

Aluminum was detected in only 8 of 56 minnow samples in nine sampling events. Six of the eight detects were in minnows from BG 7, and ranged from 10.4 to 37.7 mg/kg. Five of the six detected concentrations at BG 7 were less than detection limits in non-detect samples, which ranged up to 22.5 mg/kg at BG 7 and up to 28.5 mg/kg in all other minnow samples except the one discussed in the previous paragraph (B303-F-03).

The low frequency of detection results in some uncertainty in the data interpretation because not enough data are available to distinguish a clear pattern of concentrations with sampling round and location. Furthermore, detection limits in samples during round 5 tended to be greater than in other rounds, resulting in some uncertainty. The aluminum data set is too limited to draw clear conclusions concerning similarity or dissimilarity of data between the nine sampling events. Moreover, aluminum is not a chemical of concern at sites where long-term monitoring is being conducted. Therefore, there is no reason to analyze additional background minnow samples for aluminum.

Antimony

Antimony was detected in only 5 of 90 minnow samples. Detection limits varied between rounds. Detection limits were lowest in round 3 (0.31 to 0.43 mg/kg), and were highest in round 1 (4.6 to 5.0 mg/kg) with the exception of one sample (B303-F-03) from round 5 in which the detection limit was 10 mg/kg. Four of the five detected antimony concentrations were in samples from BG 7, but the highest detected concentration (1.2 mg/kg) was less than detection limits in round 1 and round 5 samples. Because of the relatively small differences in detection limits, and since the few detected concentrations were within the range of non-detects, antimony concentrations from all sixteen sampling events appear to be similar enough that the data can be combined to form one overall background data set. Therefore, there is no reason to collect additional background minnow samples for analysis of antimony.

Arsenic

Arsenic was detected in seven of the sixteen sampling events and in 32 of 90 minnow samples. As shown in Table B-2 and in the box and whisker plot (Appendix B.A-1), arsenic concentrations in killifish were greater than in other species, and killifish also had the highest frequency of detection. Killifish were collected from BG 3 during round 1, from BG 3 during round 3, and BG 7 during round 2. Arsenic was not detected in crested gobies, and detected concentrations in sailfin mollies and sheepshead minnows were at or near the detection limits in non-detect samples. The killifish data compared to data from other species indicates that arsenic should not be combined across all species to create an overall background data set. Instead, minnow data should be separated into two data sets; one data set for killifish and one for the remaining species (crested goby, killifish, and sailfin molly) for use in investigations of sites where arsenic is a chemical of concern. The size of the two data sets (26 killifish and 64 non-killifish) and detection limits in samples collected to date are sufficient so that there is no reason to analyze additional background minnow samples for arsenic.

Barium

Barium was detected in 15 of the 16 sampling events, and in 57 of 90 samples. Concentrations were greatest in sailfin mollies from BG7 (see box and whisker plot, Appendix B.A-1), ranging from 5.9 to 9.9 mg/kg. Detected concentrations in other sampling events tended to range from 1 to 4 mg/kg, and detection limits in non-detect samples ranged from 0.36 to 1.7 mg/kg. Concentrations tended to be lowest in minnows from BG 3. Although no information could be located on normal background values or toxicity thresholds for barium in fish tissue, barium is relatively abundant in nature, is commonly detected in tissue, and barium-related toxicity is rarely observed (Goyer, 1986). The maximum concentration in minnow samples was 9.9 mg/kg; this does not seem substantially elevated in view of common nature of this metal. Thus, it is recommended that barium data be combined to form one overall background data set for minnows, and the analysis of additional samples is not needed. Barium has not been a chemical of concern at any NAS Key West RCRA/CERCLA site.

Chromium

Chromium was detected in 26 of 90 samples and in eight of the 16 sampling events. Detected concentrations of chromium ranged from 0.28 to 0.53 mg/kg with three exceptions: a crested goby from BG 1, round 1 (3.1 mg/kg), a sheepshead minnow from BG 1, round 5 (2.8 mg/kg), and a killifish from BG 3 round 1 (1.0 mg/kg). Detection limits in non-detect samples ranged from 0.16 to 1.0 mg/kg, but most were 0.6 mg/kg or less. Although the two concentrations near 3 mg/kg are outside the range of the other 88 samples, they do not invalidate the background data set as being indicative of background conditions. The overall tightly clustered data indicate that the samples can reasonably be combined to form a single data set for all species and locations, and additional sampling is not needed.

Cobalt

Cobalt was detected in only 1 of 90 samples. The single detected concentration (0.39 mg/kg) was in a sailfin molly sample collected from BG 7 during round 2. The detection limit in all other round 2 samples was 0.11 mg/kg. Detection limits during other rounds ranged from 0.08 to 1.0 mg/kg, except for sample B303-F-03, in which the detection limit was 2.5 mg/kg. The overall consistency of the data indicates that the cobalt data can be combined to form one overall background data set, and additional sampling is not necessary.

Copper

Copper was detected in 82 of 90 samples and in 15 of the sixteen sampling events. Detected concentrations ranged from 0.7 to 35.3 mg/kg, and concentrations in all but five samples were less than 11 mg/kg. Otherwise, no trends are distinguishable when comparing the species, locations, and rounds to each other. Therefore, copper concentrations across all locations in all rounds can be combined to form a single background data set, and additional sampling is not needed.

Iron

Laboratory analyses for metals during round 1 did not include iron, but iron was analyzed in subsequent sampling rounds. Iron was detected in 23 of 56 minnow samples in nine sampling events. The iron data varied considerably across the nine sampling events. Iron concentrations tended to be greatest in sheepshead minnows (Table B-2 and Appendix B.A-1). The nine highest detected concentrations (37.8 to 65.6 mg/kg) were in sheepshead minnows, eight of which were collected at BG 3 during round 3. Detection limits in non-detect samples were also variable, and tended to be higher than for other metals, ranging from 4.7 to 32.2 mg/kg, except in the previously discussed sample B303-F-03, which had elevated detection limits for several metals. The variability in detected concentrations and detection limits blurs differences from round to round and species to species. However, iron is not a chemical of concern in minnows at sites where long-term monitoring is being conducted. Therefore, there is no reason to analyze additional background minnow samples for iron. In the unlikely event that iron should become a chemical of concern in fish tissues in future investigations, the sheepshead minnow data could be separated from data in other species.

Lead

Lead was detected in 58 of 90 samples and in 13 of 16 sampling events. Lead concentrations in sheepshead minnows from BG 3 during rounds 1 and 3 were noticeably greater than in other sampling events (see box and whisker plot, Appendix B.A-1), and were highest in the eight sheepshead minnow samples from BG 3 round 3. As discussed above, iron was also elevated in the same eight samples. The analytical data for these samples were therefore examined to determine if other chemicals were elevated in these samples; if so, the eight sheepshead minnow samples from BG 3 round 3 might not be representative of background conditions. The maximum detected aluminum concentration (62.5 mg/kg) was in one of these samples (KB3-FI-002), and the pesticide 4,4'-DDD was elevated, relative to all other samples, in four of the eight samples. Concentrations of other analytes were not elevated in these eight samples, but pesticide detection limits tended to be higher than in most other samples. The data from the eight samples in question do not appear to unduly bias the overall data set.

The 20 sheepshead minnow samples were responsible for 18 of the 19 greatest detected lead concentrations. Detected lead concentrations in killifish, sailfin molly, and crested goby samples tended to range from 0.2 to 0.6 mg/kg. These values are comparable to detection limits in non-detect samples, which with a single exception, ranged from 0.13 to 0.92 mg/kg. The data indicate that lead should not be combined across species to create a single overall background data set. Instead, minnow data should be separated into two data sets (one for sheepshead minnows and one for the other minnows) for use in investigations of sites where lead is a chemical of concern (Table B-2). The size of the two data sets (20 sheepshead minnows and 70 non-sheepshead minnows) and detection limits in samples collected to date are sufficient so that there is no reason to analyze additional background minnow samples for lead.

Manganese

Laboratory analyses for metals during round 1 did not include manganese, but manganese was analyzed in subsequent sampling rounds. Manganese was detected in five of nine sampling events and in 22 of 56 minnow samples. Concentrations in crested goby and sailfin molly samples were noticeably greater than in killifish and sheepshead minnow samples (see box and whisker plot, Appendix B.A-1). Crested gobies and sailfin mollies were responsible for 21 of the 22 samples with detected concentrations of manganese. Manganese was detected in only one of 14 killifish and was not detected in sheepshead minnows. Location BG 1 was responsible for 20 of these 22 samples.

The maximum manganese concentration was 16.2 mg/kg in sailfin molly sample B7F-29 from BG 7; the next highest concentration was 8.4 mg/kg. Manganese was not detected in other sailfin molly samples from BG 7, at detection limits of 1.7 to 2.3 mg/kg. Sample B7F-29 was also responsible for the maximum concentration of barium and the pesticide chlorobenzilate, but concentrations of other analytes were not elevated in this sample.

In summary, the manganese data set shows differences among species, and possibly among locations, with concentrations tending to be highest at BG 1. However, the differences were slight, and all concentrations except one were less than 8.5 mg/kg. Manganese is a vital micronutrient in plants and animals, and no information has been located on normal background values or toxicity thresholds for manganese in fish tissue. Manganese has not been a chemical of concern in minnows at any NAS Key West RCRA/CERCLA site. It is recommended that manganese data be combined to form one overall background data set for minnows, and no more samples be collected. The data set should be used with caution, however, if manganese in fish tissue is evaluated in future investigations.

<u>Mercury</u>

Mercury was detected in 38 of 89 samples and in 10 of 15 sampling events. Concentrations showed little variation among sampling events, with detected concentrations ranging from 0.01 to 0.06 mg/kg, and detection limits in non-detect samples ranging from 0.01 to 0.04 mg/kg. However, two trends are seen in the box and whisker plot (Appendix B.A-1). First, mercury was detected more frequently in crested gobies (a species collected only at BG 1) and in killifish from BG 3 than in other sampling events. Second, concentrations were lowest at BG 7, with one detection at 0.01 mg/kg and 23 non-detects at detection limits ranging from 0.01 to 0.03 mg/kg.

The apparent trend of higher concentrations in crested gobies from BG 1 and killifish from BG 3 (the five sampling events in the left-hand portion of the box and whisker plot) compared to sailfin molly and sheepshead minnow data is largely due to the fact that non-detected samples are represented in the box and whisker plots by substituting one-half the detection limit for the sample. Detection limits in sailfin molly and sheepshead minnow samples actually ranged up to 0.04 mg/kg, a value similar to concentrations detected in crested gobies and killifish. The overall similarity in concentrations among species and locations indicates that the mercury data can be combined to form one overall background data set, and no more background samples are needed.

<u>Nickel</u>

Nickel was detected in four of sixteen sampling events and in 9 of 90 samples. The maximum concentration of 12.4 mg/kg was considerably greater than the other eight detected values (0.2 to 0.46 mg/kg). Detection limits in round 1 samples were 1.4 to 1.5 mg/kg, while detection limits in most samples collected in later rounds ranged from 0.2 to 0.8 mg/kg. The maximum concentration of 12.4 mg/kg was in BG1-F-13, a sailfin molly sample collected at BG 1 in round 1. Concentrations of other analytes in this sample were not elevated. The consistency of the data (with the exception of a single outlier) indicates that the nickel data can be combined to form one overall background data set, and no more samples are needed.

Selenium

Selenium was detected in 47 of 90 samples and in 10 of 16 sampling events. Selenium was not detected in any of the 15 samples collected during round 5, but detection limits were higher in round 5 than in other rounds. Detection limits were 1.2 to 1.8 mg/kg in round 5, with the exception of sample B303-F-03, which had elevated detection limits for several metals and was previously discussed. Detection limits in other rounds ranged from 0.25 to 1.0 mg/kg, and detected concentrations ranged from 0.24 to 1.1 mg/kg. The consistency of the data indicates that selenium data can be combined to form a single background data set, and additional samples are not needed.

Silver

Silver was detected in only 1 of 90 samples. The single detected concentration (0.2 mg/kg) was in a sailfin molly sample collected from BG 7 during round 2. The detection limit in all other round 2 samples was 0.16 mg/kg. Detection limits during other rounds ranged from 0.11 to 0.5 mg/kg, except for sample B303-F-03, in which the detection limit was 1.5 mg/kg. The overall consistency of the data indicates that the silver data can be combined to form one overall background data set, and additional sampling is not necessary.

Vanadium

Vanadium was detected in only 8 of 90 samples. All detected concentrations (0.17 to 0.41 mg/kg) were in sheepshead minnows from BG 3 in round 3. The presence of detected concentrations in this single event appears to be due to detection limits; detection limits were lower in round 3 (0.08 to 0.14 mg/kg) than in other rounds. The minimum detection limit was 0.91 mg/kg in round 1, 0.19 mg/kg in round 2, and 0.59 mg/kg in round 5. Thus, the detected concentrations in round 3 were not elevated relative to detection limits in other rounds. Overall, the variation of concentrations and detection limits was small. The vanadium data can be combined to form a single background data set, and no more samples are needed.

Zinc

Zinc was detected in all minnow samples. The zinc data cover a wider range of concentrations than the other metals, but the box plot for zinc shows little variation between species, locations, or rounds. Most concentrations were between 20 and 85 mg/kg; the only exceptions were the minimum concentration of 13.6 mg/kg and the maximum concentration of 134 mg/kg. Both the minimum and maximum concentrations were in sampling events that consisted of only one sample. Overall, the zinc concentrations are relatively consistent among locations, rounds, or species, and the data can therefore be combined to form a single background data set. Additional sampling and analyses of zinc in background minnows is not necessary.

3.2.2 Detected Pesticides and PCBs

Aldrin

Aldrin was detected in only 5 of 90 minnow samples, with detected concentrations ranging from 0.28 to 2 µg/kg. The detected concentrations were similar to the range of detection limits in most non-detect samples (1 to 2 µg/kg). Detection limits in eight sheepshead minnow samples from BG 3 round 3 were 17 µg/kg. The detection limits in these eight non-detect samples introduces some uncertainty in the data evaluation, but this uncertainty is of minor consequence when the data from the other 82 samples is considered.

Aldrin was once among the most widely used organochlorine insecticides in the United States. Aldrin continues to be detected nationwide, even though most uses have been banned since 1974, and production was terminated in 1987. The variability of concentrations and detection limits in most background minnow samples was small. The aldrin data can be combined to form an overall background data set, and no additional analyses of aldrin in background minnow samples are needed.

Aroclor-1248

Aroclor-1248 was detected in 17 of 58 minnow samples. Fewer samples were analyzed for PCBs than for pesticides and most metals, since tissues were analyzed for PCBs only during rounds 1 and 2 (see Section 2.2.3). Aroclor-1248 was detected only in BG 7 samples, at concentrations ranging from 25 to 630 µg/kg. Almost all detected concentrations were considerably higher than detection limits in samples from other locations (20 to 31 µg/kg). Minnow samples were collected from BG 7 during round 2 only, so variability between rounds at BG 7 cannot be evaluated. Because of the inconsistency between BG 7 data and data from other background locations, Aroclor-1248 data should not be combined to form a single overall background data set. The tissue data suggest that Aroclor-1248 concentrations are elevated at BG 7 due to a local contaminant source, and Aroclor-1248 concentrations at BG 7 are not representative of background locations at Key West.

If Aroclor-1248 in minnow tissues is a concern in future RCRA/CERCLA investigations, the BG 7 minnow data could be deleted from the Aroclor-1248 data set, leaving 34 minnow samples from other locations in which Aroclor-1248 was not detected (Table B-2). The detection limits of Aroclor-1248 in these 34 samples ranged from 20 to 33 µg/kg, and are well below concentrations considered to be toxic to fish, piscivorous birds and mammals, and humans. Eisler (2000) recommended 400 µg/kg total PCBs as a protection criterion for fish. An International Joint Commission (1988) recommended 100 µg/kg total PCBs as a whole-body maximum fish residue to protect birds and mammals that consume fish. The U.S. Food and Drug Administration (FDA) and U.S. Environmental Protection Agency (EPA) safety level for total PCBs in the edible portion of fish is 2,000 µg/kg (FDA, 2001). The existing data set of 34 (non-BG 7) samples is probably adequate to establish background conditions, and additional sampling and analyses of Aroclor-1248 in minnows from background locations is not necessary.

Aroclor-1260

Aroclor-1260 was analyzed in the same ten sampling events as Aroclor-1248, but was more frequently detected (38 of 58 samples). Detected concentrations ranged from 16 to 200 µg/kg, while detection limits in non-detect samples ranged from 20 to 33 µg/kg. Detected concentrations in five samples exceeded 100 µg/kg. Concentrations tended to be greater in sheepshead minnows from BG 7, but unlike the Aroclor-1248 data, concentrations in killifish and sailfin molly samples from BG 7 were not elevated relative to other locations. Overall, the data are quite variable within and between sampling events. Nevertheless, the data suggest that the samples can be combined to form a single background data set, and additional sampling and analyses are not necessary.

Beta-BHC

Beta-BHC was detected in only 5 of 90 minnow samples, with detected concentrations ranging from 1.3 to 6.0 µg/kg. Detection limits in most non-detect samples ranged from 1 to 1.7 µg/kg, but the detection limits were 17 µg/kg in eight sheepshead minnow samples from BG 3 round 3. The eight samples with higher detection limits were the same samples mentioned in the discussion of aldrin. Detection limits for all pesticides in these eight samples were elevated relative to other samples. The uncertainty resulting from the elevated detection limits in these eight samples is of minor consequence when the data from the other 82 samples is considered. The detected concentrations and low detection limits in most non-detect samples indicate that the beta-BHC data can be combined to form one overall background data set, and additional sampling is not necessary.

Chlorobenzilate

Chlorobenzilate was detected in only 3 of 74 minnow samples, at concentrations of 73, 77, and 190 µg/kg. Detection limits were 17 µg/kg in round 2, but ranged from 280 to 4200 µg/kg during round 1 and from 33 to 330 µg/kg during round 3. The uncertainty resulting from the elevated detection limits greatly confounds the evaluation of chlorobenzilate data. If chlorobenzilate in minnow tissues is a concern in future RCRA/CERCLA investigations, additional minnow samples should be collected and analyzed from background locations, and care should be taken to ensure that detection limits are similar to those during round 2.

DDD

The organochlorine insecticide 4,4'-DDT and its close structural analogs 4,4'-DDE and 4,4'-DDD were detected in minnow samples. For convenience, 4,4'-DDT, 4,4'-DDD, and 4,4'-DDE will be referred to as DDT, DDD, and DDE, respectively.

DDD was detected in 11 of 16 sampling events and in 54 of 90 minnow samples. The first box and whisker plot for DDD (0 to 100 µg/kg scale) shows that concentrations in sheepshead minnows from BG 3 round 3 were greater than in other sampling events. DDD was detected in four of eight sheepshead minnow samples from BG 3 round 3, at concentrations of 26, 39, 59, and 100µg/kg, and was not detected (detection limit = 17µg/kg) in the four other sheepshead minnow samples from BG 3 round 3. Detected concentrations of DDD in all other background minnow samples ranged from 0.25 to 16.6 µg/kg and detection limits in non-detect samples ranged from 1 to 3.5 µg/kg.

The second box and whisker plot for DDD (0 to 20 µg/kg scale) indicates some variability in the data between species and sampling rounds. Specifically, concentrations were greater in the following five sampling events than in the other 11 sampling events: killifish at BG 3 round 1, sailfin molly at BG 2 round 1, sailfin molly at BG 3 round 1, sheepshead minnow at BG 3 round 1, and sheepshead minnow at BG 3 round 3. Secondly, DDD was not detected in any crested goby samples but was detected in most killifish, sailfin molly, and sheepshead minnow samples. Finally, note that concentrations tended to be greatest at BG 3. The observed variability is inconsequential however, since it is largely a function of the scale (0 to 20 µg/kg); DDD concentrations in 86 of 90 samples were less than 17 µg/kg, thus the data form a rather tightly clustered data set for this pesticide.

Newell et al. (1987) concluded that 200 µg/kg total DDT represents a safe fish flesh criterion for the protection of sensitive wildlife species that consume fish. Tissue threshold concentrations for total DDT that can be considered to be protective of fish span a large range of values, but are generally several hundred µg/kg (Jarvinen and Ankley, 1999). The FDA and EPA safety level for total DDT (4,4'-DDT and its structural analogs) in the edible portion of fish is 5,000 µg/kg (FDA, 2001). All concentrations of DDD in background minnow samples were well below values considered to be toxic to fish, piscivorous birds and mammals, and humans.

In summary, although DDT has not been marketed in the United States since 1972, DDD (a major metabolite of DDT) is ubiquitous in the environment due to the previous widespread use of DDT and its relatively long half-life. All detected concentrations of DDD were considerably less than values considered to be toxic to fish, piscivorous receptors, and humans, and with the exception of four samples, the observed variability in detected concentrations and detection limits was relatively low, occurring at concentrations less than approximately 17 µg/kg. Therefore, the DDD data can be combined to form one background minnow data set, and further sampling and laboratory analysis of background minnows is not needed.

DDE

DDE was detected in all sampling events and in 86 of 87 samples, and detected concentrations ranged from 1.8 to 106 µg/kg. As with DDD, the DDE the data show some variability between sampling events, and concentrations tended to be greatest at BG 3. Concentrations tended to be lowest in crested goby samples (3.4 to 9.8 µg/kg, and highest in killifish, averaging 41 µg/kg in killifish. The observed variability is inconsequential, however, since all concentrations were well below values considered to be toxic to fish, piscivorous receptors, and humans. DDE, which is a major metabolite of DDT, is ubiquitous in the environment due to previous widespread use of DDT and its relatively long half-life. The relatively low concentrations in minnow samples indicate that the data can be combined to form one background minnow data set, and further sampling and laboratory analysis of background minnows is not needed.

DDT

DDT was detected in 6 of 90 samples, with detected concentrations ranging from 0.63 to 2.8 µg/kg. The DDT detection limit in each of the previously mentioned eight sheepshead minnow samples from BG 3 round 3 was 17 µg/kg, while the detection limits in other non-detect samples ranged from 1 to 3.5 µg/kg, and were less than 2 µg/kg in most samples. As discussed in the evaluation of aldrin and beta-BHC, the detection limits in these eight sheepshead minnow samples introduces some uncertainty in the data evaluation, but this uncertainty is of minor consequence when the data from the other 82 samples is considered. In summary, the variability in the data was low, with the exception of the elevated detection limits in one sampling event. Therefore, DDT can be combined to form one overall background data set, and no additional analyses of DDT in background minnow samples are needed.

Other Pesticides

Other pesticides detected in background minnows and their frequencies of detection are shown below.

Chemical	Frequency of Detection	Maximum Concentration (µg/kg)
alpha-BHC	1/90	2.3
delta-BHC	13/90	1.0
dieldrin	14/90	4.9
endosulfan I	6/90	2.6
endosulfan II	1/90	1.9
endosulfan sulfate	3/90	9.8
endrin	6/87	5.4
endrin aldehyde	3/90	5.4
heptachlor	1/88	0.61
heptachlor epoxide	9/90	10
methoxychlor	1/90	1.9

The box and whisker plots (Appendix B.A-1) indicate that the minnow data for these 11 pesticides are similar to the previously discussed data and conclusions for aldrin, beta-BHC, and DDT. Specifically, detected concentrations were relatively low, and with the exception of sheepshead minnow samples from BG 3 round 3, the data are very tightly clustered (i.e., low variability between sampling events). Therefore, the data can be combined to form one background minnow data set for each of these 11 analytes, and further sampling and laboratory analysis of background minnows are not needed.

3.2.3 Analytes Not Detected in any Minnow Sample

As mentioned in Section 3.0, this report focuses on analytes *detected* in tissues collected from background locations. Although non-detected analytes cannot be subjected to the same degree of evaluation as detected analytes, the data for non-detected analytes can still be of value in some cases. Analytes not detected in any minnow sample consisted of chlordane, alpha-chlordane, gamma-chlordane, diallate, endrin ketone, gamma-BHC (lindane), isodrin, kepone, toxaphene, beryllium, cadmium, cobalt, thallium, tin, and five different Aroclor (PCB) compounds.

The usefulness of data for non-detected analytes depends on the range of detection limits and the number of samples in the data set. For example, detection limits for cadmium ranged from 0.03 to 0.54 mg/kg in 89 background minnow samples. This large sample size and narrow range of detection limits indicate that cadmium concentrations in background minnows are less than 0.54 mg/kg. Such data could be used to establish a useful background data set if cadmium in minnow tissues is a concern in future investigations. The pesticide diallate, on the other hand, was analyzed in only 18 samples, and its detection limit in these 18 samples ranged from 33 to 330 µg/kg. Thus, the uncertainty inherent in the dillate data set results in data that are less useful than the cadmium data set. For this report, box and whisker plots were not generated for analytes that were not detected in any tissue sample, and data evaluations for these analytes were beyond the scope of this report. The data for non-detected minnow analytes can be made available to interested parties by NAVFAC EFD SOUTH, if needed in future investigations.

The statement in the previous paragraph regarding the detection limits of cadmium excludes minnow sample B303-F-03. As mentioned in the first paragraph of Section 3.2.1, detection limits for metals in this sample were elevated due to a low sample mass. This sample should probably be deleted from the data set in future investigations of analytes not detected in any minnow sample, so as not to unduly bias the data, if such analytes are to be evaluated. It was retained for the data set in this report because four metals were detected in the sample, and it was responsible for the maximum concentrations of copper and zinc.

3.2.4 Summary and Conclusions - Minnows

Minnows were collected for tissue analyses during rounds 1, 2, 3, and 5. Different combinations of species, location, and sampling round resulted in 16 distinct "sampling events" for minnow data. Sixteen metals, 17 pesticides, and two PCBs were detected in minnow samples.

Iron and lead concentrations tended to be greater in sheepshead minnows than in other minnow species. For investigations of sites where lead or iron is a chemical of concern in minnow tissues, the background minnow data should be separated into two data sets; one data set for sheepshead minnows and one for other minnows.

Arsenic concentrations tended to be greater in killifish than in other minnow species. For investigations of sites where arsenic is a chemical of concern in minnow tissues, the background minnow data should be separated into two data sets; one data set for killifish and one for other minnows.

Aluminum was infrequently detected in minnows, but detection limits in non-detect samples were quite variable between sampling events. Because of the relatively high data variability, there is not enough evidence to conclude with high confidence that the data are similar across sampling events. However, aluminum is rarely a chemical of concern, and has not been a chemical of concern at NAS Key West sites.

Aroclor-1248 was detected only in minnow samples collected at BG 7, and almost all detected values were considerably higher than detection limits in samples from other locations. Minnow samples were collected from BG 7 only during round 2, so variability between rounds at BG 7 cannot be evaluated. The tissue data suggest that Aroclor-1248 concentrations are elevated at BG 7 due to a local contaminant source, and Aroclor-1248 concentrations at BG 7 are not representative of background locations at Key West. Therefore, the Aroclor-1248 data should not be combined to form one overall background data set. For investigations of sites where Aroclor-1248 is a chemical of concern in minnow tissues, the BG 7 minnow data should be deleted from the data set.

Chlorobenzilate was detected in only 3 of 74 minnow samples, but detection limits in non-detect samples were quite variable between sampling events, and were as high as 4200 µg/kg in some samples. The uncertainty resulting from the elevated detection limits greatly confounds the evaluation of chlorobenzilate data. If chlorobenzilate in minnow tissues is a concern in future investigations, additional minnow samples should be collected and analyzed from background locations, and care should be taken to ensure that detection limits are adequate to evaluate potential risk from this pesticide.

The evaluation of the minnow tissue data indicates that tissue data for 29 of 35 detected minnow analytes can be combined across species, locations, and sampling round to form a single background data set for each analyte. The six exceptions are discussed above, and consist of aluminum, arsenic, iron, lead, Aroclor-1248, and chlorobenzilate. Additional sampling is not needed to establish background conditions, except for chlorobenzilate and possibly aluminum. Conclusions regarding chlorobenzilate and aluminum are hindered by variable detection limits. Although there may be subtle differences in food items, habitat preferences, and physiology of the minnow species collected at background sites, available tissue data indicates that with few exceptions (arsenic, iron, and lead), the minnow data can be grouped across species.

3.3 AQUATIC VEGETATION (TURTLE GRASS)

Turtle grass is the only species of aquatic vegetation that has been collected for tissue analyses. Turtle grass samples were collected at background sites BG 4, BG 5, and BG 8 during round 2 for use in ecological risk assessments at IRs 1, 7, and 8. Turtle grass samples were collected at background sites BG 4 and BG 8 during round 4 for use in the long-term monitoring of IR 1. Thus, background turtle grass data represent five sampling events: BG 4 round 2, BG 5 round 2, BG 8 round 2, BG 4 round 4, and BG 8 round 4.

Fifteen metals (excluding calcium, magnesium, sodium, and potassium), 12 pesticides, and one PCB compound have been detected in turtle grass samples (Table B-3). The discussion of turtle grass data is organized differently than the minnow data. Whereas the minnow data represented four species collected during 16 sampling events for a total of 90 samples, the aquatic vegetation data represent 11 samples of a single species collected in five sampling events. The discussion and evaluation of turtle grass data is organized based on the number of sampling events in which specific analytes were detected.

3.3.1 Analytes Detected in One Sampling Event

Ten analytes were detected in only one of the five sampling events, and each of these 10 analytes was detected in only 1 of 11 total samples. The data for these 10 analytes are summarized below.

Chemical	Detected Concentration	Range of Detection Limits in Non-Detected Samples
aldrin	0.48 µg/kg	1.7 µg/kg
dieldrin	0.25 µg/kg	1.7-3.3 µg/kg
delta-BHC	0.68 µg/kg	1.7 µg/kg
endosulfan I	0.2 µg/kg	1.7 µg/kg
endosulfan II	0.5 µg/kg	1.7-3.3 µg/kg
endrin	0.1 µg/kg	1.7-3.3 µg/kg
Aroclor-1260	35 µg/kg	33-67 µg/kg
chromium	0.27 mg/kg	0.16-0.82 mg/kg
cobalt	0.28 mg/kg	0.11-0.37 mg/kg
silver	0.29 mg/kg	0.15-0.23 mg/kg

The single detected concentrations of aldrin, dieldrin, delta-BHC, endosulfan I, endosulfan II, and endrin were less than detection limits in the other 10 samples, and were "estimated" concentrations, i.e., the analyte was positively identified but its concentration could not be precisely quantified since it was less than the contract-required quantitation limit but greater than the instrument detection limit; the analytical laboratory denotes such concentrations by a "J" flag after the reported concentration. The 35 µg/kg concentration of Aroclor-1260 was also J-flagged. The single detected concentrations of Aroclor-1260, chromium, cobalt, and silver were consistent with detection limits in the other 10 samples. Detection limits for dieldrin, endosulfan II, and endrin were slightly lower in round 4 samples (1.7 µg/kg) than in non-detected round 2 samples (3.3 µg/kg). Otherwise, the data for the 10 analytes listed above show no perceptible trends between rounds, locations, or samples. Concentrations of these analytes were not consistently elevated in any particular sample, and the detected concentrations noted above represent seven separate samples. The consistency of detected and non-detected concentrations indicates that the data can be combined to form a single background data set for each of these analytes.

3.3.2 Analytes Detected in Two Sampling Events:

Seven analytes (barium, mercury, vanadium, alpha-BHC, beta-BHC, DDD, and DDE) were detected in two of the five sampling events, and each of these seven analytes was detected in two of 11 total samples.

Barium and vanadium were detected at BG 4 and BG 8 in round 4. Only one turtle grass sample was collected for analysis at each of these two background locations during round 4. The two detected concentrations of barium (1.1 and 1.6 mg/kg) were only slightly greater than the detection limits in the non-detect samples (0.41 to 1 mg/kg). Similarly, the two detected concentrations of vanadium (1.5 and 2.5 mg/kg) were only slightly greater than the detection limits in the non-detect samples (0.46 to 1.5 mg/kg).

Mercury, alpha-BHC, and beta-BHC were each detected in the same two samples, a BG 4 sample during round 2 and a BG 5 sample during round 2. The detected concentrations of alpha-BHC (0.5 and 0.55 µg/kg) and beta-BHC (0.55 and 1.1 µg/kg) were less than detection limits in the non-detect samples (1.7 µg/kg), and the detected concentrations of mercury (0.01 and 0.02 mg/kg) were the same as the detection limits in the non-detect samples.

DDD and DDE were detected during round 2 at BG 4 and BG 8. The detections for these two analytes follow the same pattern as alpha-BHC and beta-BHC, i.e., the maximum detected concentrations (0.79 µg/kg DDD and 0.7 µg/kg DDE) were less than detection limits in the non-detect samples (1.7 to 3.3 µg/kg).

The relatively low detected concentrations and small variation in concentrations among sampling events indicates that the tissue data for barium, mercury, vanadium, alpha-BHC, beta-BHC, DDD, and DDE can be combined to form one data set for each analyte.

3.3.3 Analytes Detected in Three Sampling Events:

Five analytes (cadmium, copper, nickel, endrin aldehyde, and gamma-BHC) were detected in three of the five sampling events.

Cadmium was detected at BG 4 in round 2 (0.11 mg/kg), BG 8 in round 2 (0.12 mg/kg) and BG 4 in round 4 (18.4 mg/kg). The detected values in the two round 2 samples were similar to the detection limits in non-detect samples (0.08 to 0.53 mg/kg), but the 18.4 mg/kg detected concentration in the BG 4 round 4 sample was more than 150 times greater than other values in the cadmium data set. An elevated concentration such as this might be due to a local contaminant source, even though concentrations at BG 4 were not elevated during round 2. Since only one sample was collected from BG 4 during round 4, conclusions regarding the cadmium concentration in this sample compared to samples collected in other rounds and at other locations are unclear. If cadmium is a chemical of concern in turtle grass at shoreline sites in future investigations, additional turtle grass samples could be collected and analyzed from background locations. Alternatively, the existing data set should be used with caution regarding the outlier at 18.4 mg/kg.

Copper was detected in three samples, and detected concentrations (1.4 to 2.4 mg/kg) were consistent with detection limits in non-detect samples (0.34 to 2.2 mg/kg). The small variation in concentrations over all sampling events indicates that copper data can be combined across sampling locations and rounds to form one data set.

Nickel was detected in three samples. Detected concentrations both round 4 samples (0.92 and 1.2 mg/kg) were similar to the detection limits in non-detect samples (0.29 to 0.93 mg/kg). The maximum detected value (26.1 mg/kg) in a round 2 sample from BG 8 was more than 20 times greater than the next highest nickel concentration. Even with the uncertainty that is inherent in the evaluation of small data sets, the single elevated concentration at BG 8 round 2 is problematic. If nickel is a chemical of concern in turtle grass at shoreline sites in future investigations, additional turtle grass samples could be collected and analyzed from background locations.

Endrin aldehyde was detected in five of nine samples during round 2, and was not detected in either of the two round 4 samples. Detected concentrations were 14 and 18 µg/kg at BG 4, 3.3 and 8 µg/kg and at BG 8, and 6.6 µg/kg at BG 5. Detection limits in non-detect samples were 3.3 µg/kg during round 2 and 1.7 µg/kg during round 4. The data are not as tightly clustered as most other turtle grass analytes. The wider range of detected concentrations might reflect background conditions resulting from historical use of the pesticide endrin, but this is only speculation. Nevertheless, the available data suggest that the endrin aldehyde data can be combined to form an overall background data set.

Gamma-BHC was detected in seven samples during round 2, with concentrations ranging from 0.13 to 0.64 µg/kg. The detection limit in non-detect samples was 1.7 µg/kg. The relatively low detected concentrations and small variation in concentrations among sampling events indicate that the gamma-BHC data can be combined across all sampling locations and rounds.

3.3.4 Analytes Detected in Four Sampling Events

Lead was the only analyte that was detected in four of the five sampling events. It was detected in four samples, and at concentrations ranging from 0.43 to 0.93 mg/kg; these concentrations are consistent with detection limits in non-detect samples (0.32 to 0.61 mg/kg). The narrow range of low concentrations and detection limits indicate that lead concentrations can be combined to form one background data set.

3.3.5 Analytes Detected in Five Sampling Events

Five metals (aluminum, arsenic, iron, manganese, and zinc) were detected in every sampling event.

Aluminum was detected in ten of 11 samples. As shown in the box and whisker plot, concentrations in BG 4 samples were lower than concentrations in BG 5 and BG 8 samples. The highest aluminum concentration at BG 4 was 13.3 mg/kg, while concentrations in BG 5 and BG8 samples ranged from 14.5 to 36.5 mg/kg. The higher concentrations at BG 5 and BG 8 could be due to local geomorphology, local contaminant sources, or simply random variation in a small data set. Aluminum is a common metallic element, comprising eight percent of the earth's crust (Press and Siever, 1974). Because aluminum is such a common element and is rarely a chemical of concern, the observed differences among locations are probably not significant. Aluminum is not a chemical of concern at sites where long-term monitoring is being conducted, and currently there is no reason to analyze additional background turtle grass samples for aluminum. If aluminum should become a chemical of concern at shoreline sites in future investigations, additional turtle grass samples could be analyzed for aluminum, or the existing data can be considered to represent two separate background data sets.

Arsenic was detected in five of 11 samples, once in each of the five sampling events. Detected concentrations ranged from 0.51 to 1.6 mg/kg. Detection limits in non-detect samples ranged from 0.94 to 1.9 mg/kg. The consistency of detected concentrations and detection limits among sampling events indicates that the arsenic data represent one background data set among locations and rounds.

Iron was detected in eight of 11 samples. Concentrations tended to be greatest in the five samples from BG 8, where concentrations ranged from 42.6 to 90.2 mg/kg. Detected concentrations in BG 4 and BG 5 samples ranged from 26.9 to 47 mg/kg; detection limits in non-detects at BG 4 and BG 5 ranged from 18.9 to 22 mg/kg. The trend of higher concentrations at BG 8 is made somewhat uncertain by the limited number of samples in the data set. The BG 5 data, for example, represent only two samples. Furthermore, the iron concentration in the single BG 4 sample collected during round 4 (47 mg/kg) was within the range of concentrations from BG 8. As discussed in Section 3.2.1, iron concentrations in minnow samples were also quite variable among sampling events. If iron in turtle grass should become an ecological chemical of concern at shoreline sites in future investigations, additional turtle grass samples could be analyzed for iron. Collection of additional data would allow stronger conclusions regarding the spatial and temporal disparity or similarity of the data sets.

Manganese was detected in all 11 samples. Concentrations ranged from 3.2 to 18.2 mg/kg. As shown in the box and whisker plot, concentrations in samples from BG 4 were greater than concentrations in other samples. Concentrations from BG 4 ranged from 13.2 to 18.2 mg/kg, while concentrations at BG 5 and BG 8 ranged from 3.2 to 7.9 mg/kg. The higher concentrations at BG 4 contrast with the aluminum data; aluminum concentrations were higher at BG 4. The higher manganese concentrations at BG 4 could be due to local geomorphology, a local contaminant source, or random variation in a small data set. Manganese is a common metallic element and is a vital micronutrient for plants and animals. Manganese has not been a chemical of concern at any NAS Key West shoreline site, and the observed difference in turtle grass concentrations among locations is probably not significant. There is currently no reason to analyze additional background turtle grass samples for manganese. If manganese should become a chemical of concern at shoreline sites in future investigations, additional turtle grass samples could be analyzed for manganese, or the existing data can be considered to represent two separate background data sets.

Zinc was detected in all samples, with concentrations ranging from 1.1 to 27.5 mg/kg. The maximum concentration of 27.5 mg/kg was measured in the only sample collected from BG 4 during round 4, and was approximately twice as high as the next highest value (14.6 mg/kg). Concentrations at BG 4 during round 2 (6.9 mg/kg to 9.3 mg/kg) were similar to concentrations in the other sampling events (see box and whisker plot). Similar to the situation discussed above for aluminum, iron, and manganese, the significance of the 27.5-mg/kg value is unclear. If zinc is a chemical of concern in turtle grass at shoreline sites in future investigations, additional turtle grass samples could be analyzed for zinc.

3.3.6 Analytes Not Detected in any Turtle Grass Sample

Several pesticides, PCBs, and metals were not detected in any turtle grass sample. This report focuses on analytes *detected* in tissues collected from background locations. Although non-detected analytes cannot be subjected to the same degree of evaluation as detected analytes, the data for non-detected analytes can still be of value, depending on the range of detection limits and the number of samples in the data set. For example, selenium and tin were not detected in turtle grass. Selenium was analyzed in all 11 samples, and its detection limits spanned a narrow concentration range (0.97 to 1 mg/kg). This consistency indicates that selenium concentrations in background turtle grass are typically less than 1 mg/kg. Tin, however, was analyzed in only two turtle grass samples. Tin data based on two samples provide less useful information than the selenium data. Box and whisker plots were not generated for analytes that were not detected in any tissue sample, and data evaluations for these analytes were beyond the scope of this report. If needed in future investigations, the data for non-detected turtle grass analytes can be made available by NAVFAC EFD SOUTH.

3.3.7 Summary and Conclusions – Turtle Grass Tissue

Turtle grass samples have been collected for tissue analysis during five sampling events (BG 4 round 2, BG 5 round 2, BG 8 round 2, BG 4 round 4, and BG 8 round 4). A total of 11 samples have been collected and analyzed. Fifteen metals, 12 pesticides, and one PCB compound (Aroclor-1260) have been detected in turtle grass samples.

The relatively low detected concentrations and small variation in detected concentrations and detection limits among sampling events indicate that the analytical data for pesticides, most metals, and Aroclor-1260 can be combined to form a single background data set for each of these analytes, and no further sampling is necessary to establish background turtle grass concentrations.

Concentrations of six metals (aluminum, cadmium, iron, nickel, manganese, and zinc) were inconsistent between sampling events, producing uncertainty with regard to combining data for all sampling rounds and locations to yield a composite background data set. The data for cadmium, nickel, and zinc were inconsistent between samples because of a single sample with an elevated concentration. Iron concentrations at BG 8 tended to be greater than at other locations. Aluminum concentrations at BG 4 were lower than at other locations. Manganese concentrations at BG 4, on the other hand, were greater than at other locations.

The observed range of concentrations in the data sets for aluminum, iron, manganese, and zinc might not be significant. These four metals are common elements under natural conditions, and iron, manganese, and zinc are essential biological micronutrients. Determining the concentration at which these elements become toxic to turtle grass or to organisms that forage on turtle grass was beyond the scope of this report. If concentrations of these metals in turtle grass are monitored at shoreline sites in future investigations, available literature should be examined for toxicity thresholds in order to determine whether the existing data are sufficient to represent background conditions. A similar situation exists for cadmium and nickel. These metals, however, are not micronutrients, and can be toxic at low concentrations. If cadmium or nickel is a chemical of concern at shoreline sites in future investigations, additional turtle grass samples should probably be collected and analyzed from background locations.

Turtle grass samples were collected from three locations, all of which were distant from RCRA/CERCLA sites under investigation. Ecological conditions at the three background locations are similar. The extent to which the three locations might be impacted from local contaminant sources is uncertain. Overall, however, the turtle grass tissue data corroborate the conclusion that the analytes discussed in this section represent background conditions, and further sampling is not needed. Uncertainty exists regarding the data for aluminum, cadmium, iron, nickel, manganese, and zinc.

3.4 TERRESTRIAL VEGETATION (SEA OXEYE DAISY)

Three species of terrestrial vegetation have been collected at background sites: sea oxeye daisy, seashore dropseed, and red mangrove. One sample of each of each of these three species was initially collected from BG 6 and BG 7 during round 2 of background sampling. Subsequent sampling of terrestrial vegetation has been limited to sea oxeye daisy. Because only two samples of seashore dropseed and two samples of red mangrove have been collected, the data set for these species is too small for more than a cursory examination of the results, and the following discussion of terrestrial vegetation is limited to the sea oxeye daisy data.

Following the initial collection of sea oxeye daisy samples at background sites BG 6 and BG 7, sea oxeye daisy samples were collected at BG 3 and BG 6 during round 3 (three samples at each site), and at BG 1 and BG 6 during round 5 (three samples at each site), for use in the long-term monitoring of SWMUs 1 and 2. Thus, background sea oxeye daisy data represent 14 samples collected over six sampling events: BG 6 round 2, BG 7 round 2, BG 3 round 3, BG 6 round 3, BG 1 round 5, and BG 6 round 5. Seven pesticides and seven metals (excluding calcium, magnesium, potassium, and sodium) have been detected in background sea oxeye daisy samples (Table B-4). Eight analytes were detected in only one of the six sampling events, three analytes were detected in two sampling events, and three analytes were detected in four sampling events. These are discussed below.

3.4.1 <u>Analytes Detected in One Sampling Event:</u>

Alpha-BHC, delta-BHC, DDD, DDT, heptachlor, barium, chromium, and selenium were detected in only one of the six sampling events.

Alpha-BHC, delta-BHC, DDT, heptachlor, and barium were each detected in only one of 14 samples. Alpha-BHC was detected in a BG 7 sample during round 2 and heptachlor was detected in the same sample. Delta-BHC was detected in a BG 6 sample during round 2, and DDT was detected in a BG 6 sample during round 5. The detected concentrations for these four pesticides were J-flagged, signifying estimated concentrations that could not be precisely quantified because they were less than the quantitation limit but greater than the instrument detection limit. In addition, the J-flagged concentrations of alpha-BHC, beta-BHC, and heptachlor were less than detection limits in the 13 non-detect samples.

The J-flagged concentration of DDT was less than or equal to detection limits in the 13 non-detect samples. Barium was detected at BG 1 during round 5, at a concentration of 0.46 mg/kg. Barium detection limits in the 13 non-detect samples ranged from 0.04 mg/kg to 0.41 mg/kg. The small variation in concentrations over all sampling events indicates that alpha-BHC, delta-BHC, DDT, heptachlor, and barium data represent background conditions among all sampling locations for each analyte.

Chromium and selenium were detected at BG 6 during round 3. Chromium was detected in three samples at concentrations ranging from 0.23 to 0.25 mg/kg, and selenium was detected in two samples (0.47 and 0.49 mg/kg). For both chromium and selenium, the detected concentrations were within the detection limits of non-detect samples (Table B-4). DDD was detected in two samples (1 and 1.6 µg/kg) from BG 1 during round 5. Both values were J-flagged (estimated) concentrations and were less than detection limits in the 12 non-detect samples. Therefore, chromium, selenium, and DDD data are similar enough so that the data from all sampling events can be combined to form one data set for each analyte.

3.4.2 <u>Analytes Detected in Two Sampling Events:</u>

Endrin, endrin aldehyde, and copper were detected in two of the six sampling events.

Endrin and endrin aldehyde were detected only in round 2. Detected concentrations (0.23 to 1.2 µg/kg) were less than detection limits in non-detect samples (1.7 to 17 µg/kg). Therefore, endrin and endrin aldehyde data can be combined to form one background data set for each analyte.

Copper was detected in all six samples collected during round 5, and was not detected in other rounds. Detected concentrations ranged from 1.7 to 2.5 mg/kg. Detection limits in non-detect samples ranged from 1 to 1.9 mg/kg. Although the copper concentrations during round 5 were greater than in the four previous rounds, the difference was slight. The small variation in concentrations over all sampling events indicates that the copper data represent a single background data set across background locations and rounds.

3.4.3 <u>Analytes detected in Four Sampling Events:</u>

Mercury, manganese, and zinc were detected in four of the six sampling events.

Mercury was detected in four of 14 samples, at concentrations of 0.01 mg/kg in two samples and 0.02 mg/kg in two samples. The detected values were very similar to detection limits in non-detect samples (0.017 to 0.024 mg/kg). Since the detected concentrations are consistent with the detection limits in non-detect samples, mercury concentrations are considered to represent one data set among all background locations for all rounds.

Manganese was detected in 11 of 14 samples. As shown in the box and whisker plots, concentrations were greatest during round 5 at BG 1, where concentrations in three samples were 3, 3.7, and 6.1 mg/kg. Samples were not collected at BG 1 during other rounds, so comparisons over time at BG 1 cannot be made. Detected manganese concentrations in other samples ranged from 0.66 mg/kg to 2.8 mg/kg. The higher concentrations at BG 1 are not greatly elevated relative to the other samples, and the difference is considered to be insignificant. Thus, the data from all sampling events can be combined to form one data set. However, if manganese is a chemical of concern in future investigations, the existing data set should be used with caution regarding the outlier at 6.1 mg/kg.

Zinc was detected in eight of 14 samples, at concentrations ranging from 1.6 to 6.9 mg/kg. Zinc was detected in the same sampling events as manganese (BG 3 and BG 6 during round 3 and BG 1 and BG 6 during round 5). Like manganese, the zinc data from round 5 at BG 1 were different from other sampling events, but unlike manganese, the zinc concentrations in this sampling event were less than in other sampling events (see box and whisker plot). Zinc was detected in two of three samples at BG 1 during round 5 (1.6 and 2.1 mg/kg), while detected concentrations in other sampling events ranged from 1.6 to 4.9 mg/kg. Overall, the detected concentrations and detection limits in non-detect samples were similar enough so that the data from all sampling events can be combined to form one data set.

3.4.4 Analytes Not Detected in any Sea Oxeye Daisy Sample

Several pesticides, PCBs, and metals were not detected in any sea oxeye daisy grass sample. Although non-detected analytes cannot be subjected to the same degree of evaluation as detected analytes, the data for non-detected analytes can still be of value, depending on the range of detection limits and the number of samples in the data set. For example, iron and silver were not detected in any sea oxeye daisy samples. Iron and silver were analyzed in all 11 samples, but iron detection limits ranged from 3.4 to 13.9 mg/kg while silver detection limits ranged from 0.19 to 0.31 mg/kg. The narrower range of detection limits for silver results in much less uncertainty than the detection limits for iron. Box and whisker plots were not generated for analytes that were not detected in any tissue sample, and data evaluations for these analytes were beyond the scope of this report. If needed in future investigations, the data for non-detected sea oxeye daisy analytes can be made available by NAVFAC EFD SOUTH.

3.4.5 Summary and Conclusions – Sea Oxeye Daisy Tissue

Sea oxeye daisy samples have been collected for tissue analysis during six sampling events (BG 6 round 2, BG 7 round 2, BG 3 round 3, BG 6 round 3, BG 1 round 5, and BG 6 round 5). A total of 14 samples have been collected and analyzed. Seven pesticides and seven metals have been detected in background sea oxeye daisy samples.

The relatively low detected concentrations and small variation between detected concentrations and detection limits among sampling events indicates that the sea oxeye daisy tissue data can be combined to form a single background data set for each detected analyte, and no further sampling is necessary to establish background tissue concentrations of sea oxeye daisy. The slight anomalies in the tissue data for copper, manganese, and zinc are considered to be insignificant.

Sea oxeye daisy samples were collected from four locations, all of which were distant from RCRA/CERCLA sites under investigation. Ecological conditions at the four background locations are similar. The extent to which the four locations might be impacted from local contaminant sources is uncertain. Overall, however, the tissue data corroborate the conclusion that the analytes discussed in this section represent background conditions, and further sampling is not needed.

3.5 OTHER TISSUE TYPES

3.5.1 Mollusks

Mollusks were collected from background sites during rounds 1, 2, and 4. Two mangrove oyster samples were collected during round 1 for use in the ecological risk assessment of SWMU 9. Two milk conch samples, two Florida horse conch samples, four true tulip snail samples, and five Caribbean vase conch samples were collected during round 2 for use in the ecological risk assessment of IR 1 and IR 8. Two additional Caribbean vase conch samples and one true tulip snail were collected during round 4 for use in the long-term monitoring of IR 1. Contaminants in mollusks are not currently being monitored at any NAS Key West RCRA/CERCLA site.

If contaminant concentrations in mangrove oysters should become a concern at NAS Key West sites, additional samples of this bivalve mollusk should be collected, since the existing data set consists of only two samples. The gastropod mollusk data set consists of four species and a total of 16 samples. If contaminant concentrations in marine gastropods should become a concern at NAS Key West sites, the existing data set should be examined to determine if the tissue data can be combined across species, location, and sampling round. The mollusk tissue data from rounds 1 and 2 can be found in Appendix F of the *Final Supplemental RFI/RI Report for Eight Sites, NAS Key West, Florida* (B&RE, 1998). The mollusk tissue data from round 4 can be found in the *IR 1 and IR 8 Third Quarter Performance Monitoring Report* (TtNUS, 2002).

3.5.2 Crustaceans

Crustaceans were collected from background sites during rounds 2 and 3. Four crustacean species were collected from background sites during round 2. Nineteen spiny lobster samples, 10 stone crab samples, four spiny spider crab samples, and one red hermit crab sample were collected during round 2 for use in the ecological risk assessments of IR 1, IR7, and IR 8. Contaminants in these four crustacean species are not currently being monitored at any NAS Key West RCRA/CERCLA site.

Three mud fiddler crab samples were collected during round 3 for use in the long-term monitoring of SWMU 1. Mud fiddler crabs were sparse at SWMU 1 during the second biennial monitoring of that site (January 2003), so no attempts were made to collect mud fiddler crabs at background sites during round 5.

If contaminant concentrations in lobsters should become a concern at NAS Key West sites, the existing data set of 19 lobster samples provides a sufficient number of samples to adequately represent background conditions in this species. However, lobsters have not been collected from background sites since 1996, so the data set must be used with caution, since conditions might have changed since 1996. If contaminant concentrations in marine crabs should become a concern at NAS Key West sites, the existing data set should be examined to determine if the tissue data can be combined across species, location, and sampling round. Mud fiddler crabs are more terrestrial than the three marine crab species collected at background sites (stone crab, spiny spider crab, red hermit crab). Additional mud fiddler crab samples will be needed if this species is used in future risk evaluations, since the current data set consists of only three samples.

The crustacean tissue data from round 2 can be found in Appendix F of the *Final Supplemental RFI/RI Report for Eight Sites, NAS Key West, Florida* (B&RE, 1998). The crustacean tissue data from round 3 (mud fiddler crabs) can be found in the *Performance Monitoring Quarterly Report, Fall 2000* (TtNUS, 2001).

3.5.3 Terrestrial Vegetation

Three species of terrestrial vegetation were collected at background sites: sea oxeye daisy, seashore dropseed, and red mangrove. Sea oxeye daisy data were evaluated in Section 3.4. Two samples of seashore dropseed and two samples of red mangrove were collected during round 2 of background sampling for use in the ecological risk assessments of SWMUs 1, 2, 4, 5, and 7. Because only two samples have been collected, additional samples would need to be collected if either species is to be used to evaluate contamination at NAS Key West sites. The seashore dropseed and red mangrove tissue data can be found in Appendix F of the *Final Supplemental RFI/RI Report for Eight Sites, NAS Key West, Florida* (B&RE, 1998).

3.5.4 Fish

Tissue data from minnow-sized fish species were evaluated in Section 3.2. Larger-bodied fish species were collected from BG 1 and BG 2 during round 1 for use in the ecological risk assessments of SWMU 2 and site Area of Concern (AOC) Site B. Large fish were also collected from BG 1 during round 3 for use in long-term monitoring of SWMU 2. Contaminants in large fish are not currently being monitored at any NAS Key West RCRA/CERCLA site. If contaminant concentrations in large fish should become a concern at NAS Key West sites, the existing data set should be examined to determine if the tissue data can be combined across species, location, and sampling round.

The large fish tissue data from round 1 can be found in Appendix J of the *Final Supplemental RFI/RI Report for NAS Key West High Priority Sites* (B&RE, 1997) and Appendix F of the *Final Supplemental RFI/RI Report for Eight Sites, NAS Key West, Florida* (B&RE, 1998). The large fish tissue data from round 3 can be found in the *Performance Monitoring Quarterly Report, Fall 2000* (TtNUS, 2001).

TABLE B-2
SUMMARY OF MINNOW TISSUE DATA
NAVAL AIR STATION
KEY WEST, FLORIDA

Parameter	Frequency of Detection	Minimum Concentration	Maximum Concentration	Range of Nondetects	Mean Concentration[a]	Average of Positive Hits	Median[a]	Geometric Mean[a]	Standard Deviation[a]	95% UCL[ab]
Pesticides and PCBs (ug/kg)										
4,4'-DDD	54/90	0.25J	100	1 - 17	5.73	8.36	1.5	2.14	13.0	7.94
4,4'-DDE	86/87	1.8	106	3.3	25.4	25.7	18.3	17.8	22.6	29.4
4,4'-DDT	6/90	0.63J	2.8	1 - 17	1.69	1.86	0.85	1.09	2.21	2.08
ALDRIN	5/90	0.28J	2J	1 - 17	1.45	1.22	0.85	0.89	2.23	1.82
ALPHA-BHC	1/90	2.3J	2.3J	1 - 17	1.44	2.30	0.85	0.89	2.23	1.82
AROCLOR-1248 (all minnows)	17/58	25J	630	20 - 33	74.1	224	12	25.4	125	102
AROCLOR-1248 (BG 7 data only)	17/24	25J	630	33	164.0	224	160	87.6	156	215
AROCLOR-1248 (excluding BG 7)	0/34			20/33	10.72					
AROCLOR-1260	38/58	16J	200	20 - 33	47.5	66.4	43	32.6	41.3	56.3
BETA-BHC	5/90	1.3J	6	1 - 17	1.61	3.98	0.85	0.97	2.33	2.01
CHLOROBENZILATE	3/74	73J	190	17 - 4200	386	113	165	100	534	190
DELTA-BHC	13/90	0.08J	1J	1 - 17	1.37	0.45	0.85	0.78	2.25	1.00
DIELDRIN	14/90	0.34J	4.9	1 - 17	1.72	1.77	0.85	1.09	2.24	2.10
ENDOSULFAN I	6/90	0.66J	2.6	1 - 17	1.47	1.45	0.85	0.91	2.23	1.85
ENDOSULFAN II	1/90	1.9	1.9	1 - 17	1.65	1.90	0.85	1.07	2.20	1.90
ENDOSULFAN SULFATE	3/90	1.6	9.8J	1 - 17	1.83	7.07	0.85	1.11	2.51	2.29
ENDRIN	6/87	0.52J	5.4J	1 - 17	1.76	2.54	0.85	1.10	2.29	2.16
ENDRIN ALDEHYDE	3/90	3.4J	5.4J	1 - 17	1.74	4.63	0.85	1.09	2.27	2.13
HEPTACHLOR	1/88	0.61J	0.61	1 - 17	1.44	0.61	0.85	0.88	2.26	0.61
HEPTACHLOR EPOXIDE	9/90	1J	10	1 - 17	1.67	3.24	0.85	0.98	2.44	2.09
METHOXYCHLOR	1/90	1.9J	1.9J	1 - 33	4.20	1.90	0.85	1.83	5.10	1.90
Inorganics (mg/kg)										
ALUMINUM	8/56	10.4	62.5	1.9 - 100	9.33	24.1	6.65	5.97	11.0	11.8
ANTIMONY	5/90	0.33	1.2	0.31 - 10	1.28	0.99	0.73	0.85	1.03	1.20
ARSENIC (all minnows)	32/90	0.56	8.3J	0.18 - 10	1.73	3.51	0.93	0.81	2.08	2.10
ARSENIC (killifish only)	19/26	1.7J	8.3J	3.1-5.1	4.28	5.18	4.05	3.71	2.16	4.97
ARSENIC (excluding killifish)	13/64	0.56	1.5	0.18-10	0.695	1.08	0.65	0.44	0.70	0.84
BARIUM	57/90	0.67	9.9	0.36 - 1.7	2.26	3.30	1.6	1.38	2.11	2.62
CALCIUM	56/56	3280	40600	---	14088	14088	13100	13151	5549	15338
CHROMIUM	26/90	0.28	3.1	0.16 - 1	0.411	0.610	0.4	0.33	0.42	0.48
COBALT	1/90	0.39	0.39	0.08 - 2.5	0.255	0.39	0.17	0.16	0.22	0.29
COPPER	82/90	0.7	35.3	0.47 - 2.1	4.75	5.15	3.55	3.23	4.89	5.57
IRON (all minnows)	23/56	15.6	65.6	4.7 - 157	20.9	35.9	12.48	14.7	17.5	24.6
IRON (sheepshead only)	12/14	30.9	65.6	20.1-157	43.7	43.6	42.15	40.2	16.3	51.4
IRON (excluding sheepshead)	11/42	15.6	35.6	4.7-32.2	13.3	27.5	9.93	10.5	9.5	16.7
LEAD (all minnows)	58/90	0.14	21.9	0.13 - 5	2.69	4.00	0.40	0.62	5.42	3.61
LEAD (sheepshead only)	19/20	0.33	21.9	5	10.50	11.00	10.05	7.270	7.26	13.30
LEAD (excluding sheepshead)	39/70	0.14	5.3	0.13-0.92	0.45	0.61	0.33	0.31	0.645	0.58
MAGNESIUM	56/56	298	1210	---	513	513	477.5	499	139	543
MANGANESE	22/56	3.5	16.2	0.61 - 10.4	2.89	5.91	0.975	1.68	3.04	3.56
MERCURY	38/89	0.01	0.06	0.01 - 0.04	0.0196	0.03	0.02	0.02	0.01	0.02
NICKEL	9/90	0.2	12.4	0.19 - 5	0.561	1.64	0.355	0.330	1.31	0.794
POTASSIUM	56/56	2260	10300	---	2927	2927	2785	2845	1041	3151
SELENIUM	47/90	0.24	1.1	0.25 - 10	0.561	0.50	0.5	0.48	0.51	0.65
SILVER	1/90	0.2	0.2	0.11 - 1.5	0.158	0.20	0.13	0.13	0.10	0.18
SODIUM	56/56	1090	4940	---	1804	1804	1895	1713	640	1942
VANADIUM	8/90	0.17	0.41	0.08 - 5	0.381	0.27	0.42	0.31	0.27	0.41
ZINC	90/90	13.6	134	---	39.7	39.7	37.5	36.9	17.3	42.7

Notes:
A "J" flag after the reported concentration indicates that the analyte was positively identified but its concentration could not be precisely quantified since it was less than the contract-required quantitation limit but greater than the instrument detection limit.
a = Calculated using one-half the detection limit for non-detected values.
b = If the 95% UCL is greater than the maximum detected concentration, the maximum concentration is shown.

TABLE B-2
SUMMARY OF MINNOW TISSUE DATA
NAVAL AIR STATION
KEY WEST, FLORIDA

Parameter	Frequency of Detection	Minimum Concentration	Maximum Concentration	Range of Nondetects	Mean Concentration[a]	Average of Positive Hits	Median[a]	Geometric Mean[a]	Standard Deviation[a]	95% UCL[ab]
Pesticides and PCBs (ug/kg)										
4,4'-DDD	54/90	0.25J	100	1 - 17	5.73	8.36	1.5	2.14	13.0	7.94
4,4'-DDE	86/87	1.8	106	3.3	25.4	25.7	18.3	17.8	22.6	29.4
4,4'-DDT	6/90	0.63J	2.8	1 - 17	1.69	1.86	0.85	1.09	2.21	2.08
ALDRIN	5/90	0.28J	2J	1 - 17	1.45	1.22	0.85	0.89	2.23	1.82
ALPHA-BHC	1/90	2.3J	2.3J	1 - 17	1.44	2.30	0.85	0.89	2.23	1.82
AROCLOR-1248 (all minnows)	17/58	25J	630	20 - 33	74.1	224	12	25.4	125	102
AROCLOR-1248 (BG 7 data only)	17/24	25J	630	33	164.0	224	160	87.6	156	215
AROCLOR-1248 (excluding BG 7)	0/34			20/33	10.72					
AROCLOR-1260	38/58	16J	200	20 - 33	47.5	66.4	43	32.6	41.3	56.3
BETA-BHC	5/90	1.3J	6	1 - 17	1.61	3.98	0.85	0.97	2.33	2.01
CHLOROBENZILATE	3/74	73J	190	17 - 4200	386	113	165	100	534	190
DELTA-BHC	13/90	0.08J	1J	1 - 17	1.37	0.45	0.85	0.78	2.25	1.00
DIELDRIN	14/90	0.34J	4.9	1 - 17	1.72	1.77	0.85	1.09	2.24	2.10
ENDOSULFAN I	6/90	0.66J	2.6	1 - 17	1.47	1.45	0.85	0.91	2.23	1.85
ENDOSULFAN II	1/90	1.9	1.9	1 - 17	1.65	1.90	0.85	1.07	2.20	1.90
ENDOSULFAN SULFATE	3/90	1.6	9.8J	1 - 17	1.83	7.07	0.85	1.11	2.51	2.29
ENDRIN	6/87	0.52J	5.4J	1 - 17	1.76	2.54	0.85	1.10	2.29	2.16
ENDRIN ALDEHYDE	3/90	3.4J	5.4J	1 - 17	1.74	4.63	0.85	1.09	2.27	2.13
HEPTACHLOR	1/88	0.61J	0.61	1 - 17	1.44	0.61	0.85	0.88	2.26	0.61
HEPTACHLOR EPOXIDE	9/90	1J	10	1 - 17	1.67	3.24	0.85	0.98	2.44	2.09
METHOXYCHLOR	1/90	1.9J	1.9J	1 - 33	4.20	1.90	0.85	1.83	5.10	1.90
Inorganics (mg/kg)										
ALUMINUM	8/56	10.4	62.5	1.9 - 100	9.33	24.1	6.65	5.97	11.0	11.8
ANTIMONY	5/90	0.33	1.2	0.31 - 10	1.28	0.99	0.73	0.85	1.03	1.20
ARSENIC (all minnows)	32/90	0.56	8.3J	0.18 - 10	1.73	3.51	0.93	0.81	2.08	2.10
ARSENIC (killifish only)	19/26	1.7J	8.3J	3.1-5.1	4.28	5.18	4.05	3.71	2.16	4.97
ARSENIC (excluding killifish)	13/64	0.56	1.5	0.18-10	0.695	1.08	0.65	0.44	0.70	0.84
BARIUM	57/90	0.67	9.9	0.36 - 1.7	2.26	3.30	1.6	1.38	2.11	2.62
CALCIUM	56/56	3280	40600	---	14088	14088	13100	13151	5549	15338
CHROMIUM	26/90	0.28	3.1	0.16 - 1	0.411	0.610	0.4	0.33	0.42	0.48
COBALT	1/90	0.39	0.39	0.08 - 2.5	0.255	0.39	0.17	0.16	0.22	0.29
COPPER	82/90	0.7	35.3	0.47 - 2.1	4.75	5.15	3.55	3.23	4.89	5.57
IRON (all minnows)	23/56	15.6	65.6	4.7 - 157	20.9	35.9	12.48	14.7	17.5	24.6
IRON (sheepshead only)	12/14	30.9	65.6	20.1-157	43.7	43.6	42.15	40.2	16.3	51.4
IRON (excluding sheepshead)	11/42	15.6	35.6	4.7-32.2	13.3	27.5	9.93	10.5	9.5	16.7
LEAD (all minnows)	58/90	0.14	21.9	0.13 - 5	2.69	4.00	0.40	0.62	5.42	3.61
LEAD (sheepshead only)	19/20	0.33	21.9	5	10.50	11.00	10.05	7.270	7.26	13.30
LEAD (excluding sheepshead)	39/70	0.14	5.3	0.13-0.92	0.45	0.61	0.33	0.31	0.645	0.58
MAGNESIUM	56/56	298	1210	---	513	513	477.5	499	139	543
MANGANESE	22/56	3.5	16.2	0.61 - 10.4	2.89	5.91	0.975	1.68	3.04	3.56
MERCURY	38/89	0.01	0.06	0.01 - 0.04	0.0196	0.03	0.02	0.02	0.01	0.02
NICKEL	9/90	0.2	12.4	0.19 - 5	0.561	1.64	0.355	0.330	1.31	0.794
POTASSIUM	56/56	2260	10300	---	2927	2927	2785	2845	1041	3151
SELENIUM	47/90	0.24	1.1	0.25 - 10	0.561	0.50	0.5	0.48	0.51	0.65
SILVER	1/90	0.2	0.2	0.11 - 1.5	0.158	0.20	0.13	0.13	0.10	0.18
SODIUM	56/56	1090	4940	---	1804	1804	1895	1713	640	1942
VANADIUM	8/90	0.17	0.41	0.08 - 5	0.381	0.27	0.42	0.31	0.27	0.41
ZINC	90/90	13.6	134	---	39.7	39.7	37.5	36.9	17.3	42.7

Notes:

A "J" flag after the reported concentration indicates that the analyte was positively identified but its concentration could not be precisely quantified since it was less than the contract-required quantitation limit but greater than the instrument detection limit.

a = Calculated using one-half the detection limit for non-detected values.

b = If the 95% UCL is greater than the maximum detected concentration, the maximum concentration is shown.

TABLE B-3
SUMMARY OF TURTLEGRASS DATA
NAVAL AIR STATION
KEY WEST, FLORIDA

Parameter	Frequency of Detection	Minimum Concentration	Maximum Concentration	Range of Nondetects	Mean Concentration[a]	Average of Positive Hits	Median[a]	Geometric Mean[a]	Standard Deviation[a]	95% UCL[ab]
Pesticides PCBs (ug/kg)										
4,4'-DDD	2/11	0.21 J	0.79 J	1.7 - 3.3	1.30	0.50	1.65	1.13	0.52	0.79
4,4'-DDE	2/11	0.52 J	0.7 J	1.7 - 3.3	1.32	0.61	1.65	1.22	0.47	0.70
ALDRIN	1/11	0.48 J	0.48 J	1.7	0.816	0.48	0.85	0.81	0.11	0.48
ALPHA-BHC	2/11	0.5 J	0.55 J	1.7	0.791	0.53	0.85	0.78	0.13	0.55
AROCLOR-1260	1/11	35 J	35 J	33 - 67	19.7	35.00	16.50	18.84	7.19	22.87
BETA-BHC	2/11	0.55 J	1.1 J	1.7	0.845	0.83	0.85	0.84	0.12	0.90
DELTA-BHC	1/11	0.68 J	0.68 J	1.7	0.835	0.68	0.85	0.83	0.05	0.68
DIELDRIN	1/11	0.25 J	0.25 J	1.7 - 3.3	1.38	0.25	1.65	1.23	0.49	0.25
ENDOSULFAN I	1/11	0.2 J	0.2 J	1.7	0.791	0.20	0.85	0.75	0.20	0.20
ENDOSULFAN II	1/11	0.5 J	0.5 J	1.7 - 3.3	1.40	0.50	1.65	1.31	0.44	0.50
ENDRIN	1/11	0.1 J	0.1 J	1.7 - 3.3	1.36	0.10	1.65	1.13	0.53	0.10
ENDRIN ALDEHYDE	5/11	3.3 J	18	1.7 - 3.3	5.29	9.98	1.65	3.08	5.86	12.96
GAMMA-BHC (LINDANE)	7/11	0.13 J	0.64 J	1.7	0.532	0.35	0.51	0.44	0.29	0.64
Inorganics (mg/kg)										
ALUMINUM	10/11	12.2	36.5	10.2	19.1	20.5	17.8	17.0	9.07	24.1
ARSENIC	5/11	0.51	1.6	0.94 - 1.9	0.867	1.15	0.75	0.79	0.41	1.19
BARIUM	2/11	1.1	1.6	0.41 - 1	0.541	1.35	0.46	0.44	0.43	0.86
CADMIUM	3/11	0.11	18.4	0.08 - 0.53	1.79	6.21	0.11	0.15	5.51	4.27
CALCIUM	11/11	5030	30500	---	17366	17366	16500	15368	8118	21802
CHROMIUM	1/11	0.27	0.27	0.16 - 0.82	0.193	0.27	0.09	0.15	0.15	0.26
COBALT	1/11	0.28	0.28	0.11 - 0.37	0.117	0.28	0.06	0.10	0.08	0.16
COPPER	3/11	1.4	2.4	0.34 - 2.2	0.83	1.80	0.55	0.58	0.71	1.96
IRON	8/11	26.9	90.2	18.9 - 22	39.8	50.8	42.6	31.4	25.3	53.6
LEAD	4/11	0.43	0.93	0.32 - 0.61	0.415	0.755	0.28	0.33	0.30	0.70
MAGNESIUM	11/11	2100	5520	---	3202	3202	2890	3049	1129	3909
MANGANESE	11/11	3.2	18.2	---	9.80	9.80	7.4	8.69	4.92	14.4
MERCURY	2/11	0.01	0.02	0.01 - 0.02	0.009	0.015	0.01	0.008	0.005	0.01
NICKEL	3/11	0.92	26.1	0.29 - 0.93	2.77	9.41	0.425	0.49	7.75	6.27
POTASSIUM	11/11	2650	7880	---	3772	3772	3500	3603	1430	4415
SILVER	1/11	0.29	0.29	0.15 - 0.23	0.105	0.290	0.08	0.10	0.06	0.13
SODIUM	11/11	8760	30500	---	13198	13198	11700	12430	5943	16024
VANADIUM	2/11	1.5	2.5	0.46 - 1.5	0.762	2.00	0.6	0.59	0.67	1.30
ZINC	11/11	1.1	27.5	---	9.50	9.50	7.9	7.35	7.00	20.8

Notes:
A "J" flag after the reported concentration indicates that the analyte was positively identified but its concentration could not be precisely quantified since it was less than the contract-required quantitation limit but greater than the instrument detection limit.
a = Calculated using one-half the detection limit for non-detected values.
b = If the 95% UCL is greater than the maximum detected concentration, the maximum concentration is shown.

TABLE B-3
SUMMARY OF TURTLEGRASS DATA
NAVAL AIR STATION
KEY WEST, FLORIDA

Parameter	Frequency of Detection	Minimum Concentration	Maximum Concentration	Range of Nondetects	Mean Concentration[a]	Average of Positive Hits	Median[a]	Geometric Mean[a]	Standard Deviation[a]	95% UCL[ab]
Pesticides PCBs (ug/kg)										
4,4'-DDD	2/11	0.21 J	0.79 J	1.7 - 3.3	1.30	0.50	1.65	1.13	0.52	0.79
4,4'-DDE	2/11	0.52 J	0.7 J	1.7 - 3.3	1.32	0.61	1.65	1.22	0.47	0.70
ALDRIN	1/11	0.48 J	0.48 J	1.7	0.816	0.48	0.85	0.81	0.11	0.48
ALPHA-BHC	2/11	0.5 J	0.55 J	1.7	0.791	0.53	0.85	0.78	0.13	0.55
AROCLOR-1260	1/11	35 J	35 J	33 - 67	19.7	35.00	16.50	18.84	7.19	22.87
BETA-BHC	2/11	0.55 J	1.1 J	1.7	0.845	0.83	0.85	0.84	0.12	0.90
DELTA-BHC	1/11	0.68 J	0.68 J	1.7	0.835	0.68	0.85	0.83	0.05	0.68
DIELDRIN	1/11	0.25 J	0.25 J	1.7 - 3.3	1.38	0.25	1.65	1.23	0.49	0.25
ENDOSULFAN I	1/11	0.2 J	0.2 J	1.7	0.791	0.20	0.85	0.75	0.20	0.20
ENDOSULFAN II	1/11	0.5 J	0.5 J	1.7 - 3.3	1.40	0.50	1.65	1.31	0.44	0.50
ENDRIN	1/11	0.1 J	0.1 J	1.7 - 3.3	1.36	0.10	1.65	1.13	0.53	0.10
ENDRIN ALDEHYDE	5/11	3.3 J	18	1.7 - 3.3	5.29	9.98	1.65	3.08	5.86	12.96
GAMMA-BHC (LINDANE)	7/11	0.13 J	0.64 J	1.7	0.532	0.35	0.51	0.44	0.29	0.64
Inorganics (mg/kg)										
ALUMINUM	10/11	12.2	36.5	10.2	19.1	20.5	17.8	17.0	9.07	24.1
ARSENIC	5/11	0.51	1.6	0.94 - 1.9	0.867	1.15	0.75	0.79	0.41	1.19
BARIUM	2/11	1.1	1.6	0.41 - 1	0.541	1.35	0.46	0.44	0.43	0.86
CADMIUM	3/11	0.11	18.4	0.08 - 0.53	1.79	6.21	0.11	0.15	5.51	4.27
CALCIUM	11/11	5030	30500	---	17366	17366	16500	15368	8118	21802
CHROMIUM	1/11	0.27	0.27	0.16 - 0.82	0.193	0.27	0.09	0.15	0.15	0.26
COBALT	1/11	0.28	0.28	0.11 - 0.37	0.117	0.28	0.06	0.10	0.08	0.16
COPPER	3/11	1.4	2.4	0.34 - 2.2	0.83	1.80	0.55	0.58	0.71	1.96
IRON	8/11	26.9	90.2	18.9 - 22	39.8	50.8	42.6	31.4	25.3	53.6
LEAD	4/11	0.43	0.93	0.32 - 0.61	0.415	0.755	0.28	0.33	0.30	0.70
MAGNESIUM	11/11	2100	5520	---	3202	3202	2890	3049	1129	3909
MANGANESE	11/11	3.2	18.2	---	9.80	9.80	7.4	8.69	4.92	14.4
MERCURY	2/11	0.01	0.02	0.01 - 0.02	0.009	0.015	0.01	0.008	0.005	0.01
NICKEL	3/11	0.92	26.1	0.29 - 0.93	2.77	9.41	0.425	0.49	7.75	6.27
POTASSIUM	11/11	2650	7880	---	3772	3772	3500	3603	1430	4415
SILVER	1/11	0.29	0.29	0.15 - 0.23	0.105	0.290	0.08	0.10	0.06	0.13
SODIUM	11/11	8760	30500	---	13198	13198	11700	12430	5943	16024
VANADIUM	2/11	1.5	2.5	0.46 - 1.5	0.762	2.00	0.6	0.59	0.67	1.30
ZINC	11/11	1.1	27.5	---	9.50	9.50	7.9	7.35	7.00	20.8

Notes:

A "J" flag after the reported concentration indicates that the analyte was positively identified but its concentration could not be precisely quantified since it was less than the contract-required quantitation limit but greater than the instrument detection limit.

a = Calculated using one-half the detection limit for non-detected values.

b = If the 95% UCL is greater than the maximum detected concentration, the maximum concentration is shown.

TABLE B-4
SUMMARY OF SEA OXEYE DAISY DATA
NAVAL AIR STATION
KEY WEST, FLORIDA

Parameter	Frequency of Detection	Minimum Concentration	Maximum Concentration	Range of Nondetects	Mean Concentration[a]	Average of Positive Hits	Median[a]	Geometric Mean[a]	Standard Deviation[a]	95% UCL[ab]
Pesticides PCBs (ug/kg)										
4,4'-DDD	2/14	1 J	1.6	1.7 - 17	4.30	1.30	1.63	2.65	3.78	1.60
4,4'-DDT	1/14	1.3 J	1.3 J	1.3 - 17	4.26	1.30	1.63	2.53	3.82	1.30
ALPHA-BHC	1/14	0.58 J	0.58 J	1.7 - 17	4.11	0.58	0.85	2.22	3.95	0.58
DELTA-BHC	1/14	0.21 J	0.21 J	1.7 - 17	4.08	0.21	0.85	2.06	3.97	0.21
ENDRIN	2/14	0.23 J	0.38 J	1.7 - 17	4.05	0.31	0.85	1.96	4.00	0.38
ENDRIN ALDEHYDE	2/14	0.74 J	1.2 J	1.7 - 17	4.15	0.97	1.03	2.31	3.91	1.20
HEPTACHLOR	1/14	0.29 J	0.29 J	1.7 - 17	4.09	0.29	0.85	2.11	3.97	0.290
Inorganics (mg/kg)										
BARIUM	1/14	0.46	0.46	0.04 - 0.41	0.16	0.46	0.15	0.13	0.10	0.20
CALCIUM	14/14	761	3180	---	1702	1702	1575	1578	685	2144
CHROMIUM	3/14	0.23	0.25	0.2 - 0.72	0.21	0.24	0.2	0.19	0.08	0.25
COPPER	6/14	1.7	2.5	1 - 1.9	1.26	2.02	0.875	1.07	0.722	1.83
MAGNESIUM	14/14	677	1550	---	1062	1062	1080	1039	229	1190
MANGANESE	11/14	0.66	6.1	0.41 - 1.6	1.94	2.32	1.4	1.41	1.59	3.95
MERCURY	4/14	0.01	0.02	0.017 - 0.024	0.01	0.015	0.010	0.012	0.004	0.013
POTASSIUM	14/14	1690	3780	---	2550	2550	2420	2470	677	2926
SELENIUM	2/14	0.47	0.49	0.43 - 1.6	0.526	0.480	0.5	0.466	0.238	0.490
SODIUM	14/14	6730	13200	---	10276	10276	10150	10133	1694	11078
ZINC	8/14	1.6	6.9	1.6 - 4.9	3.53	4.78	2.325	2.93	2.11	5.51

Notes:
A "J" flag after the reported concentration indicates that the analyte was positively identified but its concentration could not be precisely quantified since it was less than the contract-required quantitation limit but greater than the instrument detection limit.
a = Calculated using one-half the detection limit for non-detected values.
b = If the 95% UCL is greater than the maximum detected concentration, the maximum concentration is shown.

TABLE B-4
SUMMARY OF SEA OXEYE DAISY DATA
NAVAL AIR STATION
KEY WEST, FLORIDA

Parameter	Frequency of Detection	Minimum Concentration	Maximum Concentration	Range of Nondetects	Mean Concentration[a]	Average of Positive Hits	Median[a]	Geometric Mean[a]	Standard Deviation[a]	95% UCL[ab]
Pesticides PCBs (ug/kg)										
4,4'-DDD	2/14	1 J	1.6	1.7 - 17	4.30	1.30	1.63	2.65	3.78	1.60
4,4'-DDT	1/14	1.3 J	1.3 J	1.3 - 17	4.26	1.30	1.63	2.53	3.82	1.30
ALPHA-BHC	1/14	0.58 J	0.58 J	1.7 - 17	4.11	0.58	0.85	2.22	3.95	0.58
DELTA-BHC	1/14	0.21 J	0.21 J	1.7 - 17	4.08	0.21	0.85	2.06	3.97	0.21
ENDRIN	2/14	0.23 J	0.38 J	1.7 - 17	4.05	0.31	0.85	1.96	4.00	0.38
ENDRIN ALDEHYDE	2/14	0.74 J	1.2 J	1.7 - 17	4.15	0.97	1.03	2.31	3.91	1.20
HEPTACHLOR	1/14	0.29 J	0.29 J	1.7 - 17	4.09	0.29	0.85	2.11	3.97	0.290
Inorganics (mg/kg)										
BARIUM	1/14	0.46	0.46	0.04 - 0.41	0.16	0.46	0.15	0.13	0.10	0.20
CALCIUM	14/14	761	3180	---	1702	1702	1575	1578	685	2144
CHROMIUM	3/14	0.23	0.25	0.2 - 0.72	0.21	0.24	0.2	0.19	0.08	0.25
COPPER	6/14	1.7	2.5	1 - 1.9	1.26	2.02	0.875	1.07	0.722	1.83
MAGNESIUM	14/14	677	1550	---	1062	1062	1080	1039	229	1190
MANGANESE	11/14	0.66	6.1	0.41 - 1.6	1.94	2.32	1.4	1.41	1.59	3.95
MERCURY	4/14	0.01	0.02	0.017 - 0.024	0.01	0.015	0.010	0.012	0.004	0.013
POTASSIUM	14/14	1690	3780	---	2550	2550	2420	2470	677	2926
SELENIUM	2/14	0.47	0.49	0.43 - 1.6	0.526	0.480	0.5	0.466	0.238	0.490
SODIUM	14/14	6730	13200	---	10276	10276	10150	10133	1694	11078
ZINC	8/14	1.6	6.9	1.6 - 4.9	3.53	4.78	2.325	2.93	2.11	5.51

Notes:
A "J" flag after the reported concentration indicates that the analyte was positively identified but its concentration could not be precisely quantified since it was less than the contract-required quantitation limit but greater than the instrument detection limit.
a = Calculated using one-half the detection limit for non-detected values.
b = If the 95% UCL is greater than the maximum detected concentration, the maximum concentration is shown.

4.0 SUMMARY AND CONCLUSIONS

Biological samples have been collected to characterize background conditions in selected flora and fauna at NAS Key West. This characterization is necessary to support long-term monitoring being conducted at SWMU 1, SWMU 2, and IR 1. The background tissue data set can also be used to evaluate the nature and extent of contamination in possible future investigations at NAS Key West.

Biological samples have been collected from eight locations during five field efforts from 1996 to 2003. Fish, mollusks, crustaceans, and vegetation from background locations and tissue samples have been analyzed for a variety of chemicals. This report focuses on the analytical results for pesticides, PCBs, and metals in minnows, turtle grass (a submerged marine herb), and sea oxeye daisy (a shrubby terrestrial plant).

4.1 MINNOWS

Sixteen metals, 17 pesticides, and two PCBs were detected in minnow samples. The evaluation of the minnow tissue data indicates that tissue data for 29 of 35 detected minnow analytes can be combined across species, locations, and sampling rounds to form a single background data set for each analyte. The six exceptions are arsenic, iron, lead, Aroclor-1248, aluminum, and chlorobenzilate.

Arsenic concentrations tended to be greater in killifish than in other minnow species. For investigations of sites where arsenic is a chemical of concern in minnow tissues, the background minnow data should be separated into two data sets; one data set for killifish and one for other minnows. Iron and lead concentrations tended to be greater in sheepshead minnows than in other minnow species. For investigations of sites where iron or lead is a chemical of concern in minnow tissues, the background minnow data should be separated into two data sets; one data set for sheepshead minnows and one for other minnows.

The tissue data suggest that Aroclor-1248 concentrations are elevated at BG 7 due to a local contaminant source, and Aroclor-1248 concentrations at BG 7 are not representative of background locations at Key West. Therefore, the Aroclor-1248 data should not be combined to form one overall background data set. For investigations of sites where Aroclor-1248 is a chemical of concern in minnow tissues, the BG 7 minnow data should be deleted from the data set.

Conclusions regarding chlorobenzilate and aluminum are hindered by variable detection limits. Additional sampling would be required to establish background conditions for these two analytes.

4.2 TURTLE GRASS

Fifteen metals, 12 pesticides, and one PCB compound (Aroclor-1260) were detected in turtle grass samples. The relatively low detected concentrations and small variation in detected concentrations and detection limits among sampling events indicate that the analytical data for pesticides, most metals, and Aroclor-1260 can be combined to form a single background data set for each of these analytes, and no further sampling is necessary to establish background turtle grass concentrations.

Concentrations of six metals (aluminum, cadmium, iron, nickel, manganese, and zinc) were inconsistent between sampling events, producing uncertainty with regard to combining data for all sampling rounds and locations to yield a composite background data set.

4.3 SEA OXEYE DAISY

Seven pesticides and seven metals have been detected in background sea oxeye daisy samples. The relatively low detected concentrations and small variation between detected concentrations and detection limits among sampling events indicates that the sea oxeye daisy tissue data can be combined to form a single background data set for each detected analyte, and no further sampling is necessary to establish background tissue concentrations of sea oxeye daisy.

4.4 RECOMMENDATIONS FOR USE OF BACKGROUND TISSUE DATA

Graphical representation of the data (i.e., box and whisker plots) should be used to compare site and background data. All comparisons should be on an analyte to analyte basis. Visual comparisons should allow an initial understanding as to whether or not the site concentrations are elevated relative to the background concentrations. If chemical concentrations at a site being investigated are less than background concentrations, then no further analysis should be warranted and it should be concluded that site data are within background levels. If the site concentrations are greater than background concentrations, then no further analysis is warranted and it should be concluded that site concentrations are greater than background values. When no clear difference is apparent between the site and background data sets on the respective plots, analysis of variance (ANOVA) methods should be used to further investigate the site data.

The determination of specific statistical analyses should be made on a case by case basis. Retrospective power can be estimated to determine if sufficient power exists for valid comparisons.

5.0 REFERENCES

B&RE (Brown & Root Environmental), 1997. Supplemental RCRA Facility Investigation and Remedial Investigation Report for Naval Air Station Key West High Priority Sites, Boca Chica Key, Florida. Prepared for Department of the Navy, Southern Division, Naval Facilities Engineering Command. Aiken, South Carolina, July.

B&RE, 1998. Supplemental RCRA Facility Investigation and Remedial Investigation Report for Eight Sites, Naval Air Station Key West, Florida, Revision 2. Prepared for Department of the Navy, Southern Division, Naval Facilities Engineering Command. Aiken, South Carolina, January.

Eisler, R. 2000. Handbook of Chemical Risk Assessment: Health Hazards to Humans, Plants, and Animals; Volume 2, Organics. Lewis Publishers, Boca Raton, FL.

FDA (U.S. Food and Drug Administration), 2001. *FDA and EPA Safety Levels in Regulations and Guidance*. Center for Food Safety and Applied Nutrition, Fish and Fisheries Products Hazards and Controls Guidance, Appendix 5. Third Edition, June. http://www.cfsan.fda.gov/~comm/haccp4.html

Goyer, R. A., 1986. “Toxic Effects of Metals.” In Klaasen, C.D., M. O. Amdur and J. Doull, 1986. *Toxicology- The Basic Science of Poisons*. Macmillan Publishing Company, New York, New York. 974 pp.

IJCUSC (International Joint Commission United States and Canada), 1988. *Great Lakes Water Quality Agreement*, amended by protocol signed November 18, 1987, Ottawa, Canada, cited in Irwin, R. J., 1988, *Impacts of Toxic Chemicals on Trinity River Fish and Wildlife*, U.S. Fish and Wildlife Service Contaminants Report, Fort Worth Field Office, November 1988.

Jarvinen, A.W. and G.T. Ankley, 1999. Linkage of effects to tissue residues: development of a comprehensive database for aquatic organisms exposed to inorganic and organic chemicals. SETAC Press, Pensacola, Florida.

Kaplan, E. H., 1988. *Southeastern and Caribbean Seashores*, Houghton Mifflin Company, New York, New York.

Lee, D.S., C.R. Gilbert, C.H. Hocutt, R.E. Jenkins, D.E. McAllister, and J.R. Stauffer, Jr., 1980. *Atlas of North American Freshwater Fishes.* North Carolina State Museum of Natural History, North Carolina Biological Survey Publication #1980-12.

Marx, J. M. and W.F. Herrnkind, 1986. *Spiny Lobster*, U.S. Fish and Wildlife Service Biological Report 82(11.61), U.S. Army Corps of Engineers, TR EL-82-4.

Newell, A. J., D. W. Johnson, and L. K. Allen, 1987. *Niagara River Biota Contamination Project: Fish Flesh Criteria for Piscivorous Wildlife*, New York State Department of Environmental Conservation, Technical Report 87-3.

Odum, W. E., C. C. McIvor, and T. J. Smith, 1982. *The Ecology of the Mangroves of South Florida: a Community Profile*, FWS/OBS-81/24, U.S. Fish and Wildlife Service, Office of Biological Services, Washington, D.C.

Pattillo, M.E., T.E. Czapla, D.M. Nelson, and M.E Monaco, 1997. Distribution and abundance of fishes and invertebrates in Gulf of Mexico estuaries, Volume II: Species life history summaries. ELMR Rep No. 11. NOAA/NOS Strategic Environmental Assessments Division, Silver Spring, MD.

Press, F. and R. Siever. 1974. *Earth*. W.H. Freeman and Co., San Francisco, California, in U.S. Environmental Protection Agency. 2003. Guidance for Developing Ecological Soil Screening Levels. OSWER Directive 9285.7-55. Office of Solid Waste and Emergency Response, Washington, D.C. November.

TtNUS (Tetra Tech NUS), 2000. Performance Monitoring Plan; Naval Air Facility Key West, Florida, Revision 2. Prepared for the Department of the Navy, Southern Division, Naval Facilities Engineering Command. Aiken, South Carolina. September.

TtNUS, 2001. Performance Monitoring Quarterly Report, Fall 2000, Naval Air Station Key West, Florida. Prepared for the Department of the Navy, Southern Division, Naval Facilities Engineering Command. Aiken, South Carolina, January.

TtNUS, 2002. IR 1 and IR 8 Third Quarter Performance Monitoring Report, Naval Air Facility, Key West, Florida. Prepared for the Department of the Navy, Southern Division, Naval Facilities Engineering Command. Aiken, South Carolina, April.

TtNUS, 2003. Annual Performance Monitoring Report. Naval Air Station Key West, Florida. Prepared for the Department of the Navy, Southern Division, Naval Facilities Engineering Command. Aiken, South Carolina, April.

USFWS (U.S. Fish and Wildlife Service), 1994. Recovery Plan for the Lower Keys Marsh Rabbit (*Sylvilagus palustris herneri*), U.S. Department of the Interior, Atlanta, Georgia.

APPENDIX B.A-1

STATISTICAL BOX AND WHISKER PLOTS
MINNOW DATA SET

STATISTICAL BOX AND WHISKER PLOTS – MINNOW DATA SET

The minnow data set represents four minnow species (crested goby, killifish, sailfin molly, and sheepshead minnow) collected at four locations (BG 1, BG 2, BG 3, and BG 7) in four sampling rounds (rounds 1, 2, 3, and 5). The different combinations of species, location and round resulted in 16 distinct "sampling events" for minnow data (Table A-1). Box and whisker plots were utilized to provide a graphical representation of concentrations of analytes detected in each sampling event

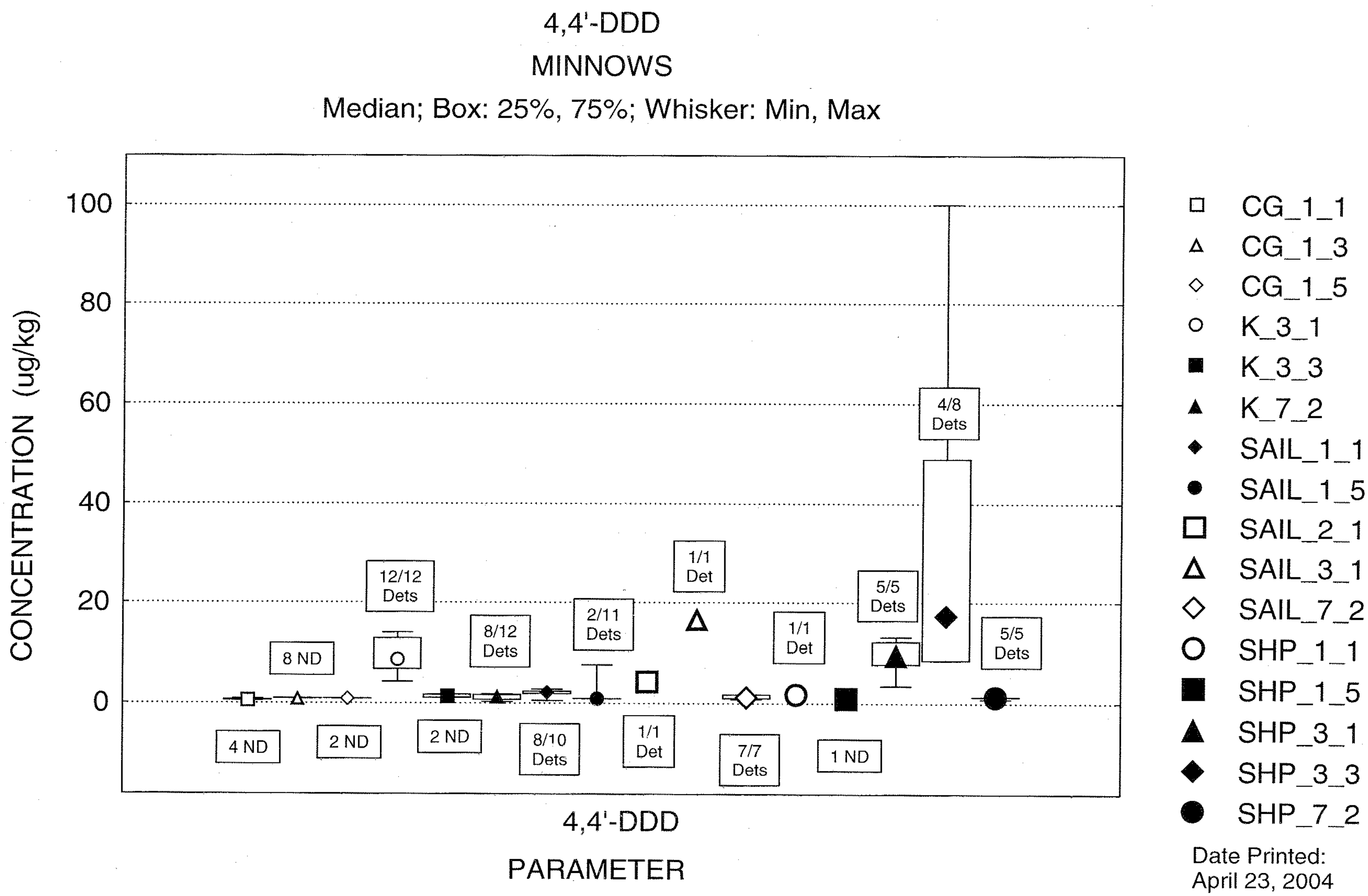
Each page of box and whisker plots depicts tissue data for a single analyte. The plots are sorted by group with pesticides presented first, followed by PCBs, then metals. Analytes are sorted alphabetically within each of these groups. There are several boxes on a page, and each box represents a single sampling event (i.e., a different combination of species, background location, and sampling round). Note that the scale of concentrations on the y-axis differs from page to page. In addition, multiple pages, each at a different scale, are presented for some analytes to reveal more detail within certain ranges of concentrations. The legend on each page shows labels such as CG_1_1. The first characters identify the species (CG = crested goby; K = killifish; SAIL = sailfin molly, SHP = sheepshead minnow [see Table A-1]). The next two characters (underscore and single digit) identify the background (BG) location, and the last two characters identify the sampling round (underscore and single digit). The boxes on each page, reading left to right, correspond to the legend labels, reading top to bottom. For example, the first box on the left of the plot for 4,4'-DDD corresponds to crested goby data for BG 1 in sampling round 1 (CG_1_1), and the box farthest to the right corresponds to sheepshead minnow data for BG 7, round 2 (SHP_7_2). Note that not all 16 minnow sampling events are depicted on every page, depending on the availability of data for each analyte (for example, the plots for Aroclor-1248 and Aroclor-1260 show data for only 10 sampling events because minnow tissues were analyzed for PCBs only during rounds 1 and 2.

The median value is near the center of the box and is represented with a triangle, square, diamond, or circle. The top and bottom of a box represent the 75th and 25th percentiles of the data, respectively. The percentile is the proportion of data that fall below that value. The upper and lower whiskers represent the maximum and minimum concentrations, respectively, of the data set. The frequency of detection is shown for each sampling event, with "ND" signifying not detected and "Dets" signifying detected. Using arsenic as an example, the 4th box from the left represents killifish collected from BG 3 during round 1 and is interpreted as follows: arsenic was detected in 12 of 12 samples, with maximum concentration = 8.3 mg/kg, 75th percentile concentration = 6.5 mg/kg, 25th percentile concentration = 3.8 mg/kg, and minimum concentration = 1.7 mg/kg. The first three boxes are quite different from the 4th box because arsenic was not detected in any crested goby samples, and the detection limits for crested goby samples covered a narrow range of concentrations within each event. In such cases, the maximum, minimum, 75th percentile, and 25th percentile concentrations are the same. As discussed in Section 3.0, non-detected samples are represented in the box and whisker plots by a value of one-half the detection limit for the sample.

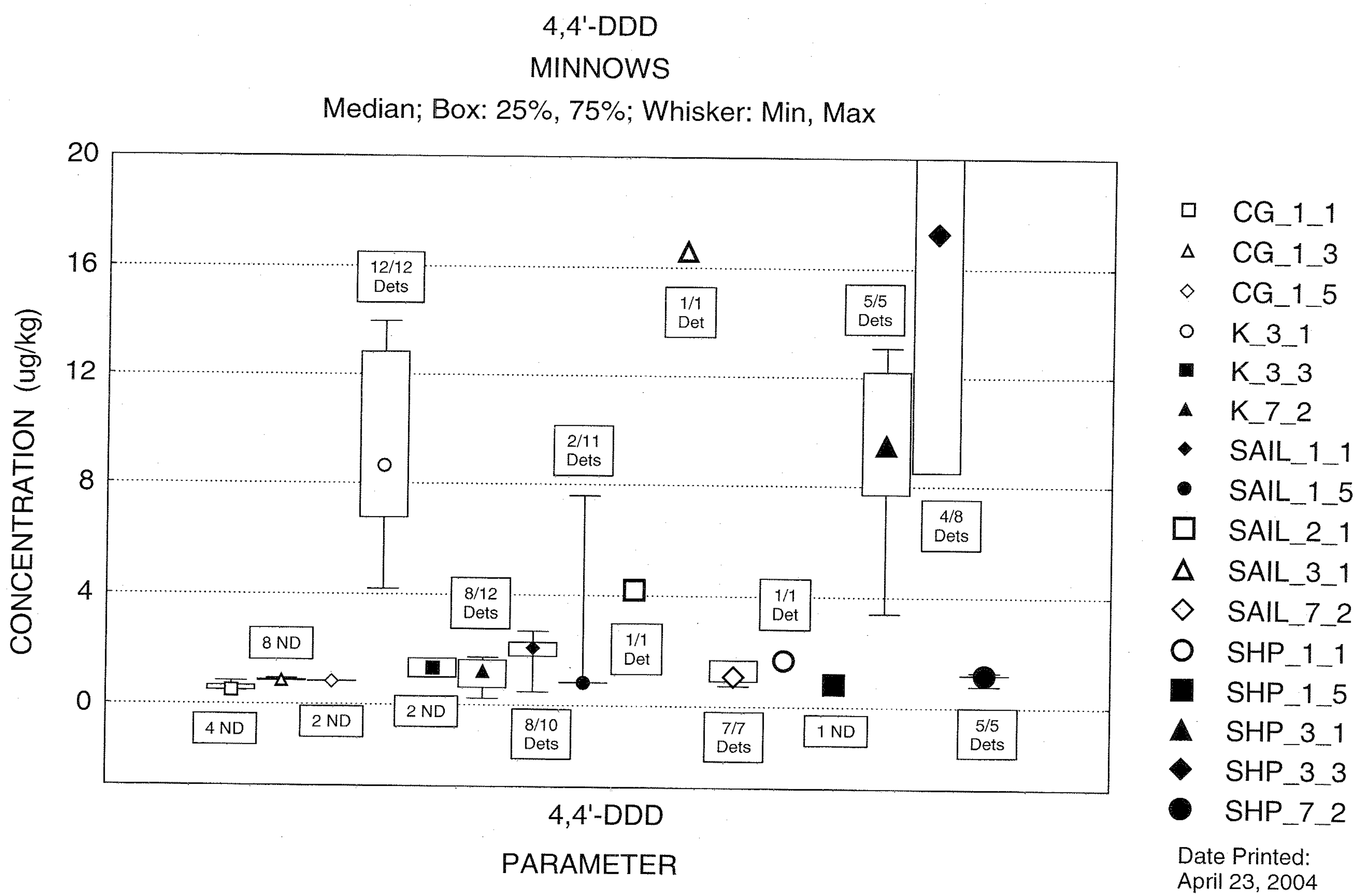
TABLE A-1

BACKGROUND MINNOW SAMPLING EVENTS

Event	Event Description
CG_1_1	Crested Goby, BG 1, Round 1
CG_1_3	Crested Goby, BG 1, Round 3
CG_1_5	Crested Goby, BG 1, Round 5
K_3_1	Killifish, BG 3, Round 1
K_3_3	Killifish, BG 3, Round 3
K_7_2	Killifish, BG 7, Round 2
SAIL_1_1	Sailfin Molly, BG 1, Round 1
SAIL_1_5	Sailfin Molly, BG 1, Round 5
SAIL_2_1	Sailfin Molly, BG 2, Round 1
SAIL_3_1	Sailfin Molly, BG 3, Round 1
SHP_1_1	Sheepshead Minnow, BG 1, Round 1
SAIL_7_2	Sailfin Molly, BG 7, Round 2
SHP_1_5	Sheepshead Minnow, BG 1, Round 5
SHP_3_1	Sheepshead Minnow, BG 3, Round 1
SHP_3_3	Sheepshead Minnow, BG 3, Round 3
SHP_7_2	Sheepshead Minnow, BG 7, Round 2



4,4'-DDD
MINNOWS
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (ug/kg)
100
80
60
40
20
0
12/12 Dets
8 ND
8/12 Dets
2/11 Dets
1/1 Det
1/1 Det
5/5 Dets
4/8 Dets
5/5 Dets
4 ND
2 ND
2 ND
8/10 Dets
1/1 Det
7/7 Dets
1 ND
4,4'-DDD
PARAMETER
CG_1_1
CG_1_3
CG_1_5
K_3_1
K_3_3
K_7_2
SAIL_1_1
SAIL_1_5
SAIL_2_1
SAIL_3_1
SAIL_7_2
SHP_1_1
SHP_1_5
SHP_3_1
SHP_3_3
SHP_7_2
Date Printed:
April 23, 2004

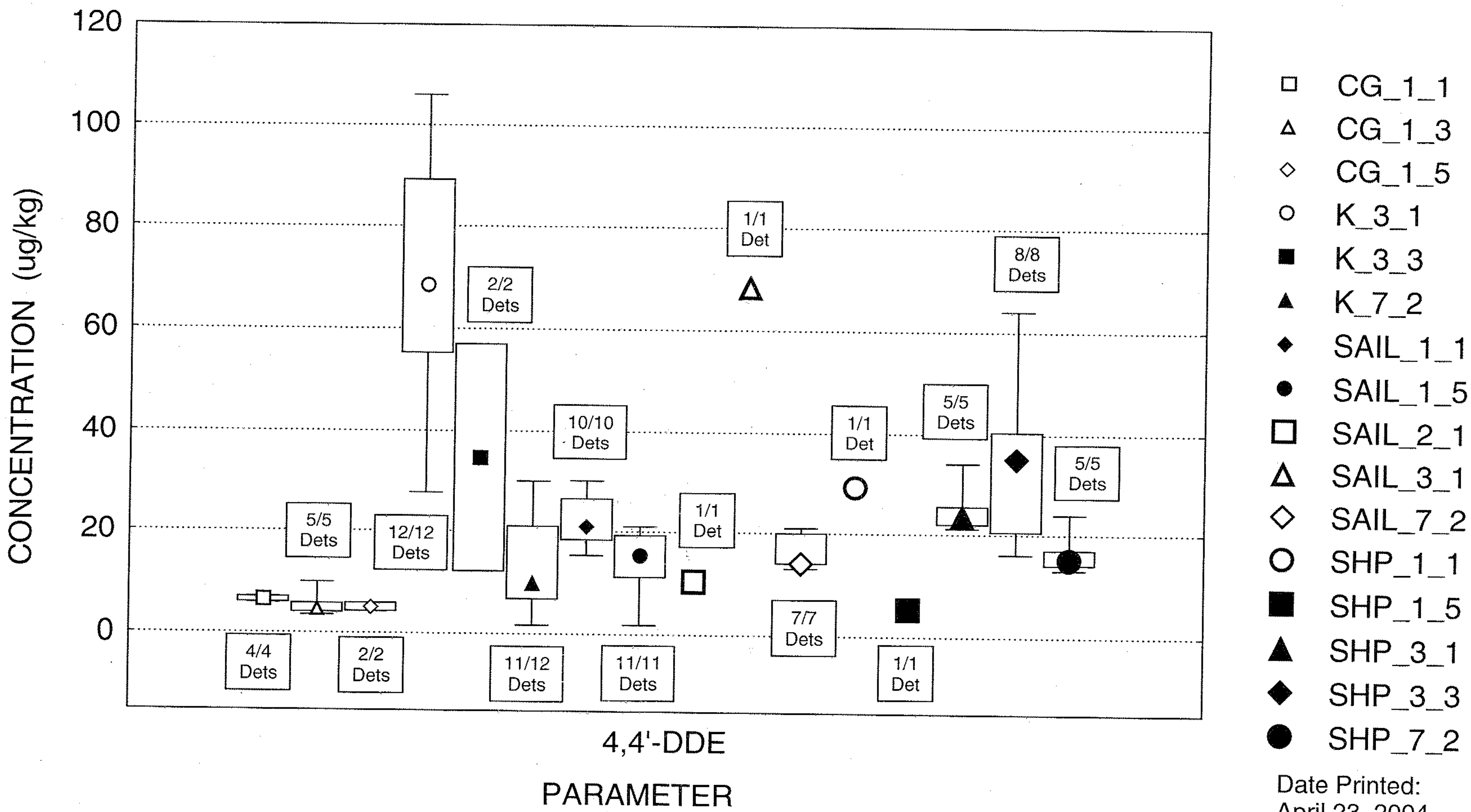


4,4'-DDD
MINNOWS
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (ug/kg)
20
16
12
8
4
0
12/12 Dets
1/1 Det
5/5 Dets
2/11 Dets
4/8 Dets
8/12 Dets
1/1 Det
8 ND
1/1 Det
4 ND
2 ND
2 ND
8/10 Dets
7/7 Dets
1 ND
5/5 Dets
4,4'-DDD
PARAMETER
CG_1_1
CG_1_3
CG_1_5
K_3_1
K_3_3
K_7_2
SAIL_1_1
SAIL_1_5
SAIL_2_1
SAIL_3_1
SAIL_7_2
SHP_1_1
SHP_1_5
SHP_3_1
SHP_3_3
SHP_7_2
Date Printed:
April 23, 2004

4,4'-DDE

MINNOWS

Median; Box: 25%, 75%; Whisker: Min, Max

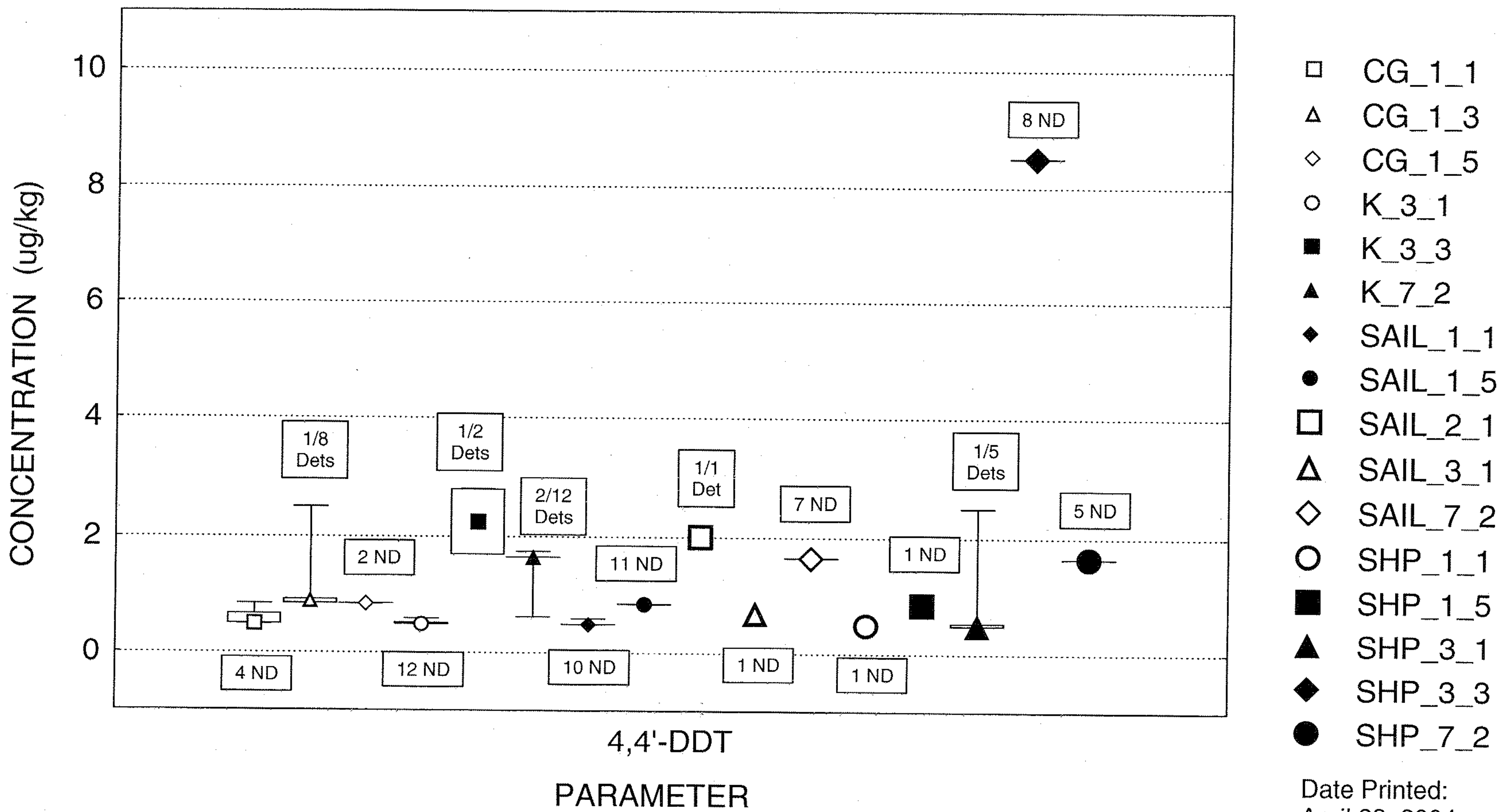


Date Printed:
April 23, 2004

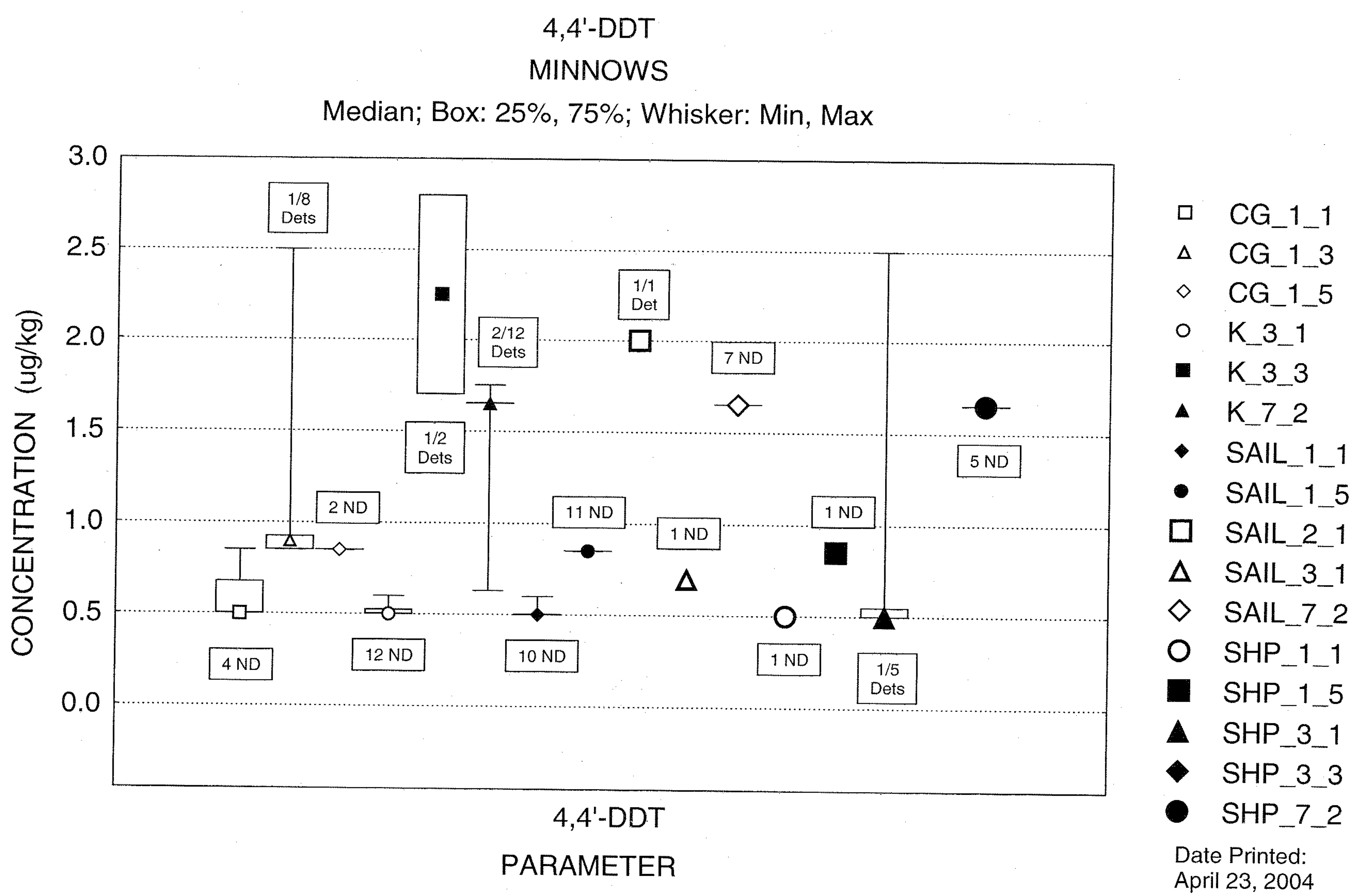
4,4'-DDT

MINNOWS

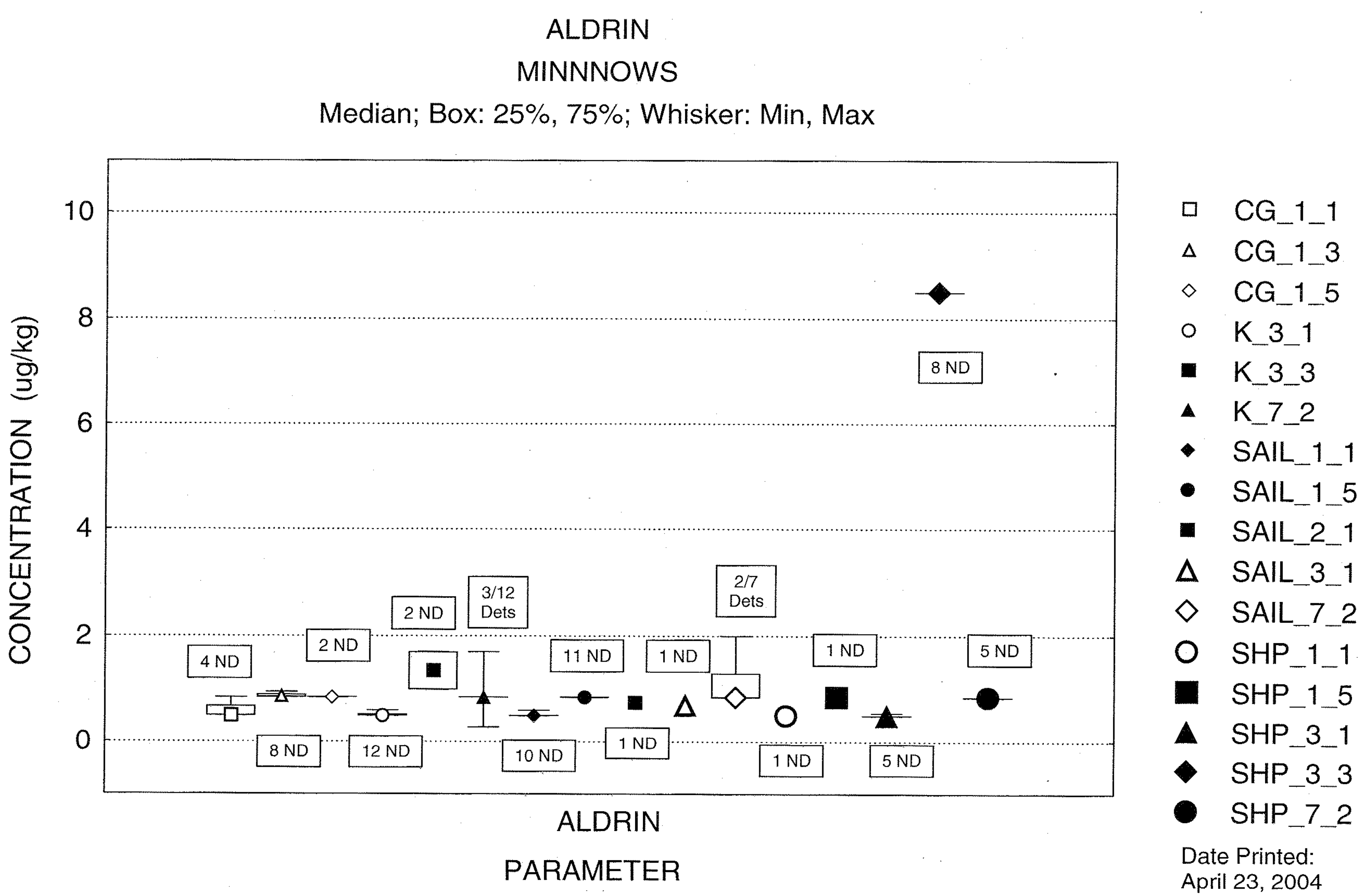
Median; Box: 25%, 75%; Whisker: Min, Max



Date Printed:
April 23, 2004



4,4'-DDT
MINNOWS
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (ug/kg)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/8 Dets
2/12 Dets
1/1 Det
7 ND
1/2 Dets
5 ND
2 ND
11 ND
1 ND
1 ND
4 ND
12 ND
10 ND
1 ND
1/5 Dets
4,4'-DDT
PARAMETER
CG_1_1
CG_1_3
CG_1_5
K_3_1
K_3_3
K_7_2
SAIL_1_1
SAIL_1_5
SAIL_2_1
SAIL_3_1
SAIL_7_2
SHP_1_1
SHP_1_5
SHP_3_1
SHP_3_3
SHP_7_2
Date Printed:
April 23, 2004


ALDRIN
MINNNOWS
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (ug/kg)
10
8
6
4
2
0
4 ND
8 ND
2 ND
12 ND
2 ND
3/12 Dets
10 ND
11 ND
1 ND
1 ND
2/7 Dets
1 ND
1 ND
5 ND
8 ND
5 ND
ALDRIN
PARAMETER
CG_1_1
CG_1_3
CG_1_5
K_3_1
K_3_3
K_7_2
SAIL_1_1
SAIL_1_5
SAIL_2_1
SAIL_3_1
SAIL_7_2
SHP_1_1
SHP_1_5
SHP_3_1
SHP_3_3
SHP_7_2
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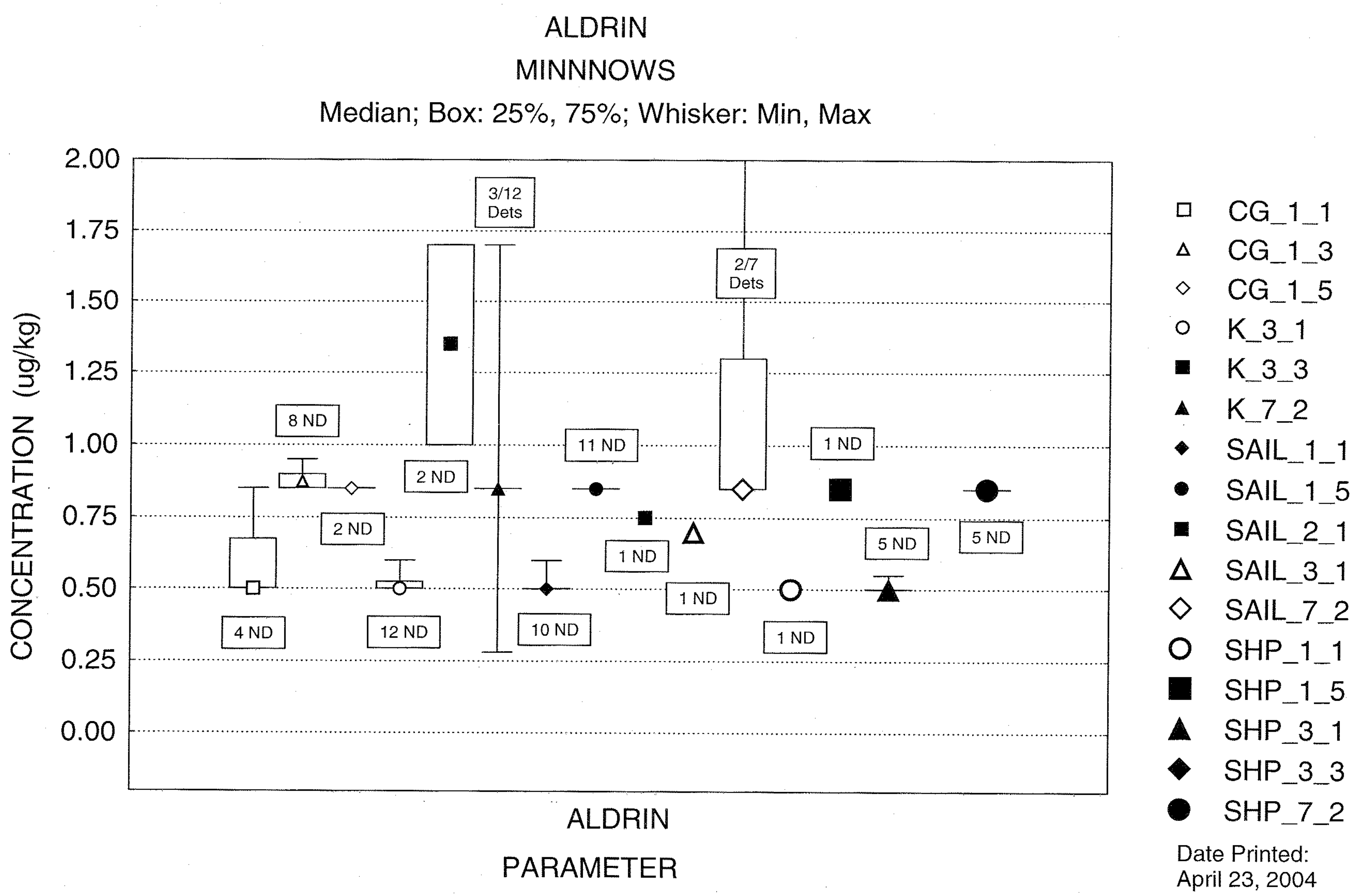
April 23, 2004


ALDRIN
MINNNOWS
Median; Box: 25%, 75%; Whisker: Min, Max
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
CONCENTRATION (ug/kg)
3/12 Dets
2/7 Dets
8 ND
2 ND
11 ND
1 ND
2 ND
1 ND
5 ND
5 ND
1 ND
4 ND
12 ND
10 ND
1 ND
ALDRIN
PARAMETER
CG_1_1
CG_1_3
CG_1_5
K_3_1
K_3_3
K_7_2
SAIL_1_1
SAIL_1_5
SAIL_2_1
SAIL_3_1
SAIL_7_2
SHP_1_1
SHP_1_5
SHP_3_1
SHP_3_3
SHP_7_2
Date Printed:
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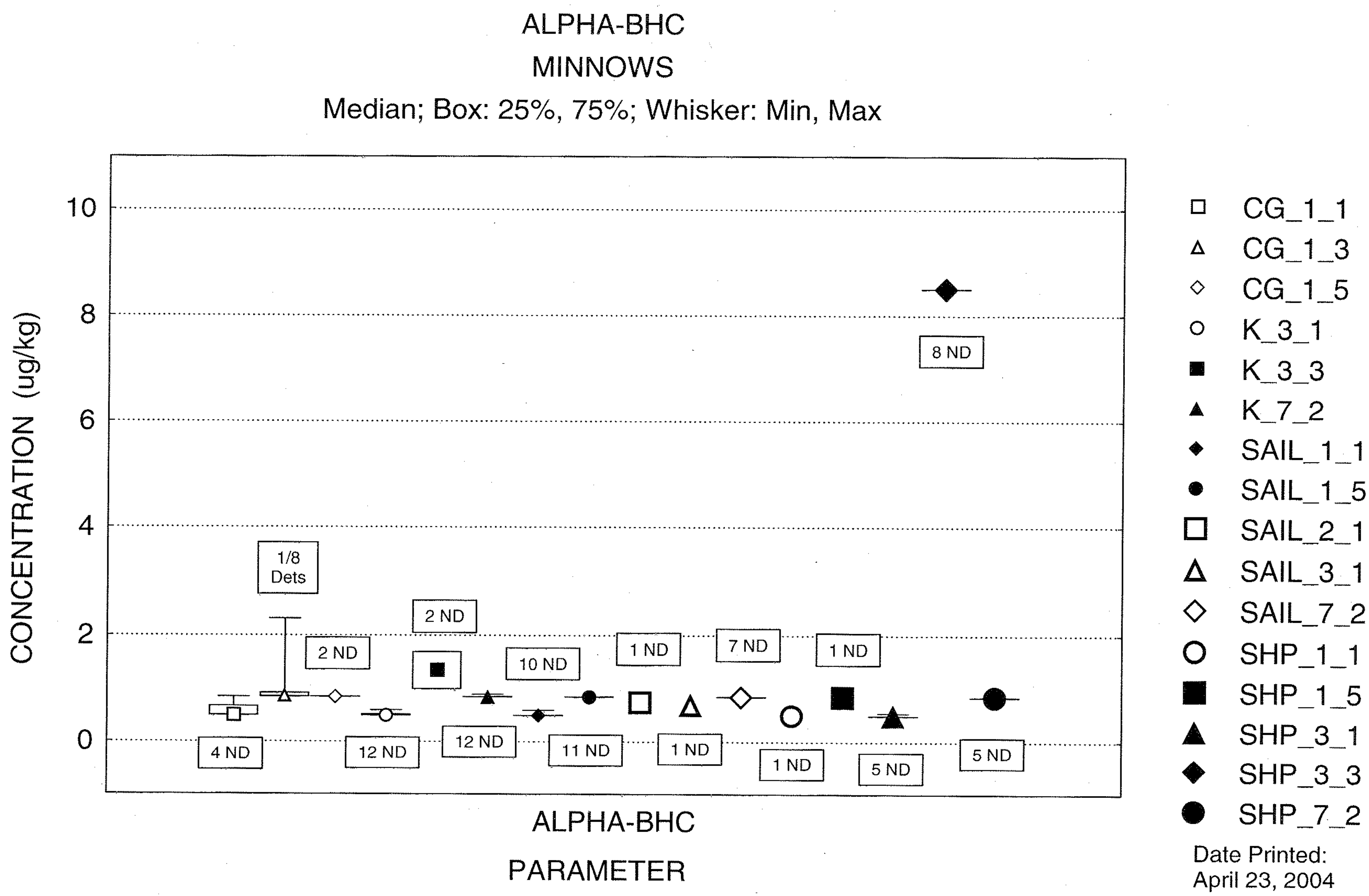
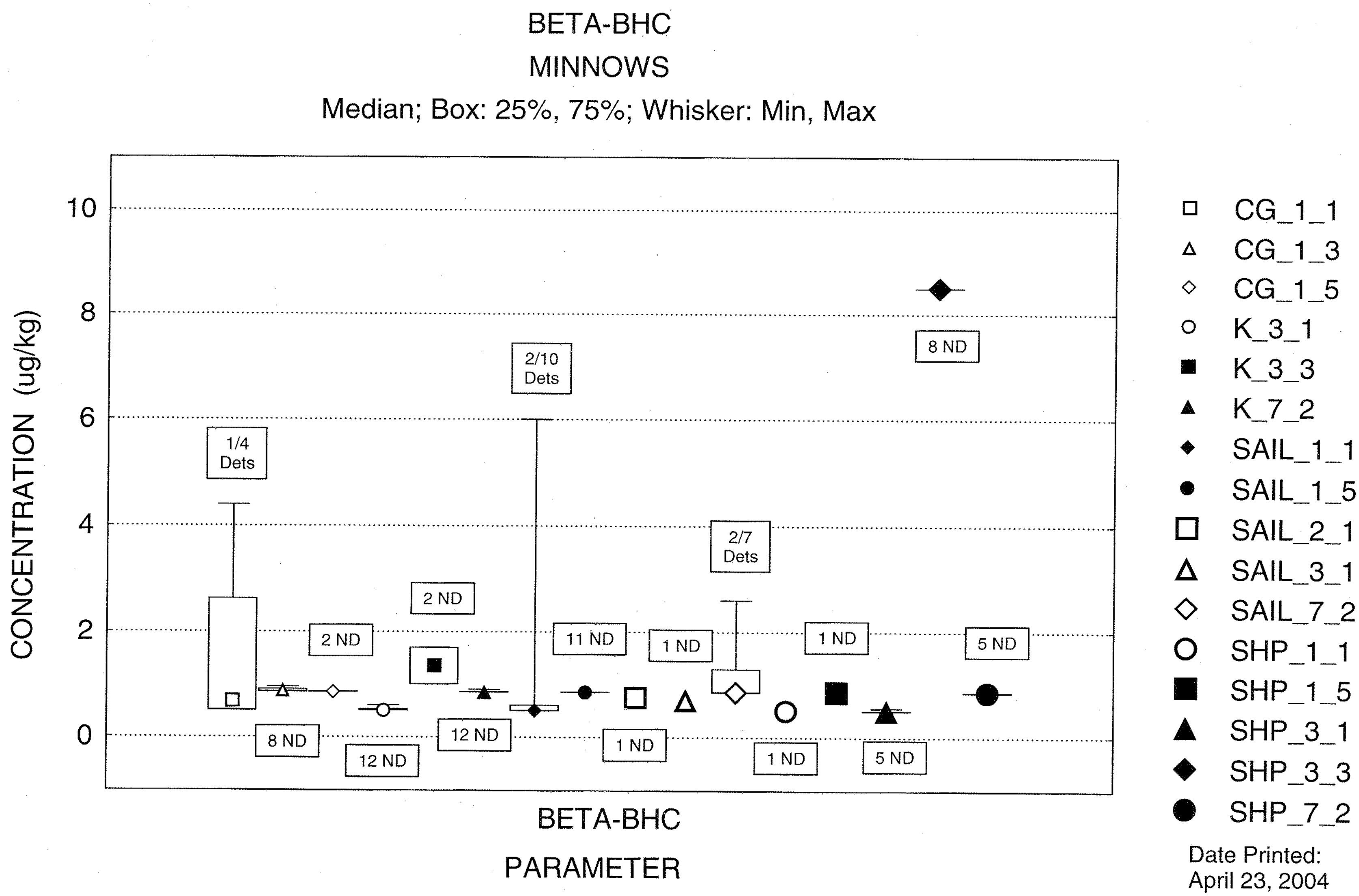
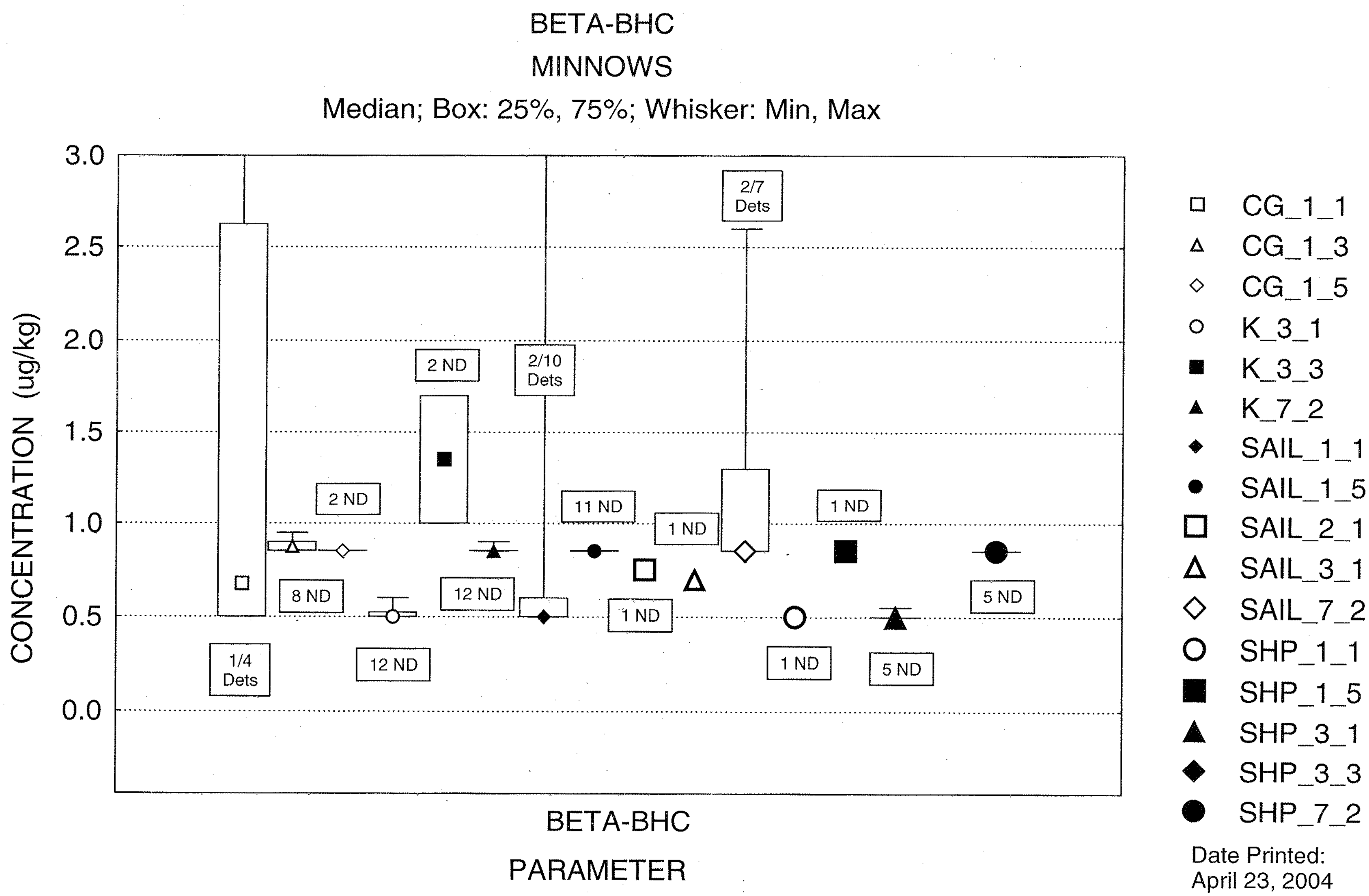
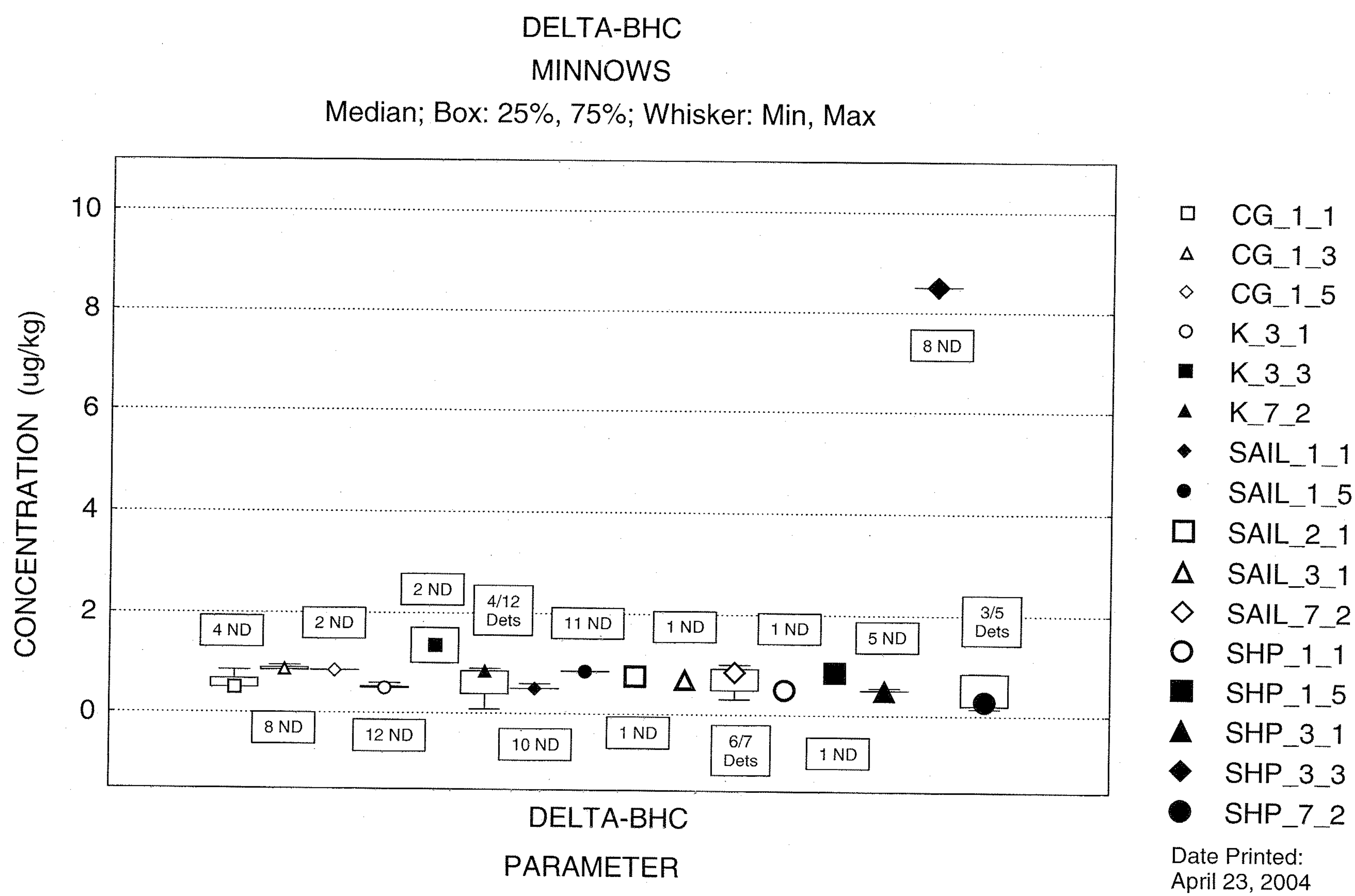

ALPHA-BHC
MINNOWS
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (ug/kg)
10
8
6
4
2
0
1/8 Dets
8 ND
2 ND
2 ND
10 ND
1 ND
7 ND
1 ND
4 ND
12 ND
12 ND
11 ND
1 ND
1 ND
5 ND
5 ND
ALPHA-BHC
PARAMETER
CG_1_1
CG_1_3
CG_1_5
K_3_1
K_3_3
K_7_2
SAIL_1_1
SAIL_1_5
SAIL_2_1
SAIL_3_1
SAIL_7_2
SHP_1_1
SHP_1_5
SHP_3_1
SHP_3_3
SHP_7_2
Date Printed:
April 23, 2004



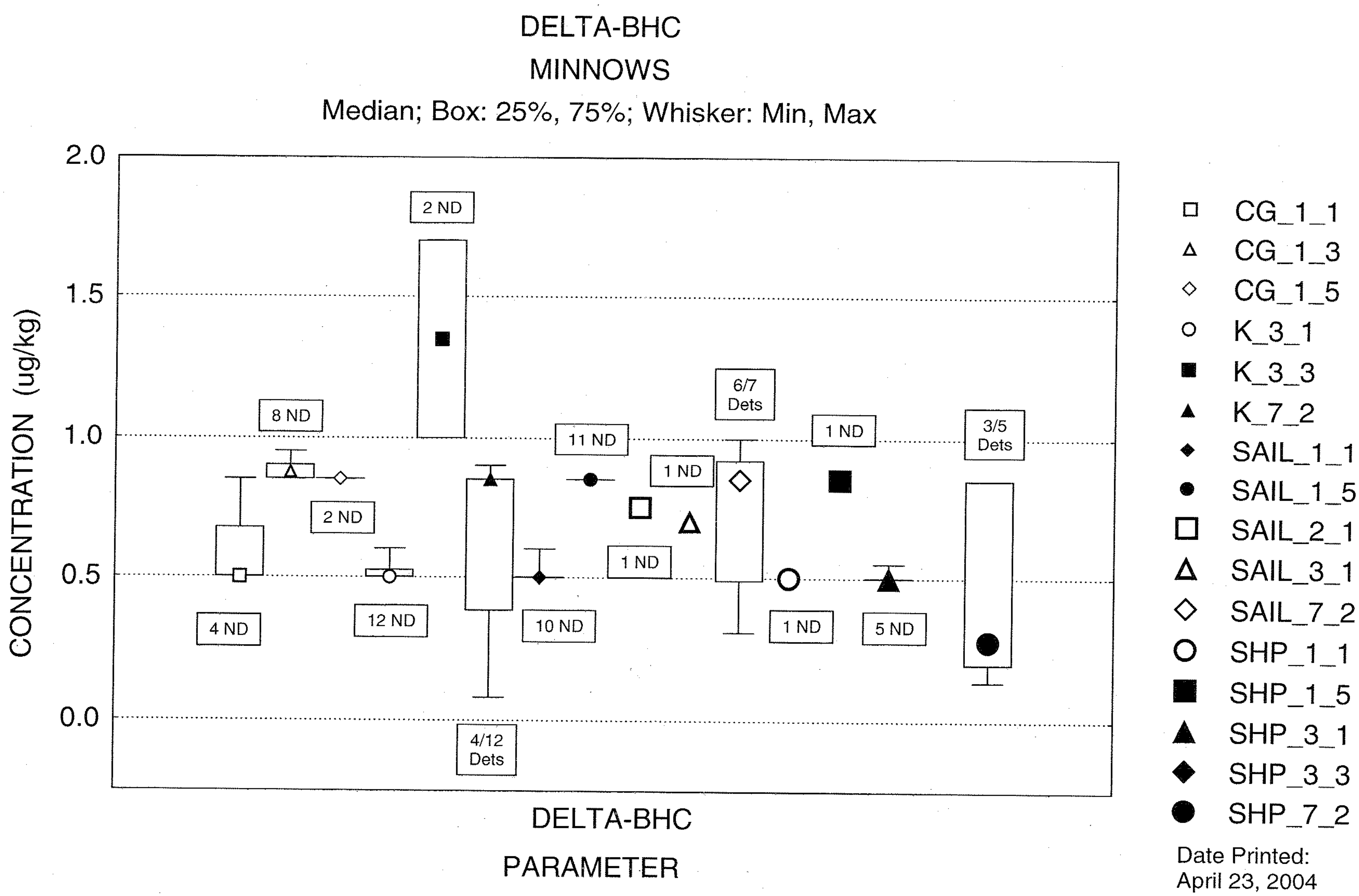
BETA-BHC
MINNOWS
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (ug/kg)
10
8
6
4
2
0
1/4 Dets
2/10 Dets
2/7 Dets
8 ND
2 ND
2 ND
11 ND
1 ND
1 ND
5 ND
8 ND
12 ND
12 ND
1 ND
1 ND
5 ND
BETA-BHC
PARAMETER
CG_1_1
CG_1_3
CG_1_5
K_3_1
K_3_3
K_7_2
SAIL_1_1
SAIL_1_5
SAIL_2_1
SAIL_3_1
SAIL_7_2
SHP_1_1
SHP_1_5
SHP_3_1
SHP_3_3
SHP_7_2
Date Printed:
April 23, 2004

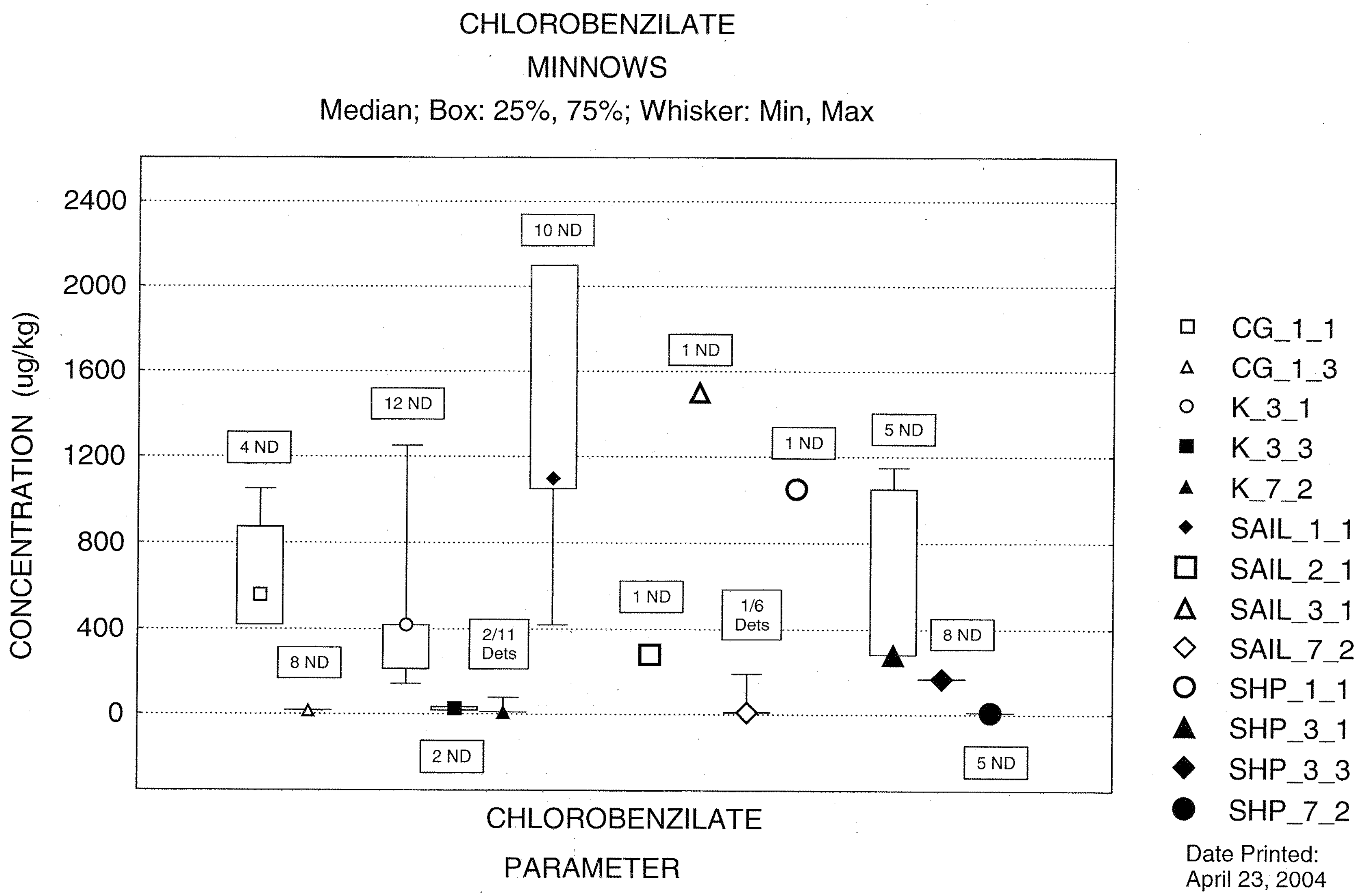


BETA-BHC
MINNOWS
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (ug/kg)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
2/7 Dets
2 ND
2/10 Dets
2 ND
11 ND
1 ND
1 ND
8 ND
12 ND
1 ND
5 ND
1/4 Dets
12 ND
1 ND
5 ND
BETA-BHC
PARAMETER
CG_1_1
CG_1_3
CG_1_5
K_3_1
K_3_3
K_7_2
SAIL_1_1
SAIL_1_5
SAIL_2_1
SAIL_3_1
SAIL_7_2
SHP_1_1
SHP_1_5
SHP_3_1
SHP_3_3
SHP_7_2
Date Printed:
April 23, 2004

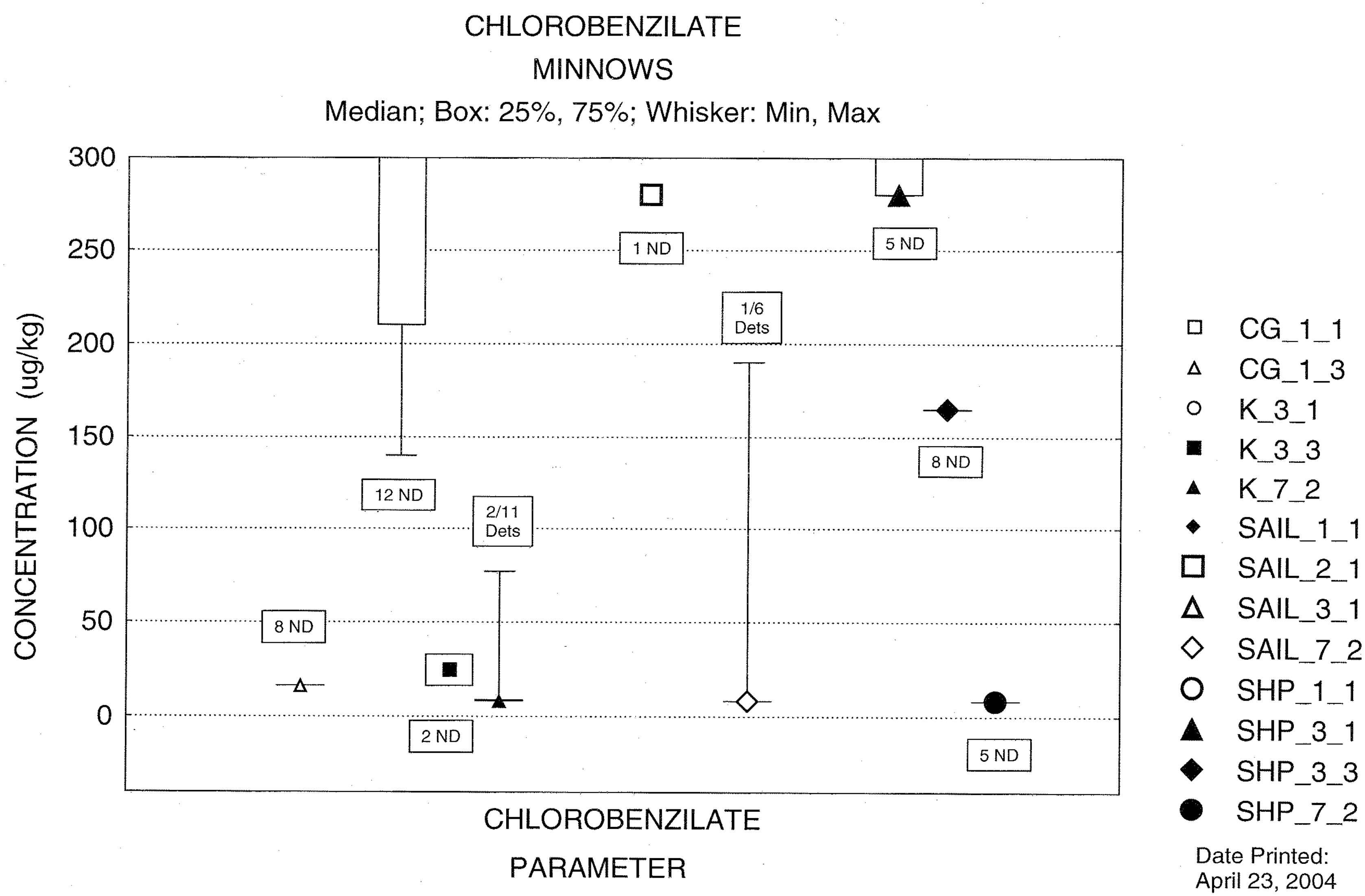


DELTA-BHC
MINNOWS
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (ug/kg)
10
8
6
4
2
0
8 ND
2 ND
4/12 Dets
4 ND
2 ND
11 ND
1 ND
1 ND
5 ND
3/5 Dets
8 ND
12 ND
10 ND
1 ND
6/7 Dets
1 ND
DELTA-BHC
PARAMETER
CG_1_1
CG_1_3
CG_1_5
K_3_1
K_3_3
K_7_2
SAIL_1_1
SAIL_1_5
SAIL_2_1
SAIL_3_1
SAIL_7_2
SHP_1_1
SHP_1_5
SHP_3_1
SHP_3_3
SHP_7_2
Date Printed:
April 23, 2004

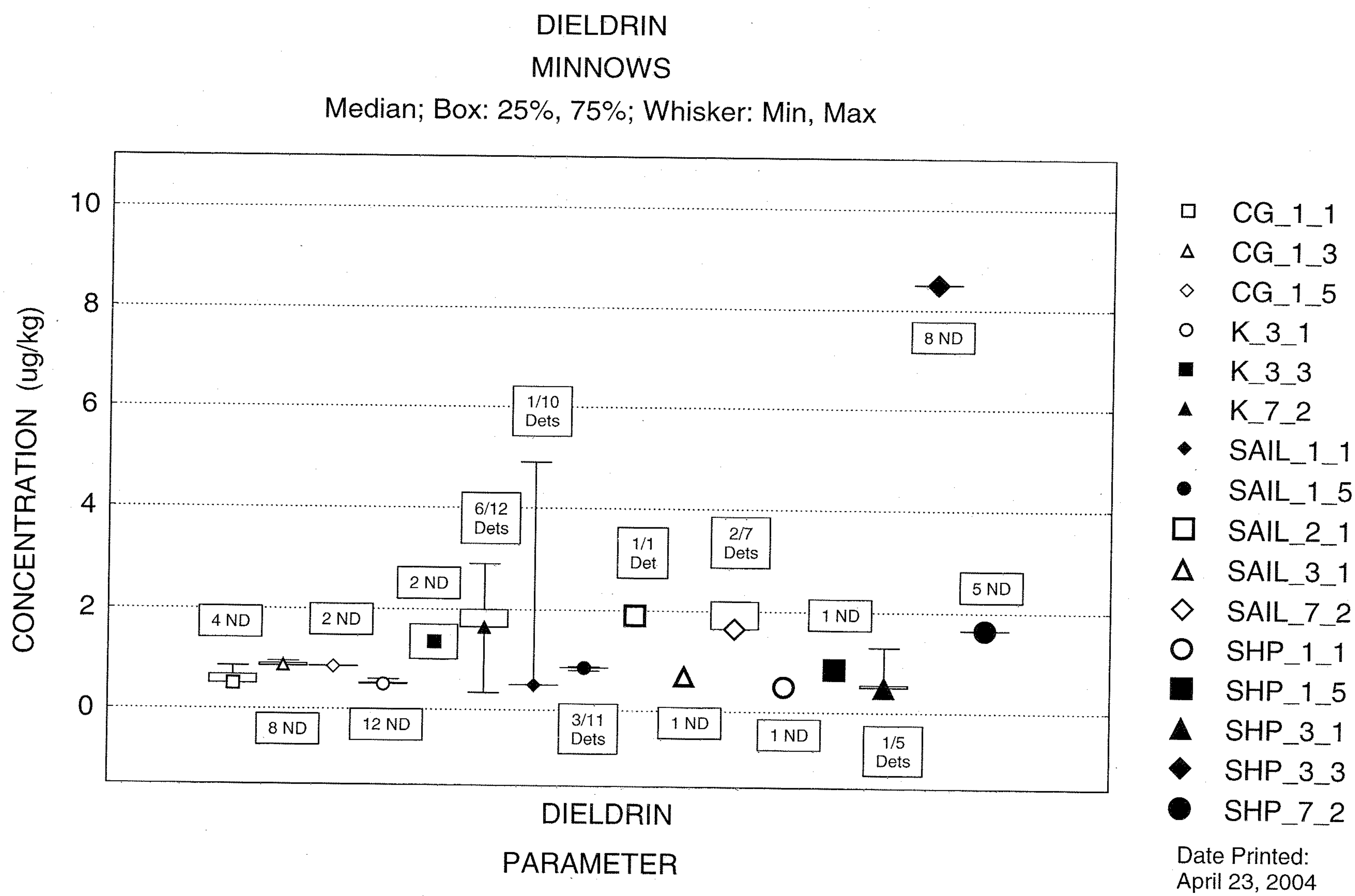

DELTA-BHC
MINNOWS
Median; Box: 25%, 75%; Whisker: Min, Max
2.0
1.5
1.0
0.5
0.0
CONCENTRATION (ug/kg)
2 ND
8 ND
2 ND
4 ND
12 ND
11 ND
1 ND
1 ND
10 ND
4/12 Dets
6/7 Dets
1 ND
1 ND
5 ND
3/5 Dets
DELTA-BHC
PARAMETER
CG_1_1
CG_1_3
CG_1_5
K_3_1
K_3_3
K_7_2
SAIL_1_1
SAIL_1_5
SAIL_2_1
SAIL_3_1
SAIL_7_2
SHP_1_1
SHP_1_5
SHP_3_1
SHP_3_3
SHP_7_2
Date Printed:
April 23, 2004



CHLOROBENZILATE
MINNOWS
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (ug/kg)
2400
2000
1600
1200
800
400
0
4 ND
8 ND
12 ND
2 ND
2/11 Dets
10 ND
1 ND
1 ND
1 ND
1/6 Dets
5 ND
8 ND
5 ND
CHLOROBENZILATE
PARAMETER
CG_1_1
CG_1_3
K_3_1
K_3_3
K_7_2
SAIL_1_1
SAIL_2_1
SAIL_3_1
SAIL_7_2
SHP_1_1
SHP_3_1
SHP_3_3
SHP_7_2
Date Printed:
April 23, 2004

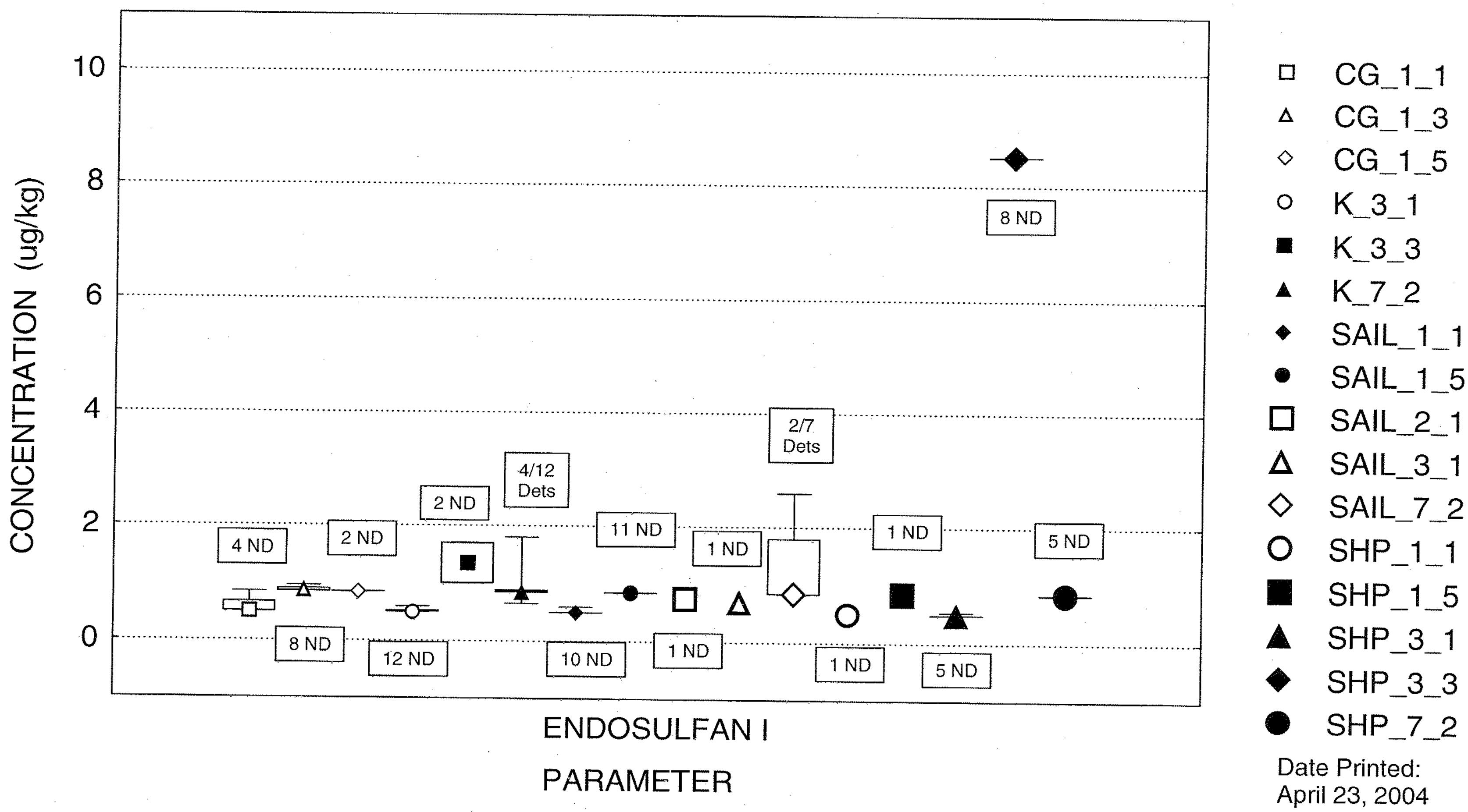


CHLOROBENZILATE
MINNOWS
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (ug/kg)
300
250
200
150
100
50
0
1 ND
5 ND
1/6 Dets
8 ND
12 ND
2/11 Dets
8 ND
2 ND
5 ND
CHLOROBENZILATE
PARAMETER
CG_1_1
CG_1_3
K_3_1
K_3_3
K_7_2
SAIL_1_1
SAIL_2_1
SAIL_3_1
SAIL_7_2
SHP_1_1
SHP_3_1
SHP_3_3
SHP_7_2
Date Printed:
April 23, 2004



DIELDRIN
MINNOWS
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (ug/kg)
10
8
6
4
2
0
8 ND
1/10 Dets
6/12 Dets
1/1 Det
2/7 Dets
2 ND
4 ND
2 ND
1 ND
5 ND
8 ND
12 ND
3/11 Dets
1 ND
1 ND
1/5 Dets
DIELDRIN
PARAMETER
CG_1_1
CG_1_3
CG_1_5
K_3_1
K_3_3
K_7_2
SAIL_1_1
SAIL_1_5
SAIL_2_1
SAIL_3_1
SAIL_7_2
SHP_1_1
SHP_1_5
SHP_3_1
SHP_3_3
SHP_7_2
Date Printed:
April 23, 2004

ENDOSULFAN I
MINNOWS
Median; Box: 25%, 75%; Whisker: Min, Max

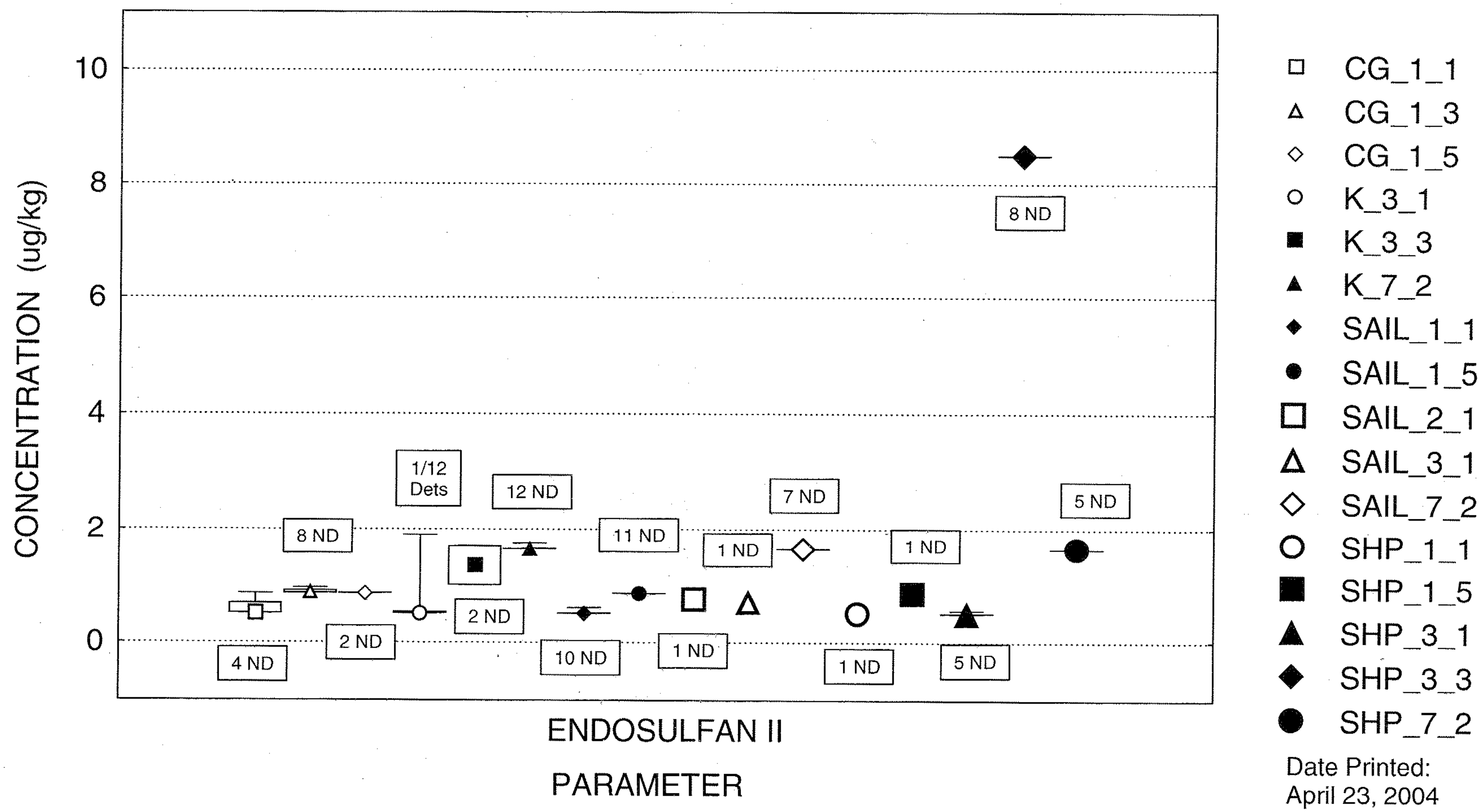


Date Printed:
April 23, 2004

ENDOSULFAN II

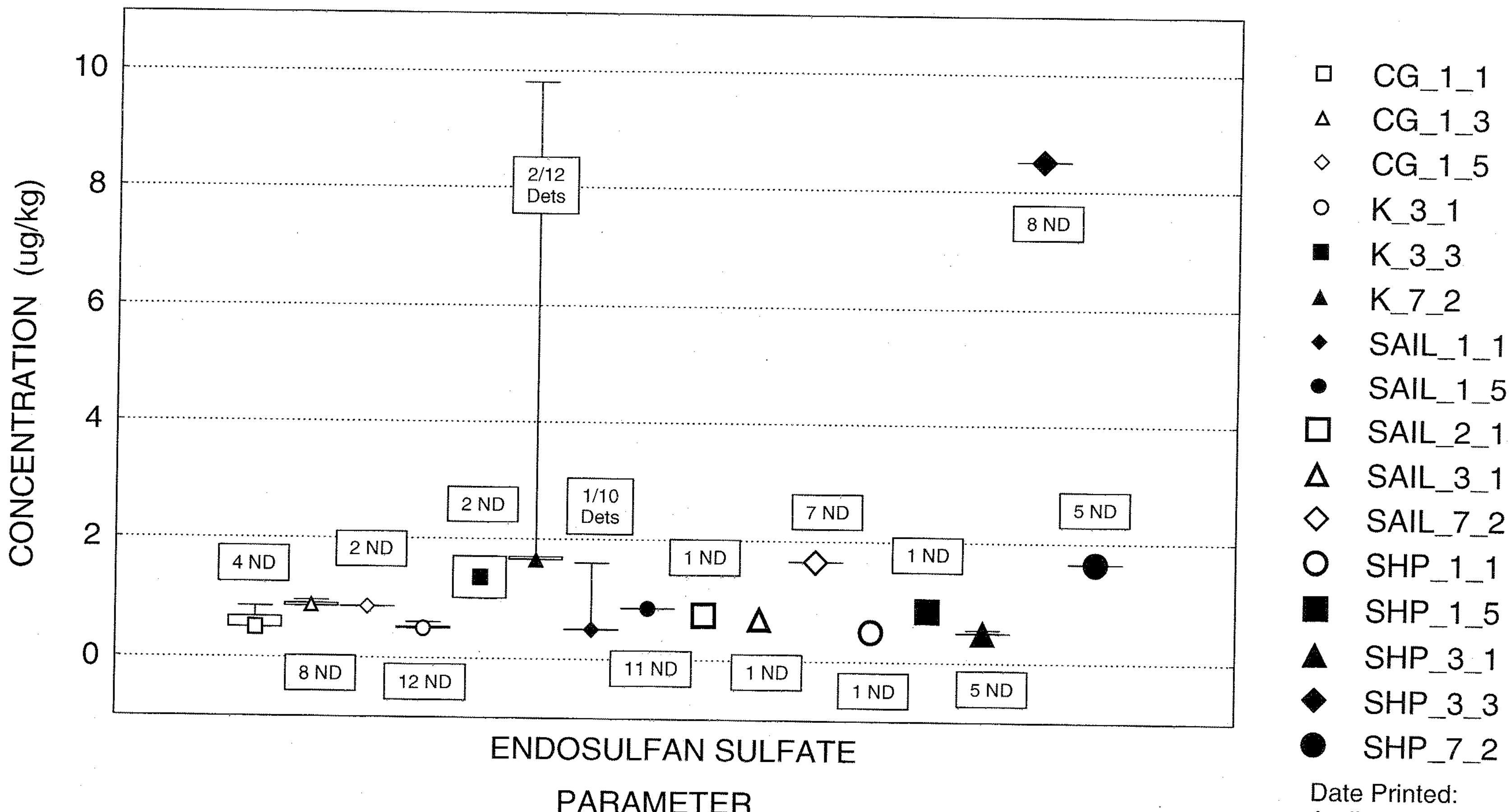
MINNOWS

Median; Box: 25%, 75%; Whisker: Min, Max

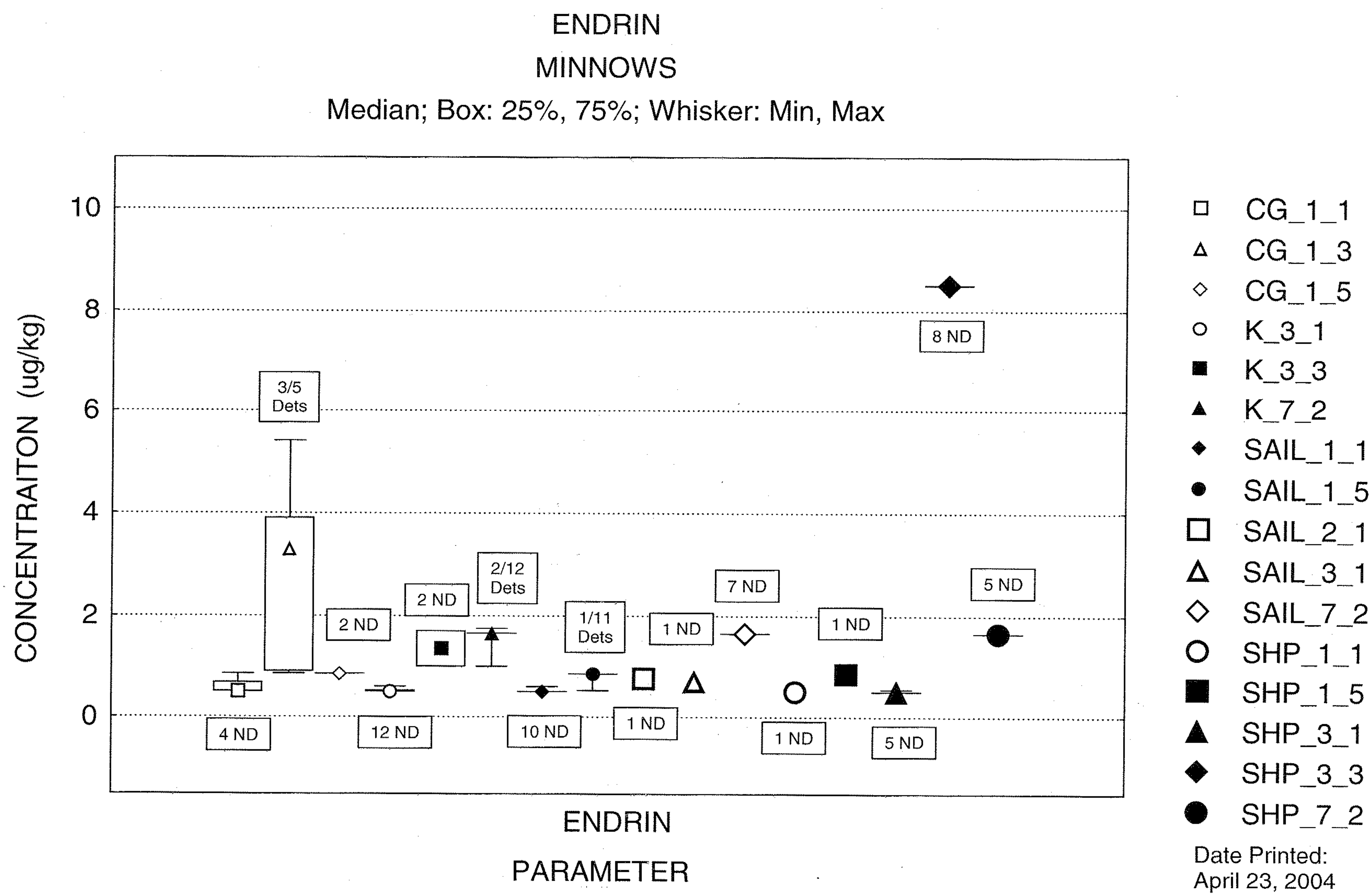


Date Printed:
April 23, 2004

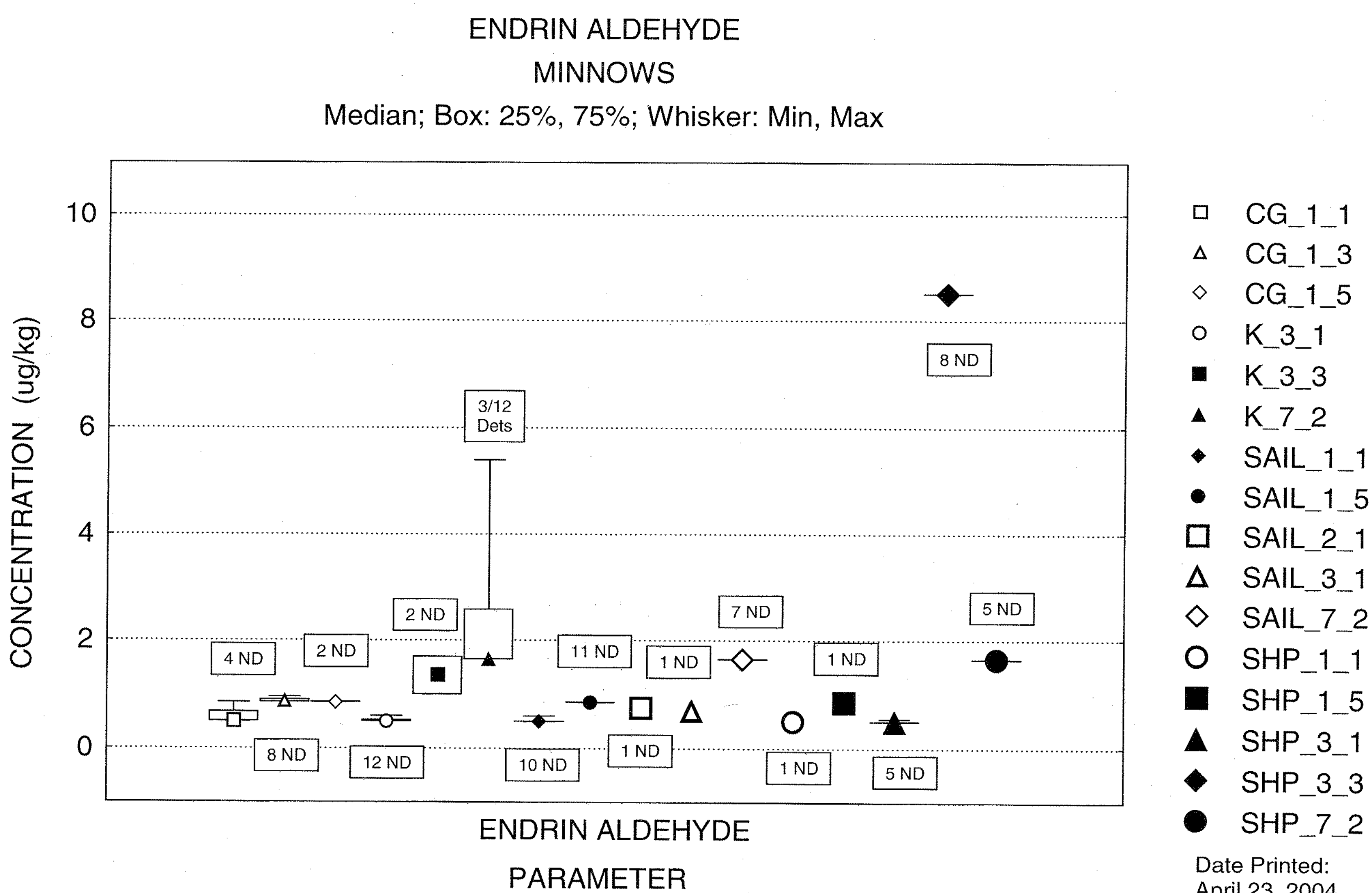
ENDOSULFAN SULFATE
MINNOWS
Median; Box: 25%, 75%; Whisker: Min, Max



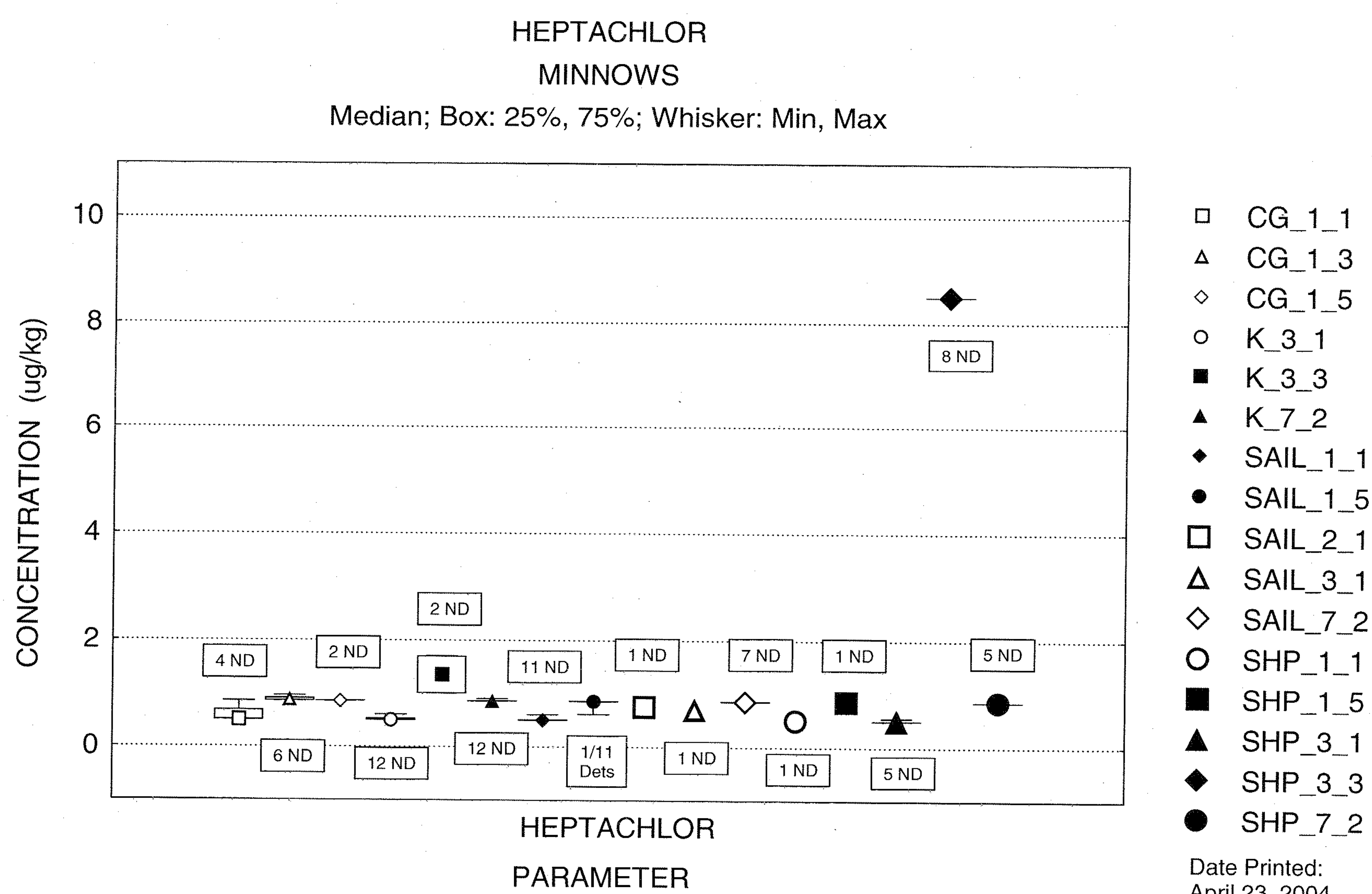
Date Printed:
April 23, 2004



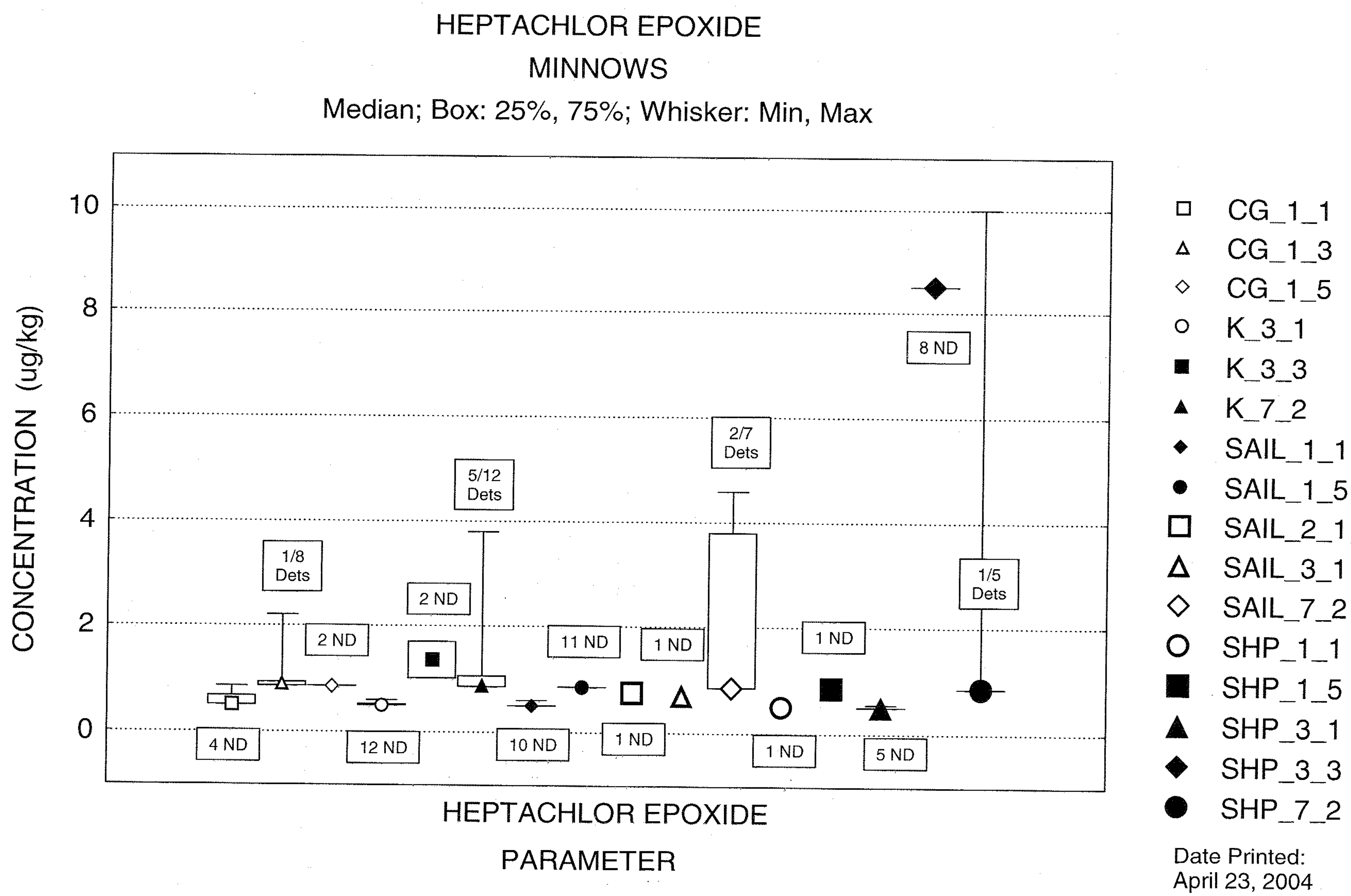
ENDRIN
MINNOWS
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRAITON (ug/kg)
10
8
6
4
2
0
3/5 Dets
8 ND
2/12 Dets
2 ND
2 ND
1/11 Dets
1 ND
7 ND
1 ND
5 ND
4 ND
12 ND
10 ND
1 ND
1 ND
5 ND
ENDRIN
PARAMETER
CG_1_1
CG_1_3
CG_1_5
K_3_1
K_3_3
K_7_2
SAIL_1_1
SAIL_1_5
SAIL_2_1
SAIL_3_1
SAIL_7_2
SHP_1_1
SHP_1_5
SHP_3_1
SHP_3_3
SHP_7_2
Date Printed:
April 23, 2004



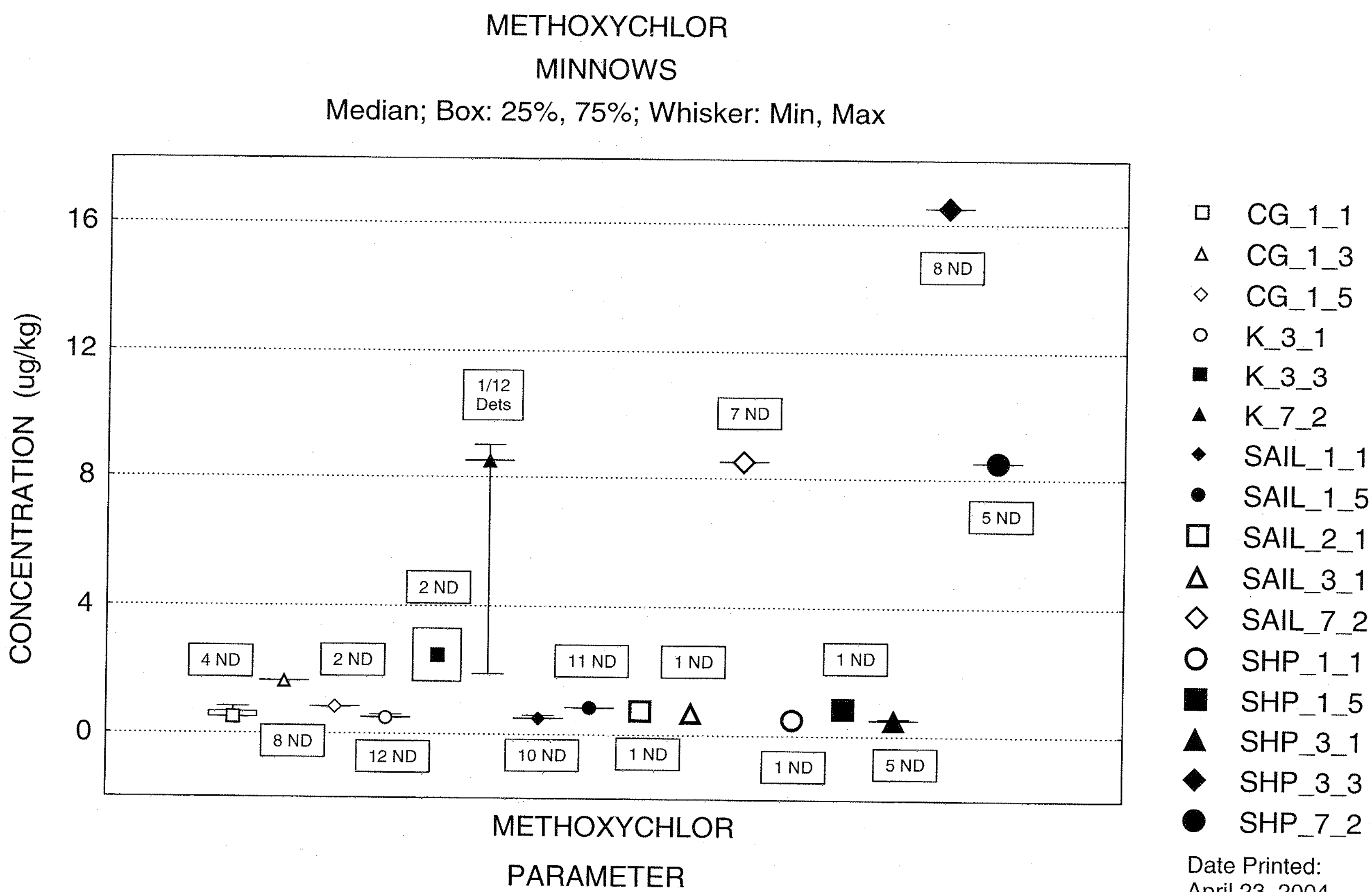
Date Printed:
April 23, 2004



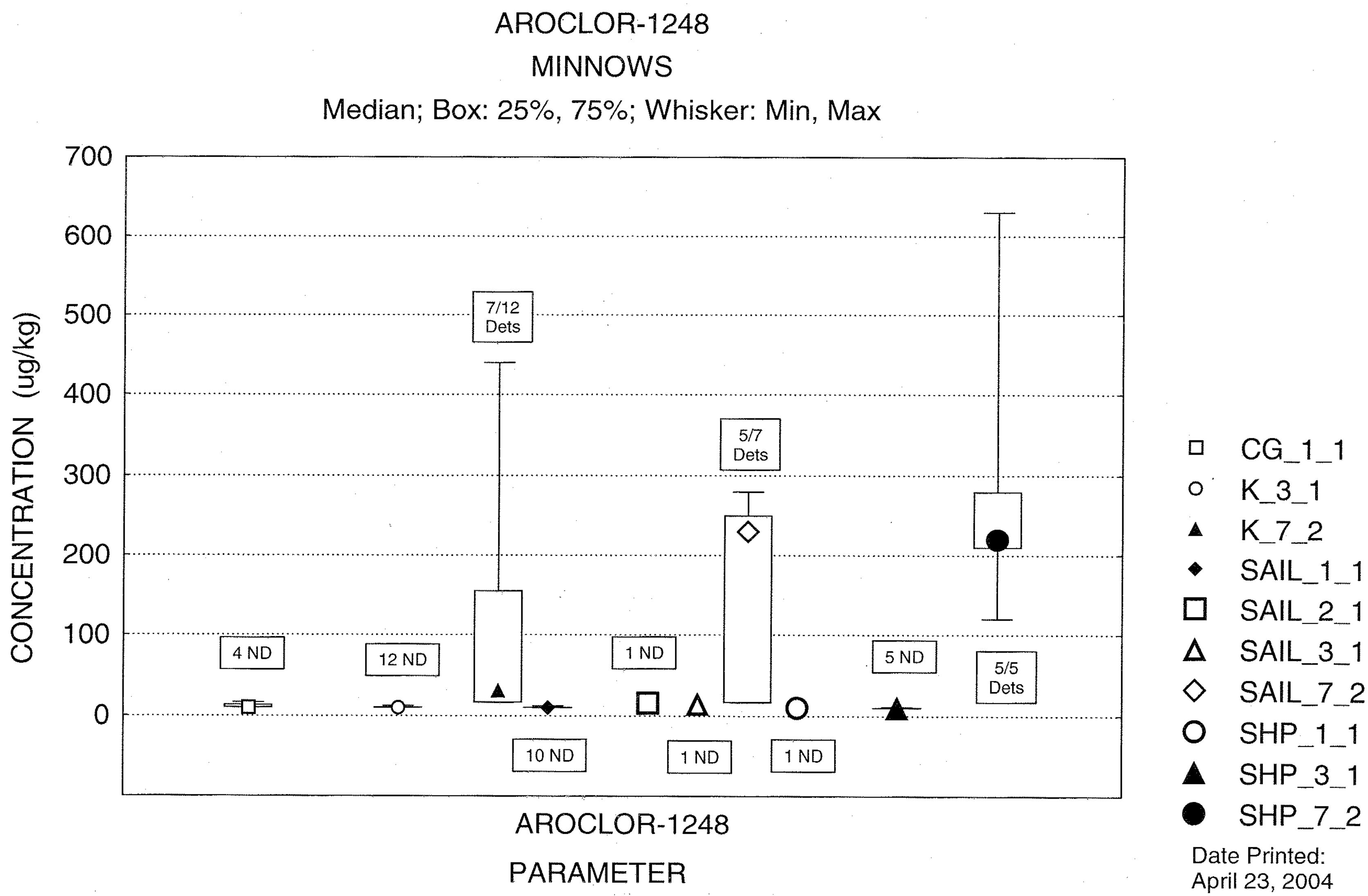
Date Printed:
April 23, 2004



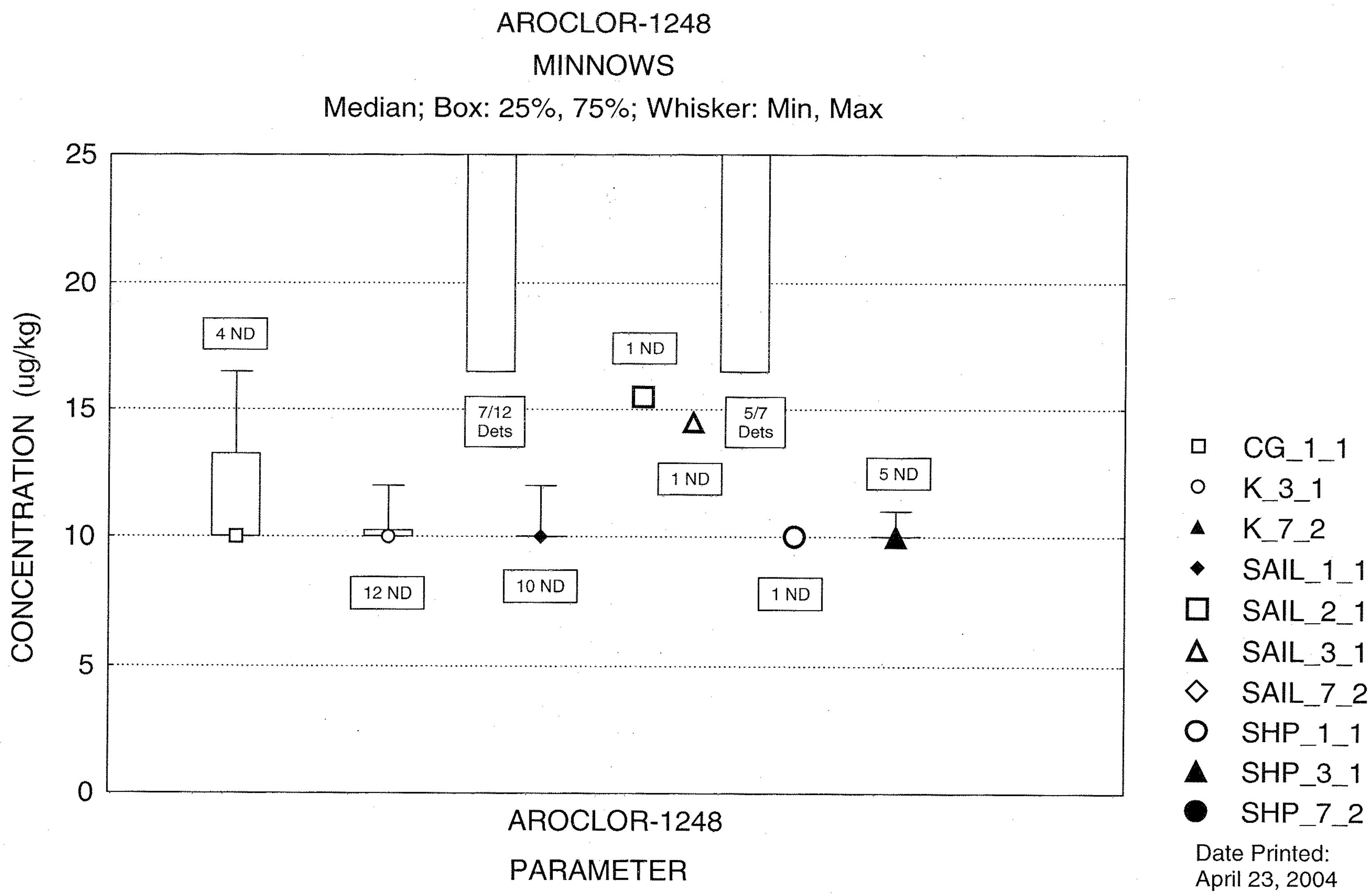
HEPTACHLOR EPOXIDE
MINNOWS
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (ug/kg)
10
8
6
4
2
0
1/8 Dets
2 ND
5/12 Dets
2 ND
2/7 Dets
8 ND
1/5 Dets
11 ND
1 ND
1 ND
4 ND
12 ND
10 ND
1 ND
1 ND
5 ND
HEPTACHLOR EPOXIDE
PARAMETER
CG_1_1
CG_1_3
CG_1_5
K_3_1
K_3_3
K_7_2
SAIL_1_1
SAIL_1_5
SAIL_2_1
SAIL_3_1
SAIL_7_2
SHP_1_1
SHP_1_5
SHP_3_1
SHP_3_3
SHP_7_2
Date Printed:
April 23, 2004



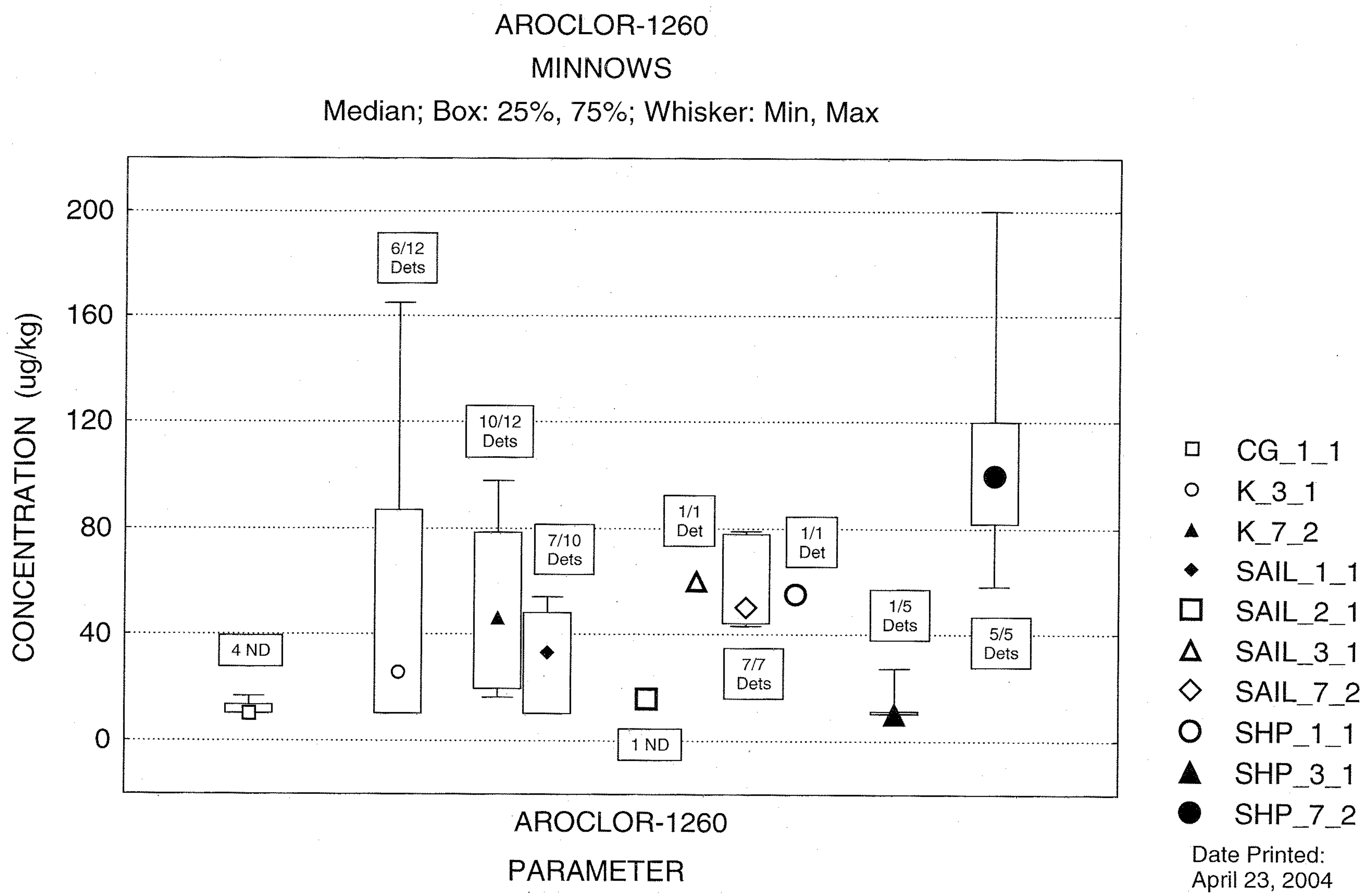
Date Printed:
April 23, 2004



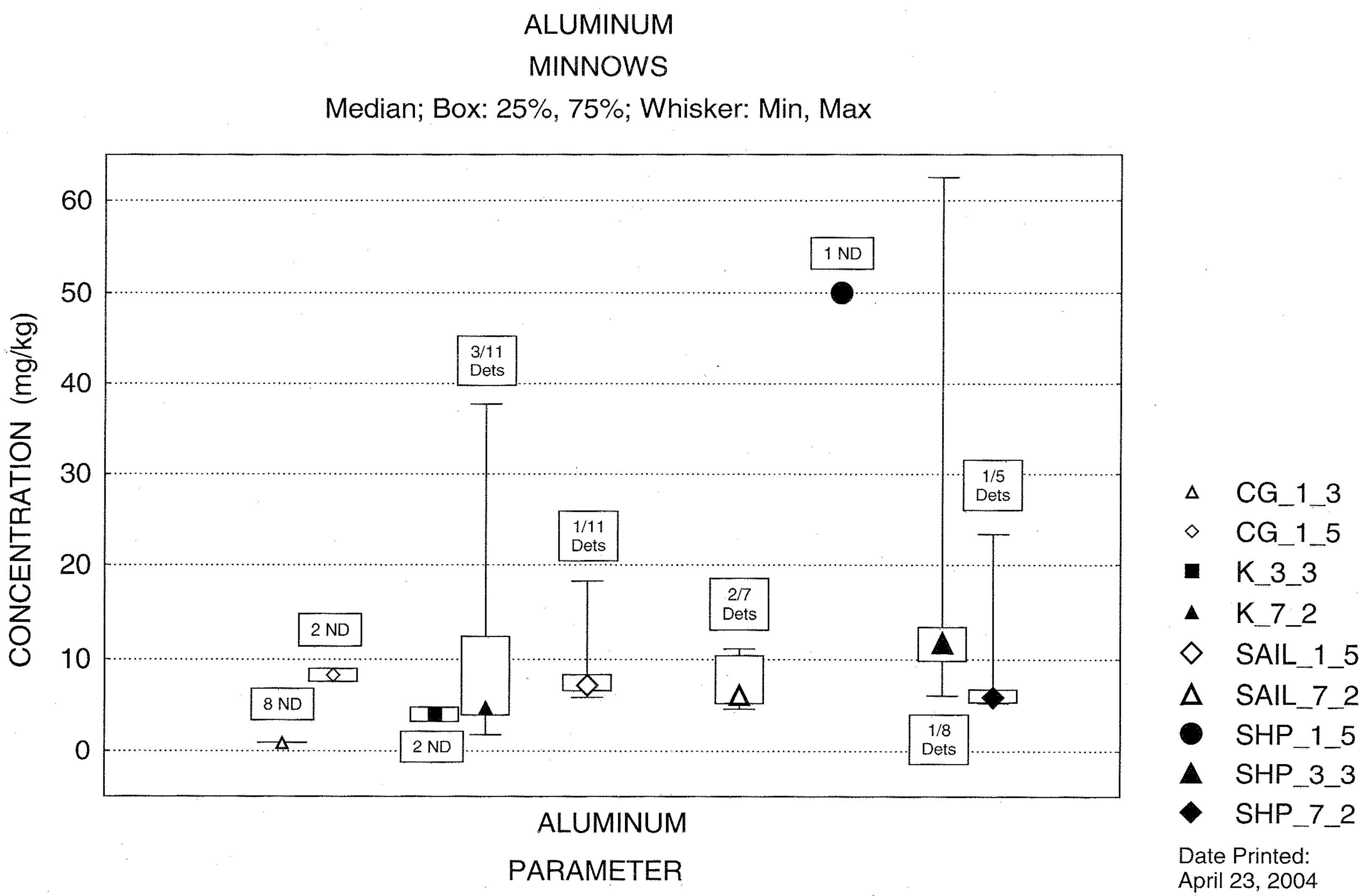
AROCLOR-1248
MINNOWS
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (ug/kg)
700
600
500
400
300
200
100
0
7/12 Dets
5/7 Dets
4 ND
12 ND
1 ND
5 ND
5/5 Dets
10 ND
1 ND
1 ND
AROCLOR-1248
PARAMETER
CG_1_1
K_3_1
K_7_2
SAIL_1_1
SAIL_2_1
SAIL_3_1
SAIL_7_2
SHP_1_1
SHP_3_1
SHP_7_2
Date Printed:
April 23, 2004



Date Printed:
April 23, 2004



AROCLOR-1260
MINNOWS
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (ug/kg)
200
160
120
80
40
0
4 ND
6/12 Dets
10/12 Dets
7/10 Dets
1 ND
1/1 Det
7/7 Dets
1/1 Det
1/5 Dets
5/5 Dets
AROCLOR-1260
PARAMETER
CG_1_1
K_3_1
K_7_2
SAIL_1_1
SAIL_2_1
SAIL_3_1
SAIL_7_2
SHP_1_1
SHP_3_1
SHP_7_2
Date Printed:
April 23, 2004

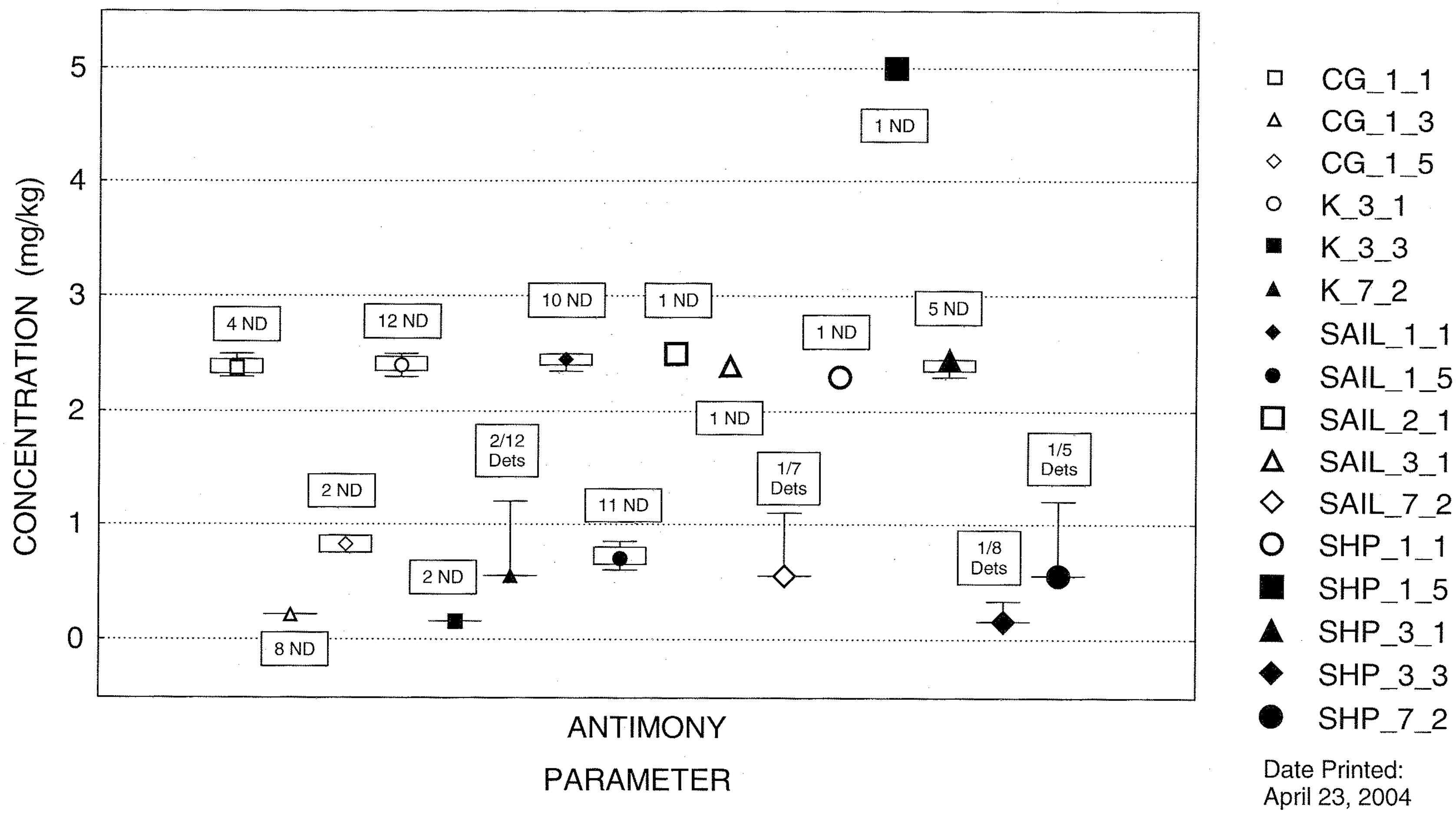


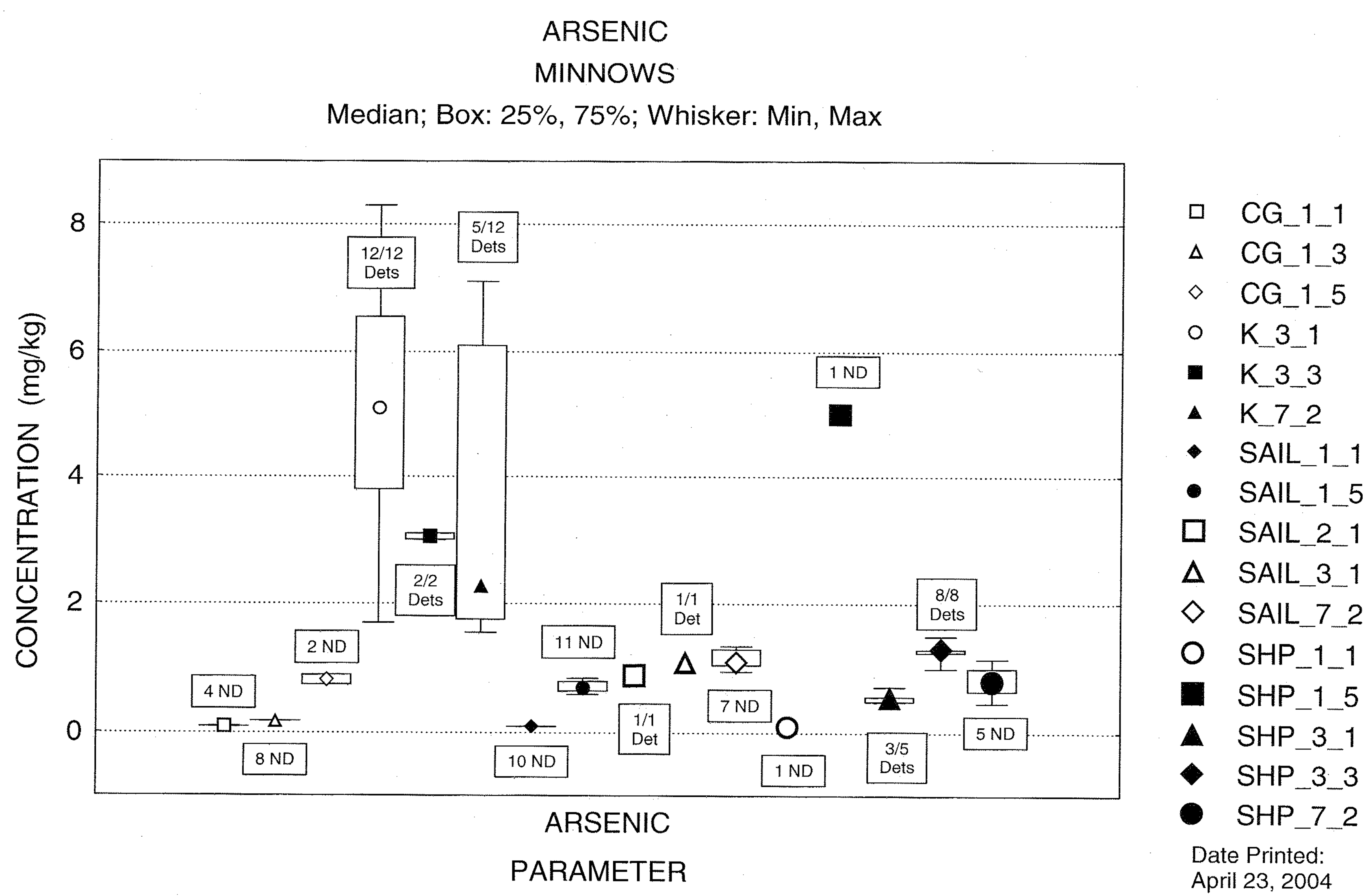
ALUMINUM
MINNOWS
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (mg/kg)
60
50
40
30
20
10
0
8 ND
2 ND
2 ND
3/11 Dets
1/11 Dets
2/7 Dets
1 ND
1/8 Dets
1/5 Dets
ALUMINUM
PARAMETER
CG_1_3
CG_1_5
K_3_3
K_7_2
SAIL_1_5
SAIL_7_2
SHP_1_5
SHP_3_3
SHP_7_2
Date Printed:
April 23, 2004

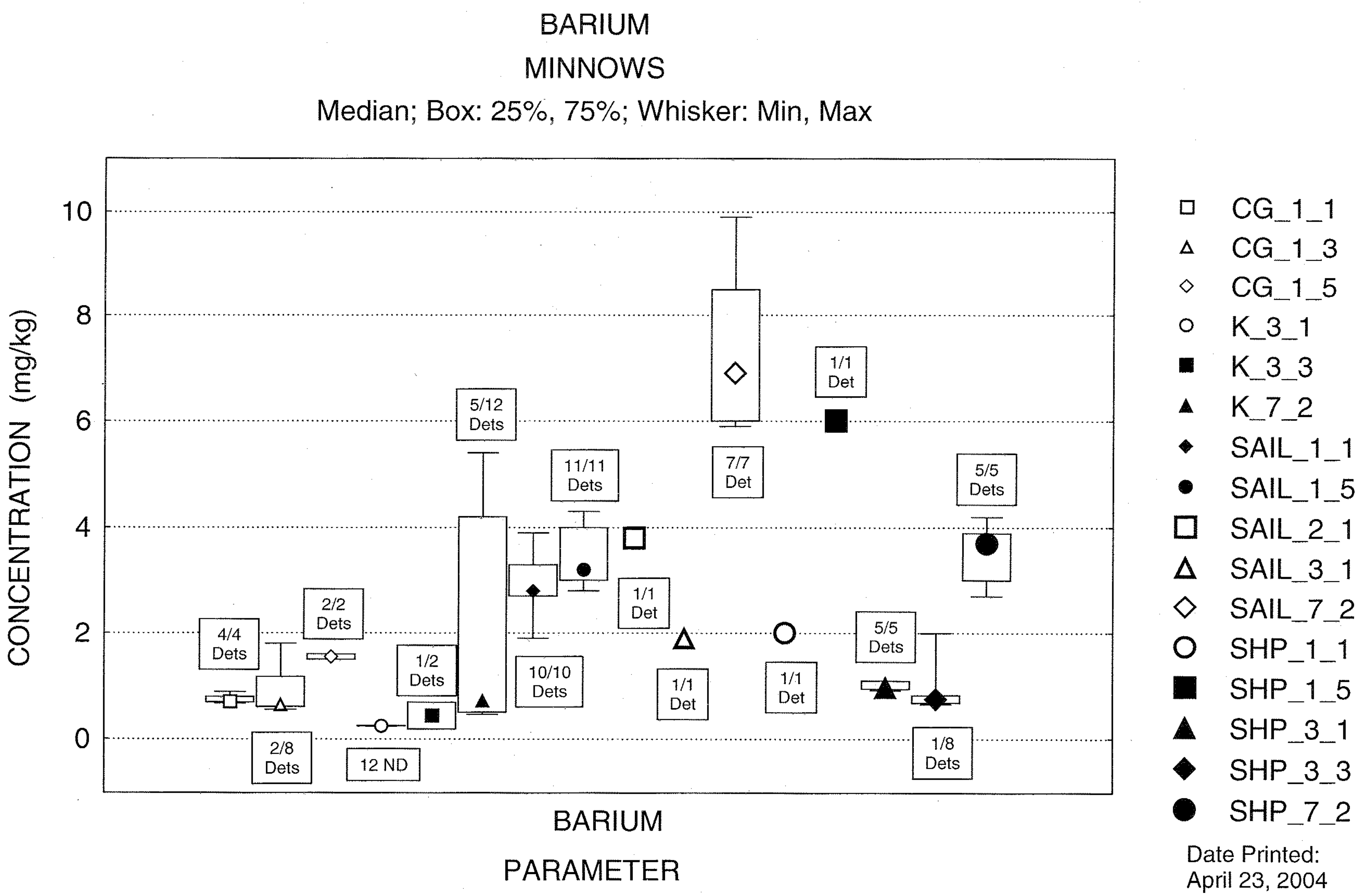
ANTIMONY

MINNOWS

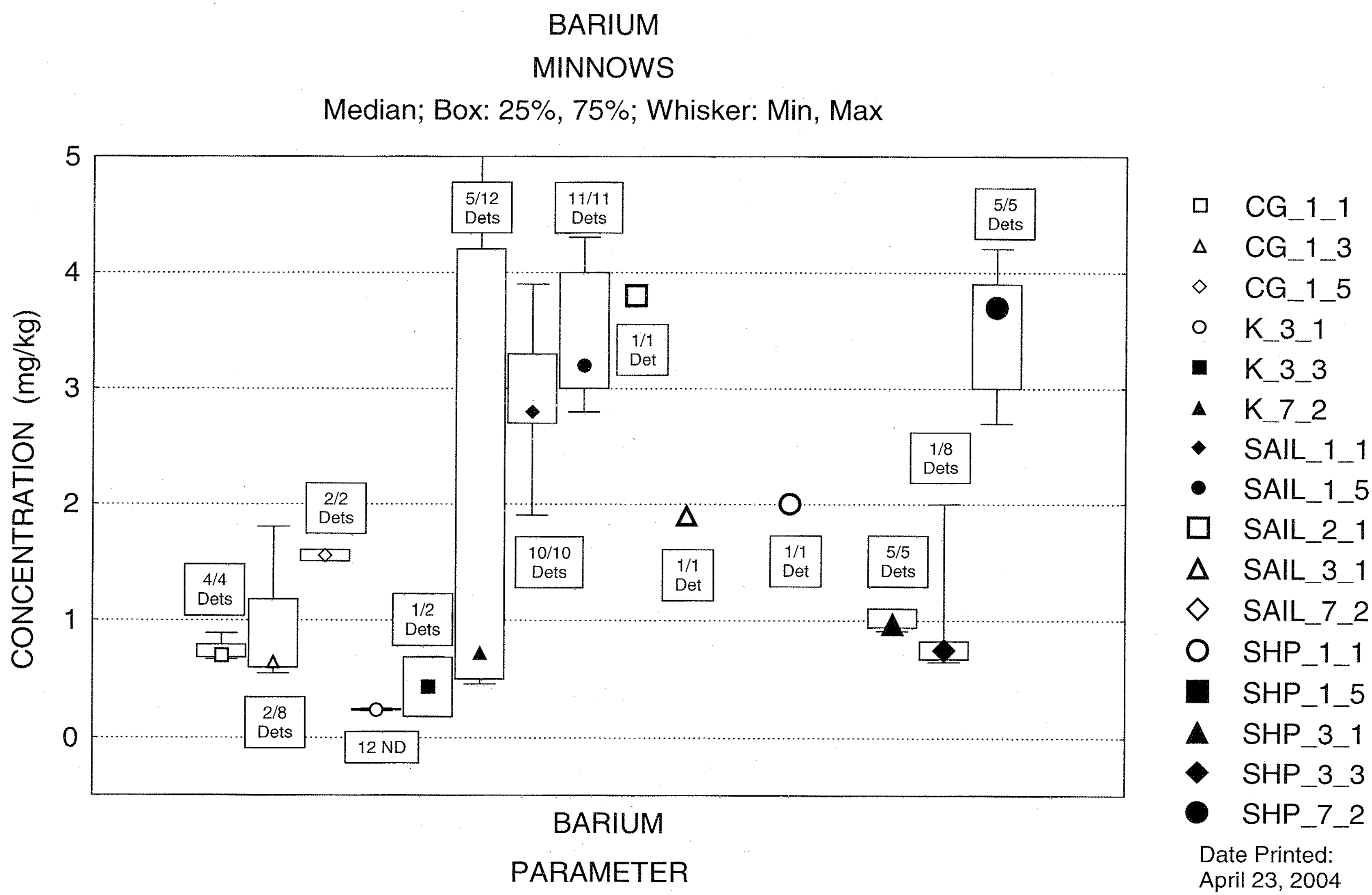
Median; Box: 25%, 75%; Whisker: Min, Max



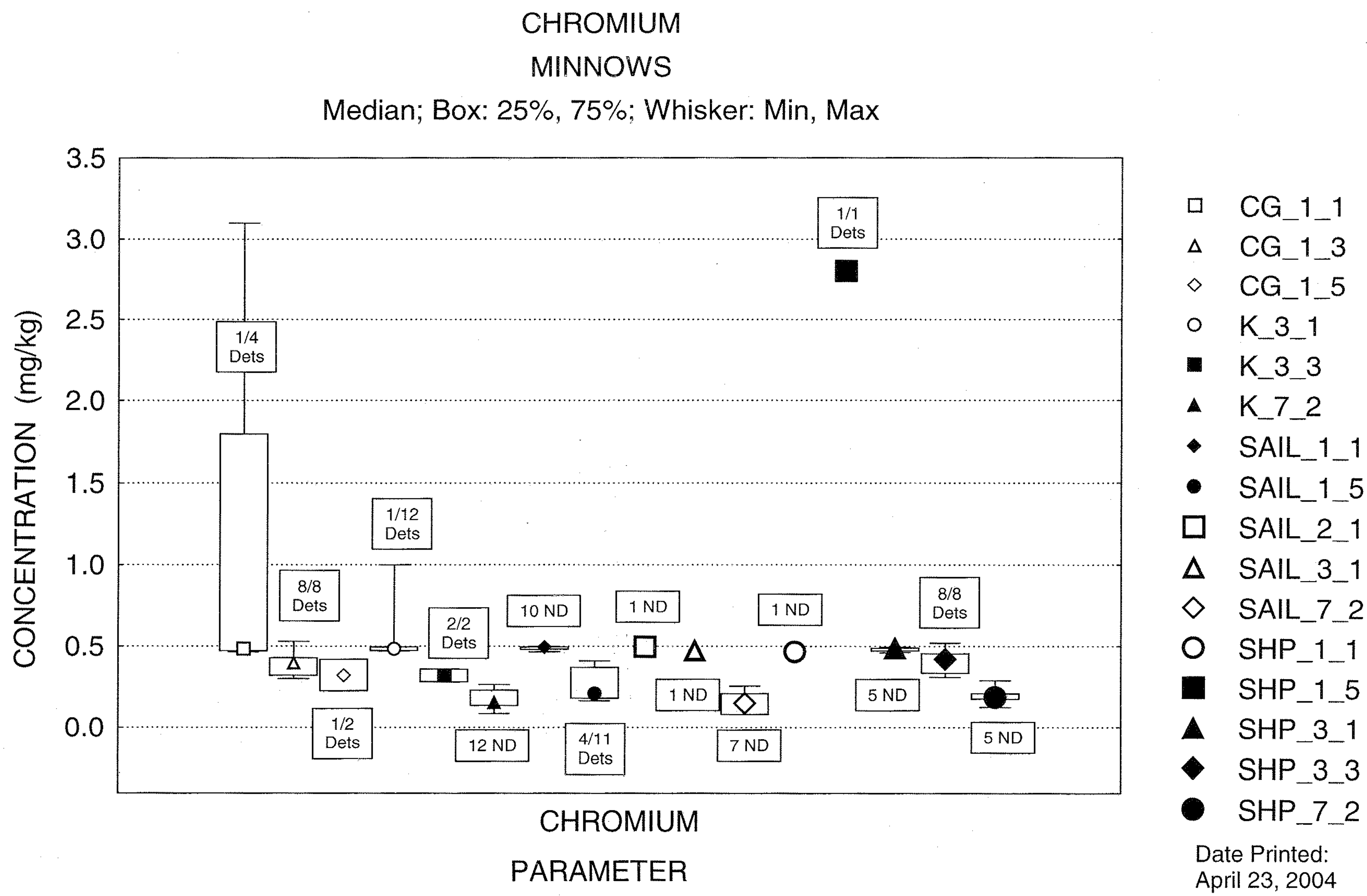

ARSENIC
MINNOWS
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (mg/kg)
8
6
4
2
0
12/12 Dets
5/12 Dets
1 ND
2/2 Dets
1/1 Det
8/8 Dets
2 ND
11 ND
4 ND
7 ND
1/1 Det
5 ND
8 ND
10 ND
1 ND
3/5 Dets
ARSENIC
PARAMETER
CG_1_1
CG_1_3
CG_1_5
K_3_1
K_3_3
K_7_2
SAIL_1_1
SAIL_1_5
SAIL_2_1
SAIL_3_1
SAIL_7_2
SHP_1_1
SHP_1_5
SHP_3_1
SHP_3_3
SHP_7_2
Date Printed:
April 23, 2004

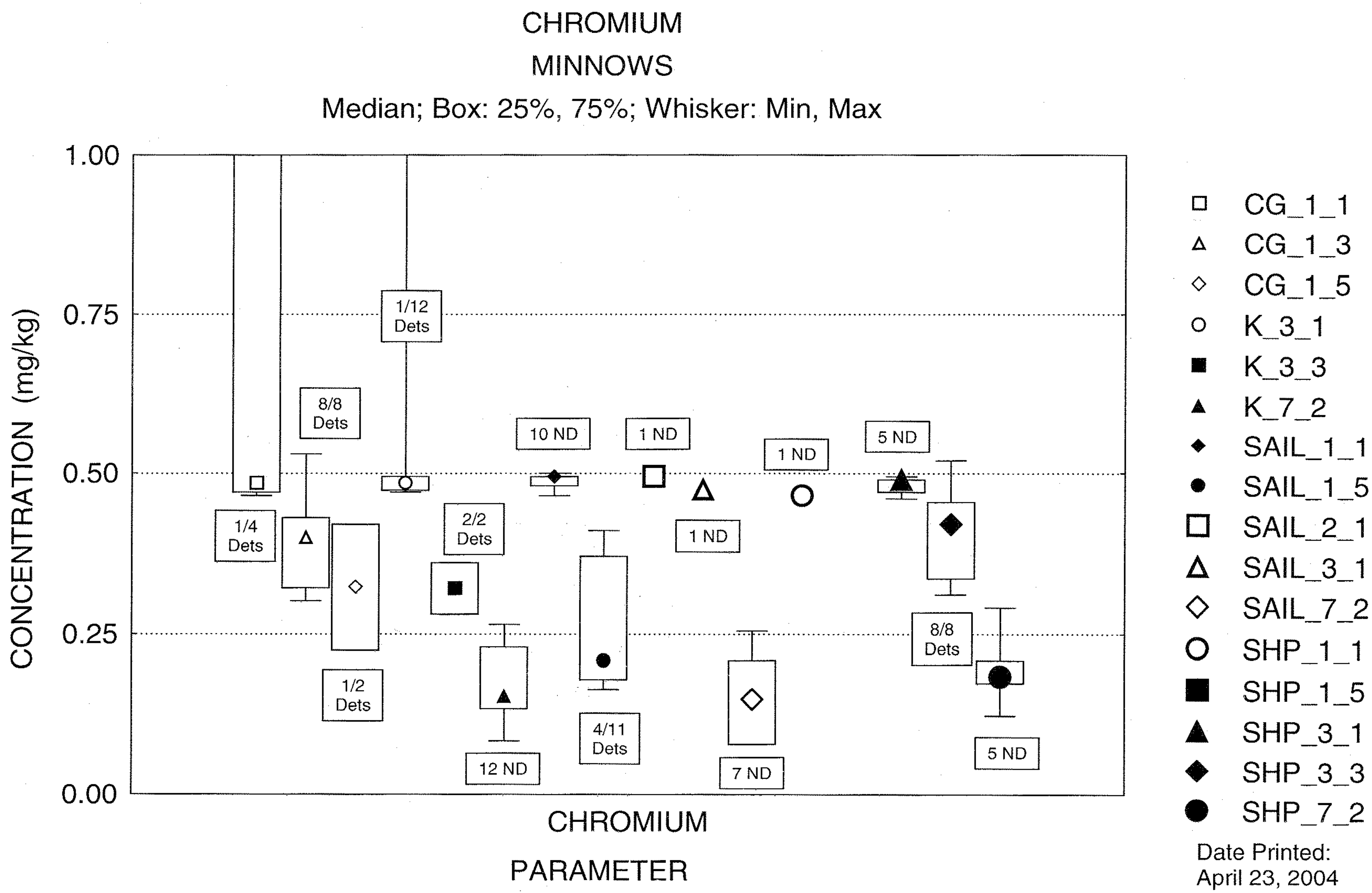


BARIUM
MINNOWS
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (mg/kg)
10
8
6
4
2
0
4/4 Dets
2/8 Dets
2/2 Dets
12 ND
1/2 Dets
5/12 Dets
10/10 Dets
11/11 Dets
1/1 Det
1/1 Det
7/7 Det
1/1 Det
1/1 Det
5/5 Dets
1/8 Dets
5/5 Dets
BARIUM
PARAMETER
CG_1_1
CG_1_3
CG_1_5
K_3_1
K_3_3
K_7_2
SAIL_1_1
SAIL_1_5
SAIL_2_1
SAIL_3_1
SAIL_7_2
SHP_1_1
SHP_1_5
SHP_3_1
SHP_3_3
SHP_7_2
Date Printed:
April 23, 2004



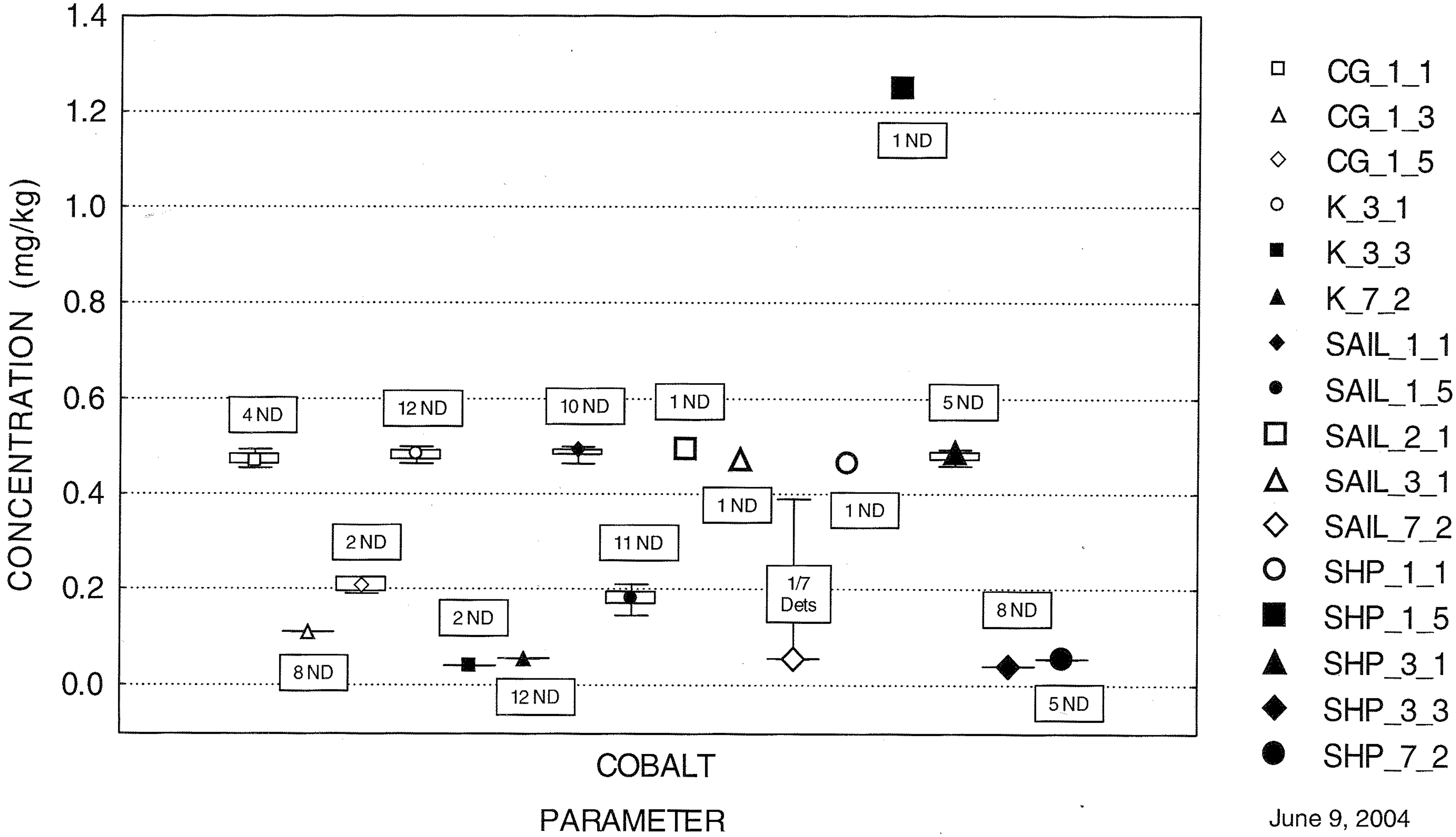
BARIUM
MINNOWS
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (mg/kg)
5
4
3
2
1
0
4/4 Dets
2/8 Dets
2/2 Dets
12 ND
1/2 Dets
5/12 Dets
10/10 Dets
11/11 Dets
1/1 Det
1/1 Det
1/1 Det
5/5 Dets
1/8 Dets
5/5 Dets
BARIUM
PARAMETER
CG_1_1
CG_1_3
CG_1_5
K_3_1
K_3_3
K_7_2
SAIL_1_1
SAIL_1_5
SAIL_2_1
SAIL_3_1
SAIL_7_2
SHP_1_1
SHP_1_5
SHP_3_1
SHP_3_3
SHP_7_2
Date Printed:
April 23, 2004


CHROMIUM
MINNOWS
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (mg/kg)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/4 Dets
8/8 Dets
1/2 Dets
1/12 Dets
2/2 Dets
12 ND
10 ND
4/11 Dets
1 ND
1 ND
7 ND
1 ND
1/1 Dets
5 ND
8/8 Dets
5 ND
CHROMIUM
PARAMETER
CG_1_1
CG_1_3
CG_1_5
K_3_1
K_3_3
K_7_2
SAIL_1_1
SAIL_1_5
SAIL_2_1
SAIL_3_1
SAIL_7_2
SHP_1_1
SHP_1_5
SHP_3_1
SHP_3_3
SHP_7_2
Date Printed:
April 23, 2004

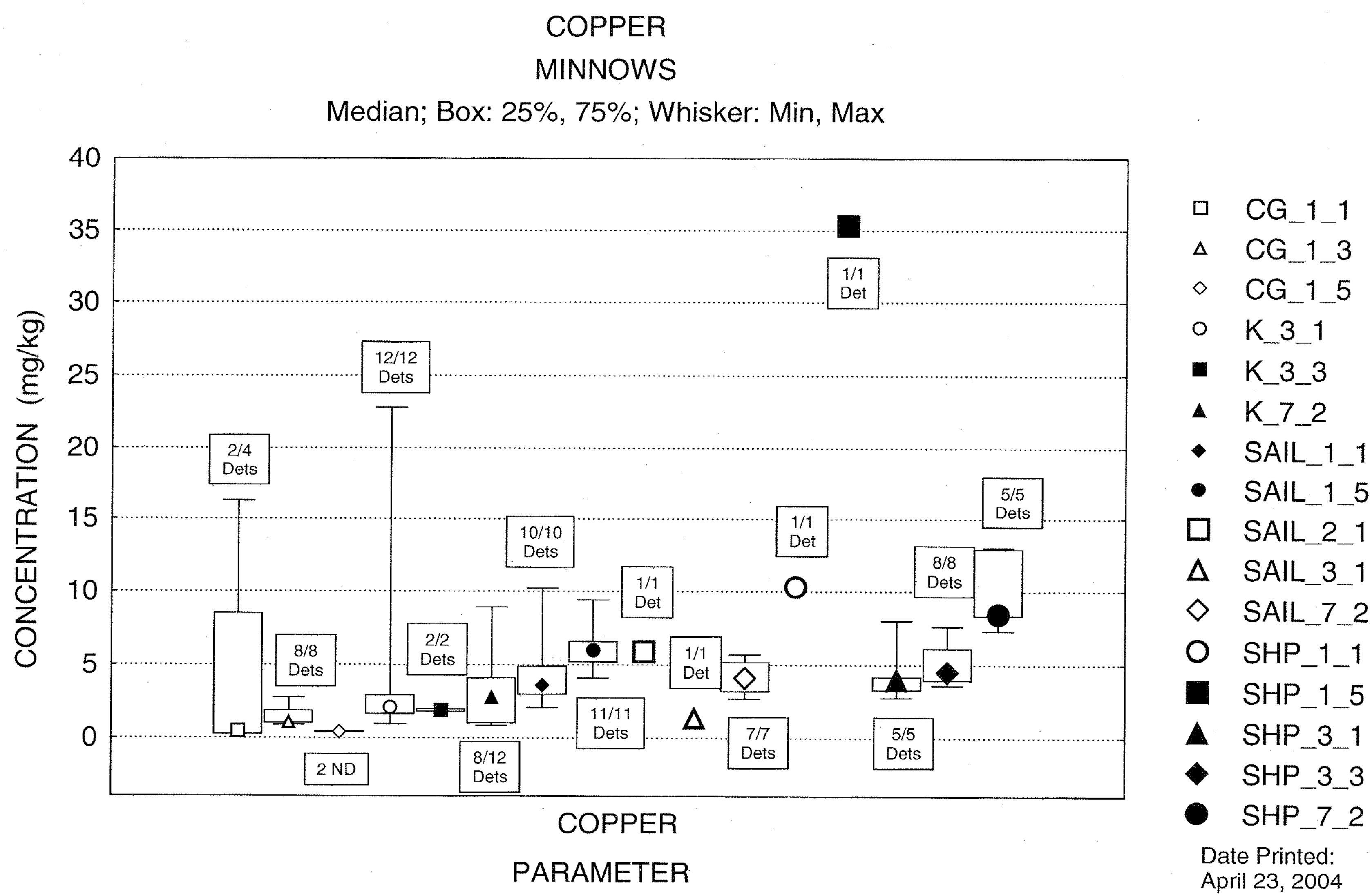


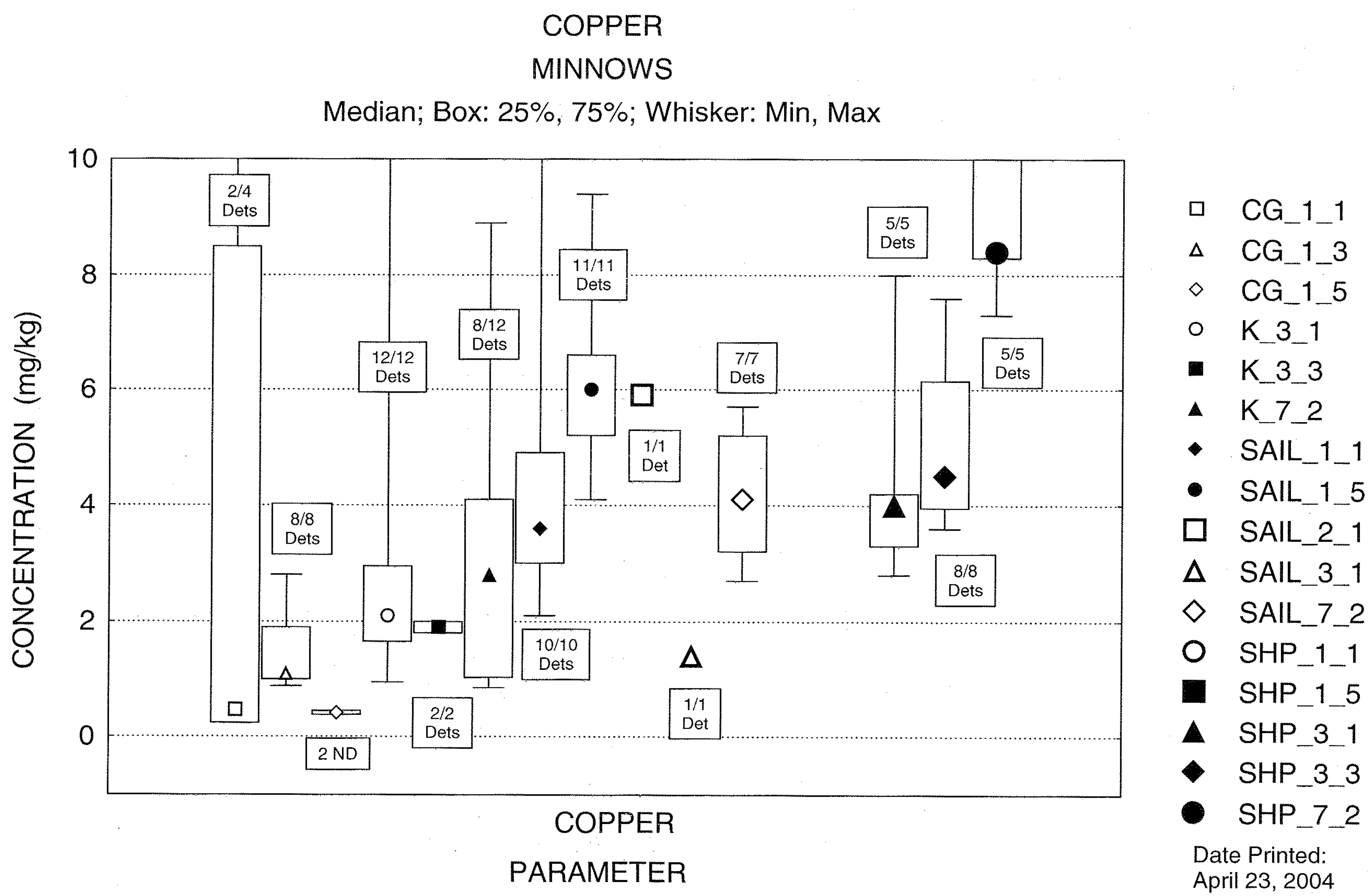
Date Printed:
April 23, 2004

COBALT
MINNOWS
Median; Box: 25%, 75%; Whisker: Min, Max

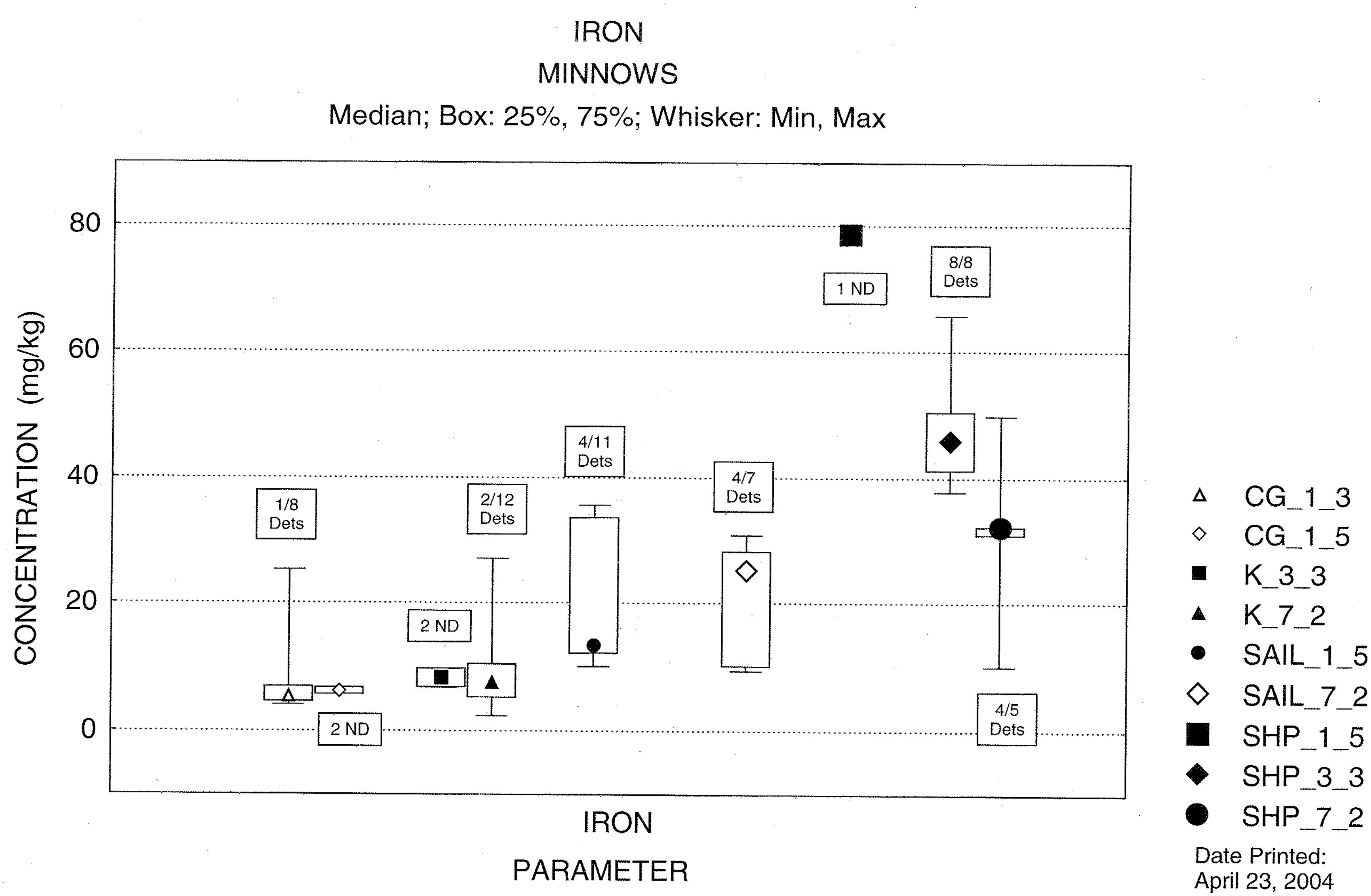


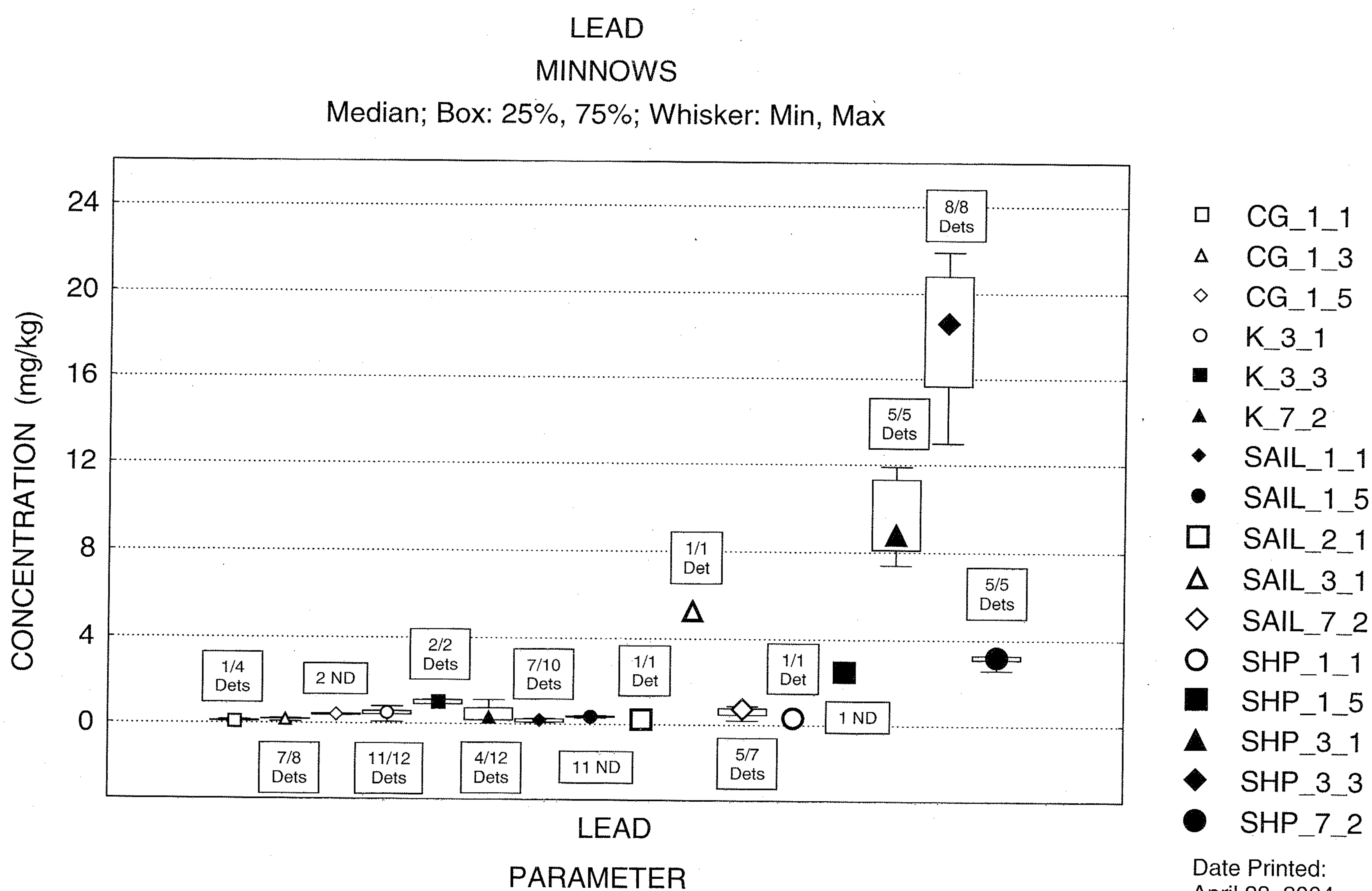
June 9, 2004


COPPER
MINNOWS
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (mg/kg)
40
35
30
25
20
15
10
5
0
2/4 Dets
8/8 Dets
2 ND
12/12 Dets
2/2 Dets
8/12 Dets
10/10 Dets
11/11 Dets
1/1 Det
1/1 Det
7/7 Dets
1/1 Det
1/1 Det
5/5 Dets
8/8 Dets
5/5 Dets
COPPER
PARAMETER
CG_1_1
CG_1_3
CG_1_5
K_3_1
K_3_3
K_7_2
SAIL_1_1
SAIL_1_5
SAIL_2_1
SAIL_3_1
SAIL_7_2
SHP_1_1
SHP_1_5
SHP_3_1
SHP_3_3
SHP_7_2
Date Printed:
April 23, 2004

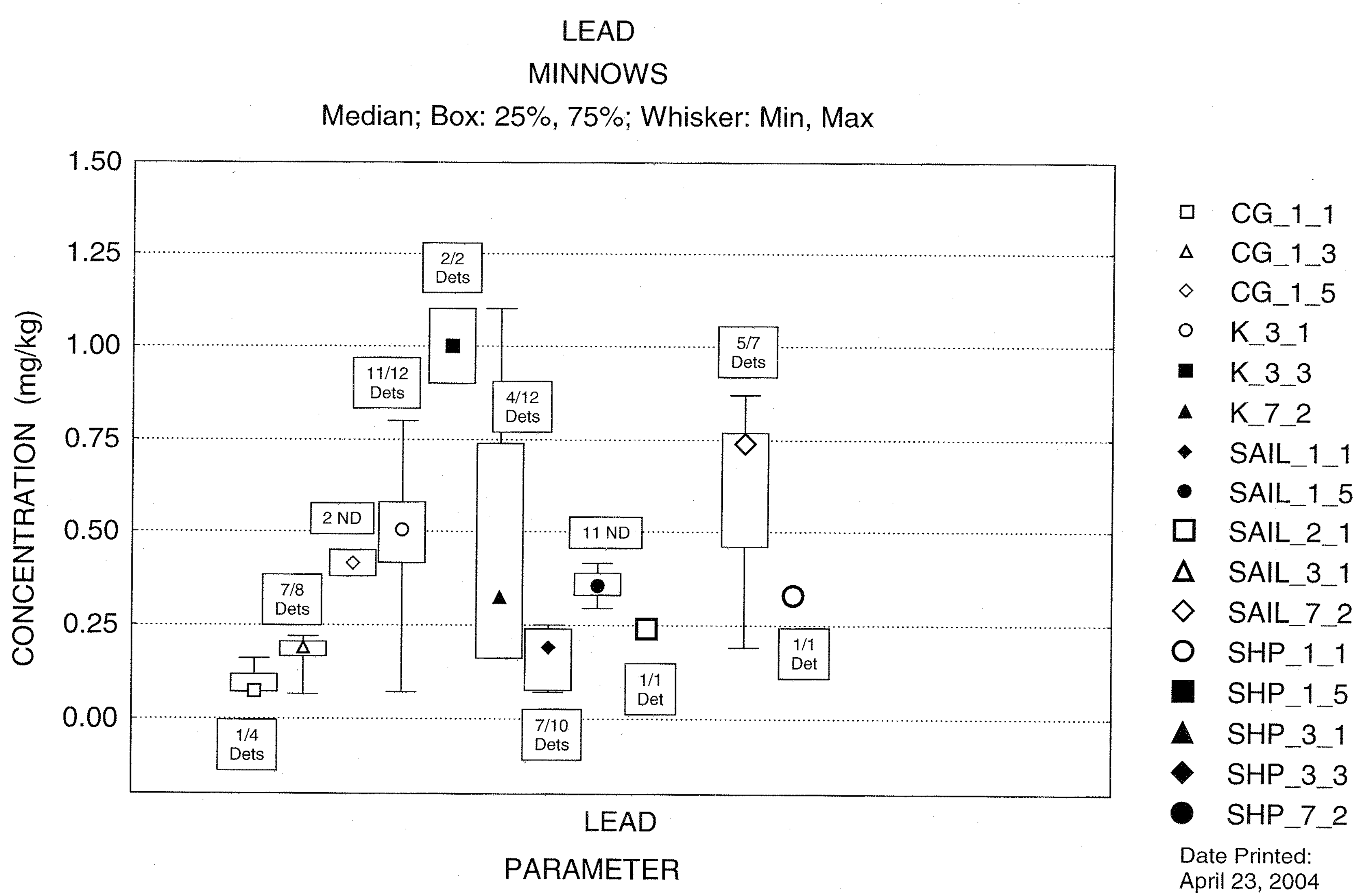


COPPER
MINNOWS
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (mg/kg)
10
8
6
4
2
0
2/4 Dets
8/8 Dets
2 ND
12/12 Dets
2/2 Dets
8/12 Dets
10/10 Dets
11/11 Dets
1/1 Det
1/1 Det
7/7 Dets
5/5 Dets
8/8 Dets
5/5 Dets
COPPER
PARAMETER
CG_1_1
CG_1_3
CG_1_5
K_3_1
K_3_3
K_7_2
SAIL_1_1
SAIL_1_5
SAIL_2_1
SAIL_3_1
SAIL_7_2
SHP_1_1
SHP_1_5
SHP_3_1
SHP_3_3
SHP_7_2
Date Printed:
April 23, 2004


IRON
MINNOWS
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (mg/kg)
80
60
40
20
0
1/8 Dets
2 ND
2 ND
2/12 Dets
4/11 Dets
4/7 Dets
1 ND
8/8 Dets
4/5 Dets
IRON
PARAMETER
CG_1_3
CG_1_5
K_3_3
K_7_2
SAIL_1_5
SAIL_7_2
SHP_1_5
SHP_3_3
SHP_7_2
Date Printed:
April 23, 2004



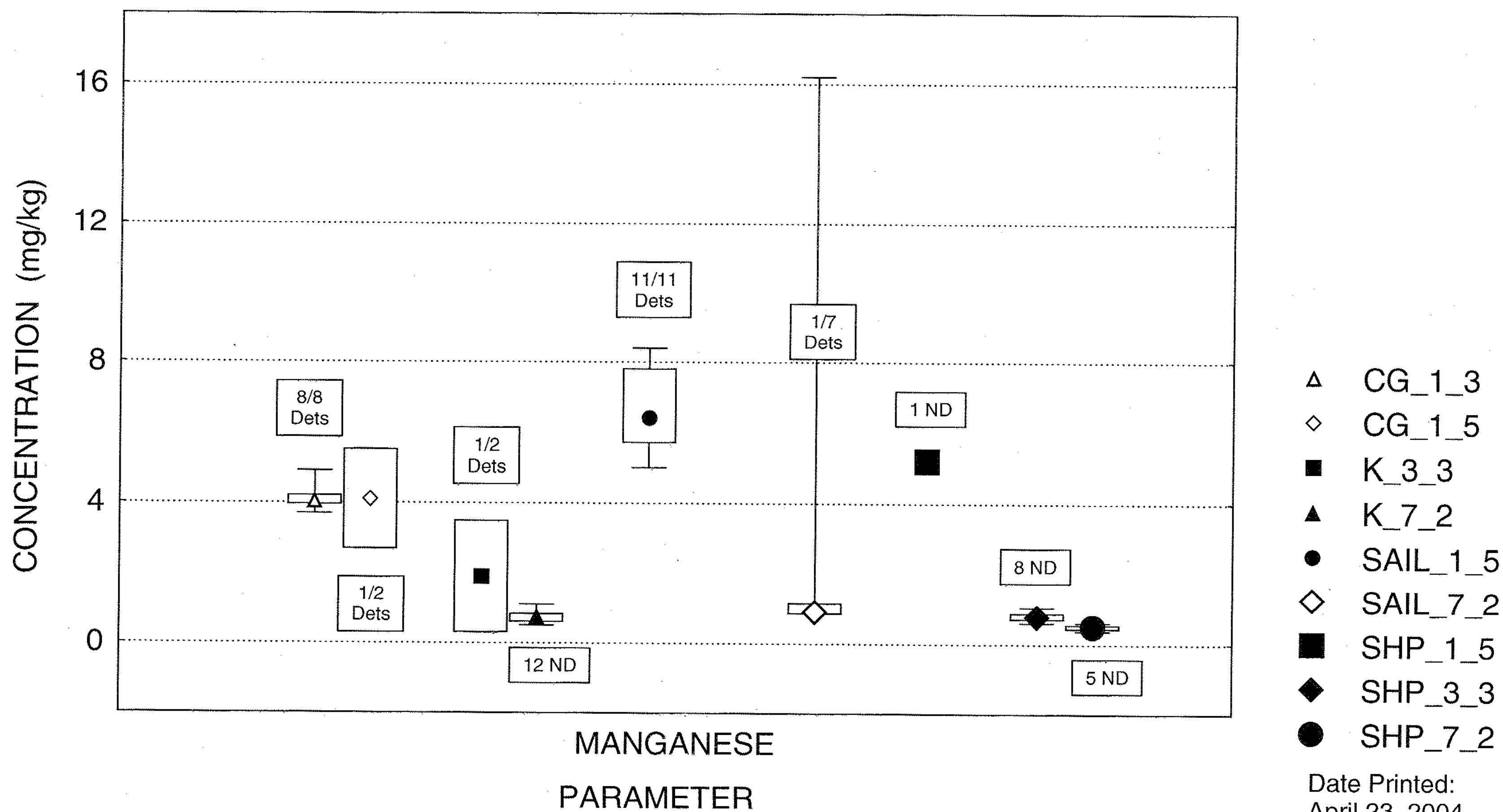
Date Printed:
April 23, 2004


LEAD
MINNOWS
Median; Box: 25%, 75%; Whisker: Min, Max
1.50
1.25
1.00
0.75
0.50
0.25
0.00
CONCENTRATION (mg/kg)
2/2 Dets
11/12 Dets
4/12 Dets
5/7 Dets
2 ND
11 ND
7/8 Dets
1/4 Dets
7/10 Dets
1/1 Det
1/1 Det
LEAD
PARAMETER
CG_1_1
CG_1_3
CG_1_5
K_3_1
K_3_3
K_7_2
SAIL_1_1
SAIL_1_5
SAIL_2_1
SAIL_3_1
SAIL_7_2
SHP_1_1
SHP_1_5
SHP_3_1
SHP_3_3
SHP_7_2
Date Printed:
April 23, 2004

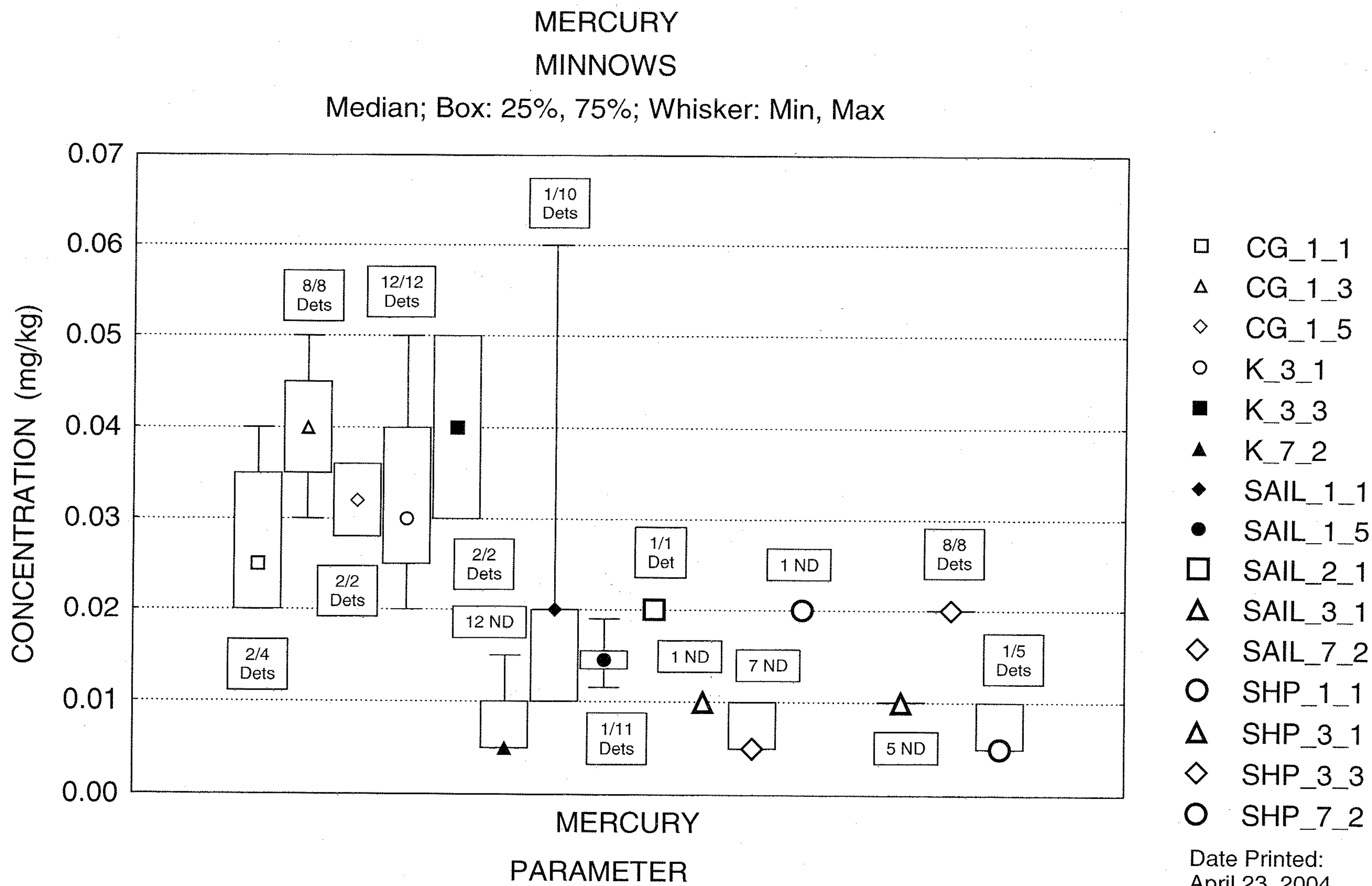
MANGANESE

MINNOWS

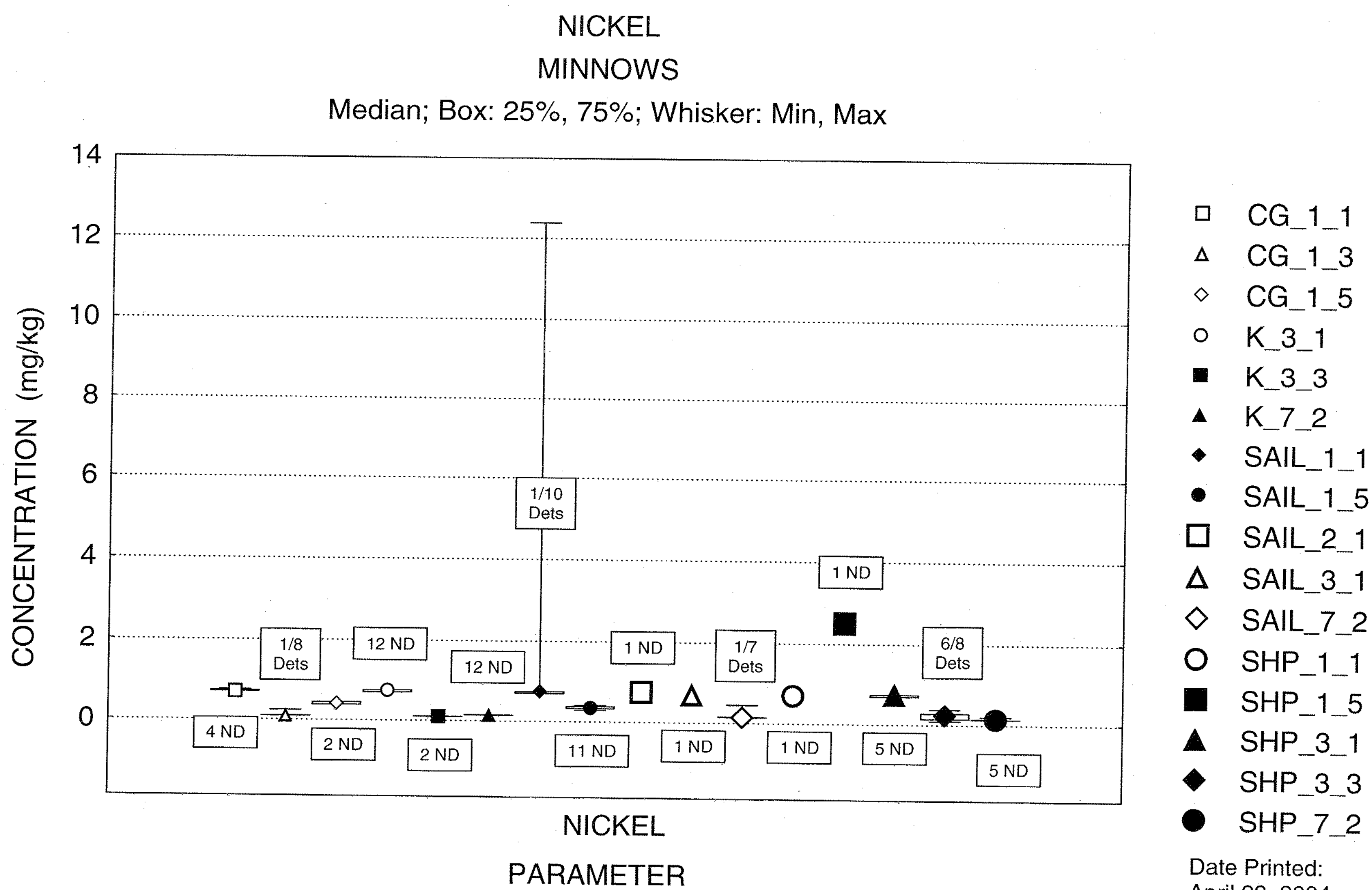
Median; Box: 25%, 75%; Whisker: Min, Max



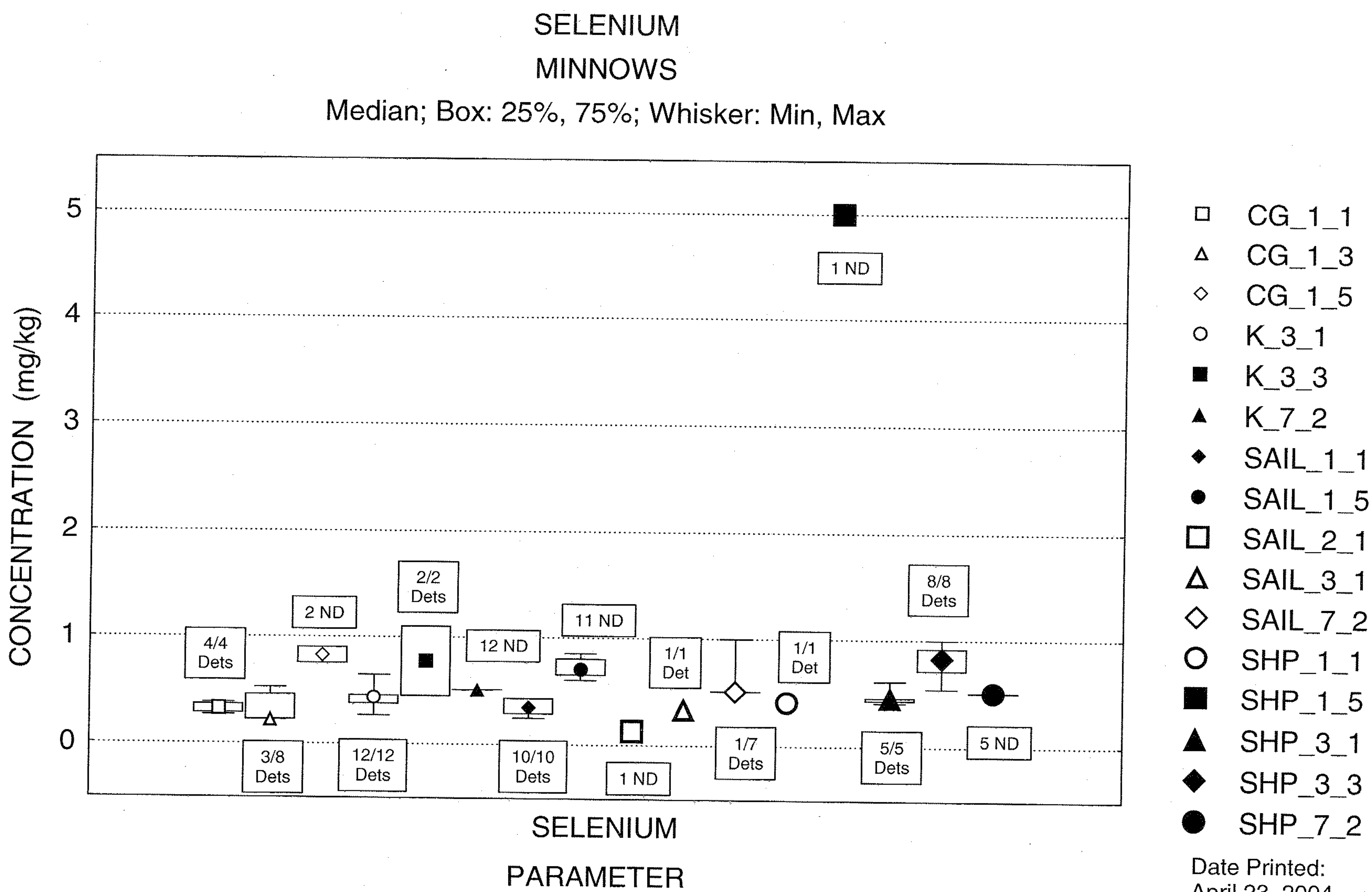
Date Printed:
April 23, 2004



Date Printed:
April 23, 2004



Date Printed:
April 23, 2004



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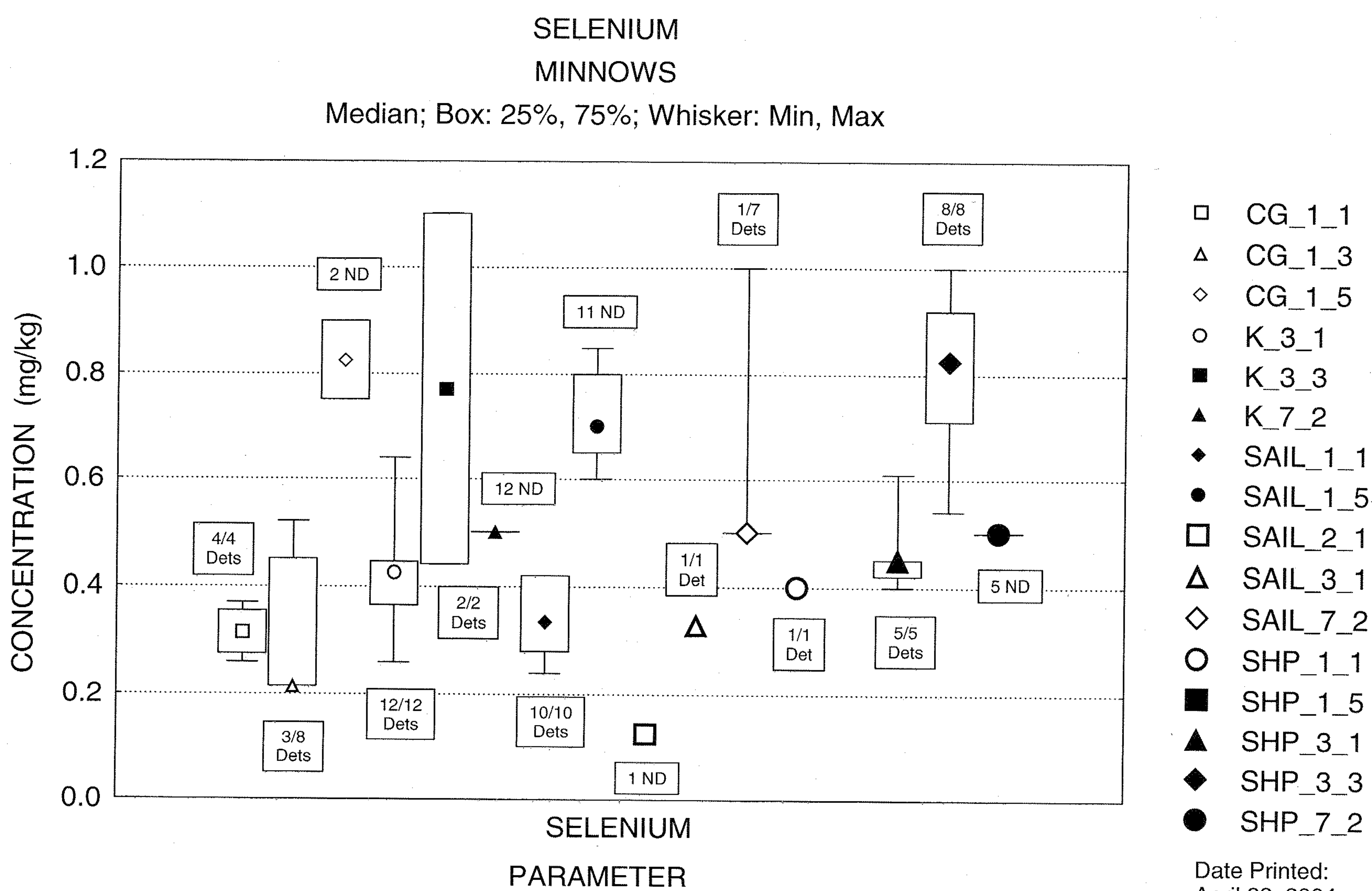
April 23, 2004



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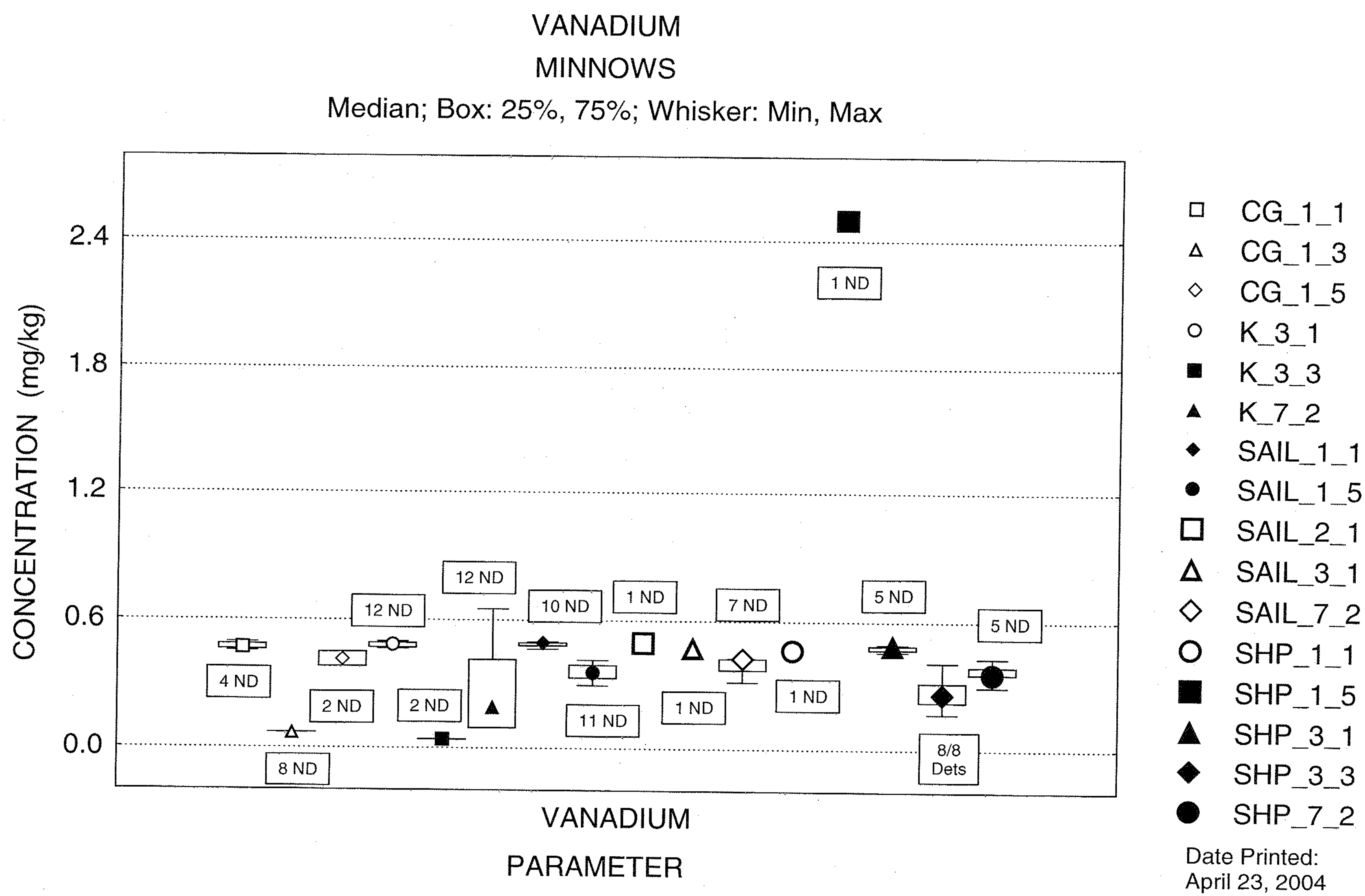
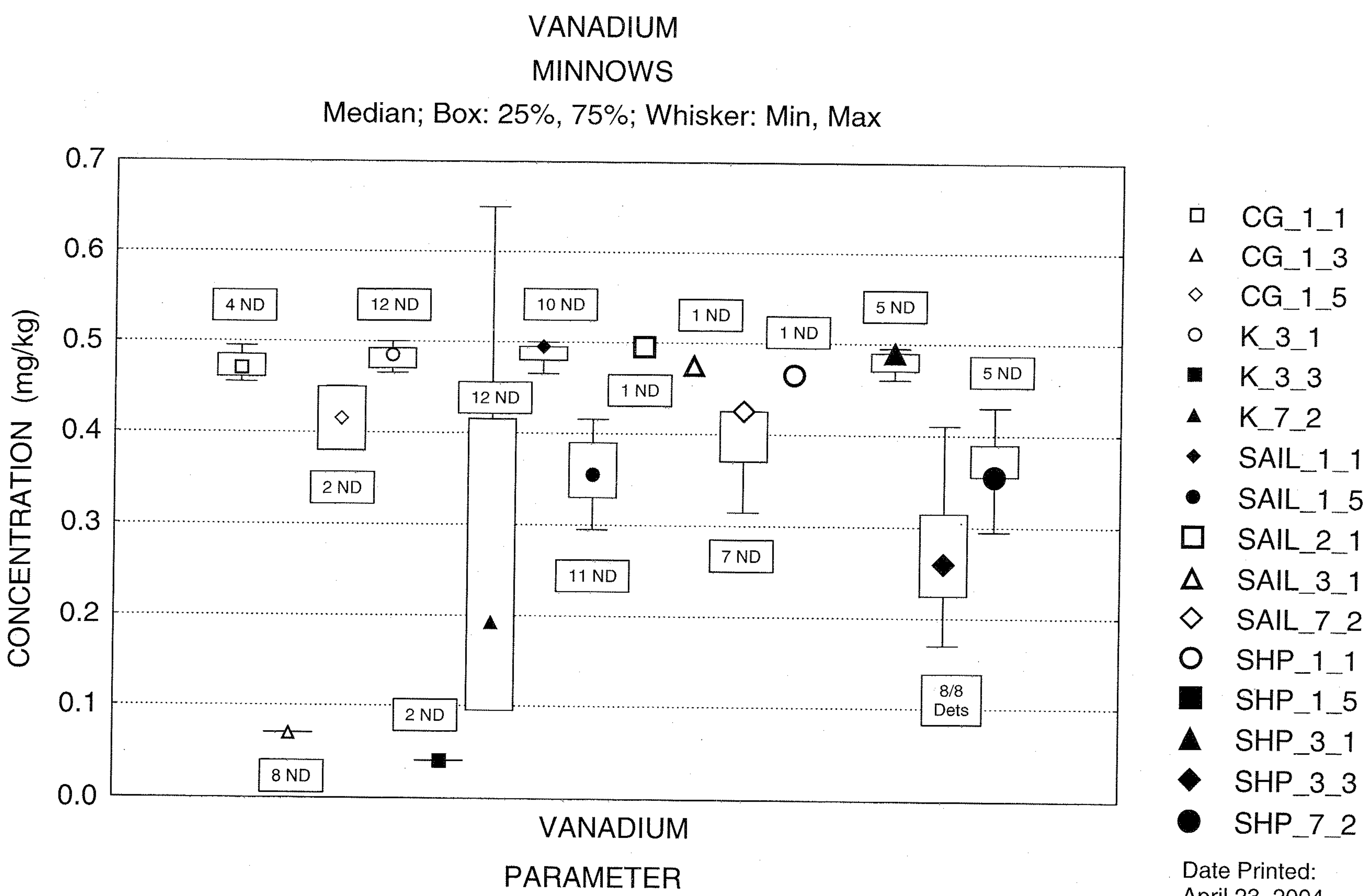
SILVER
MINNOWS
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (mg/kg)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1 ND
4 ND
12 ND
10 ND
1 ND
1/7 Dets
5 ND
8 ND
1 ND
1 ND
11 ND
2 ND
2 ND
12 ND
8 ND
5 ND
SILVER
PARAMETER
CG_1_1
CG_1_3
CG_1_5
K_3_1
K_3_3
K_7_2
SAIL_1_1
SAIL_1_5
SAIL_2_1
SAIL_3_1
SAIL_7_2
SHP_1_1
SHP_1_5
SHP_3_1
SHP_3_3
SHP_7_2
Date Printed:
April 23, 2004

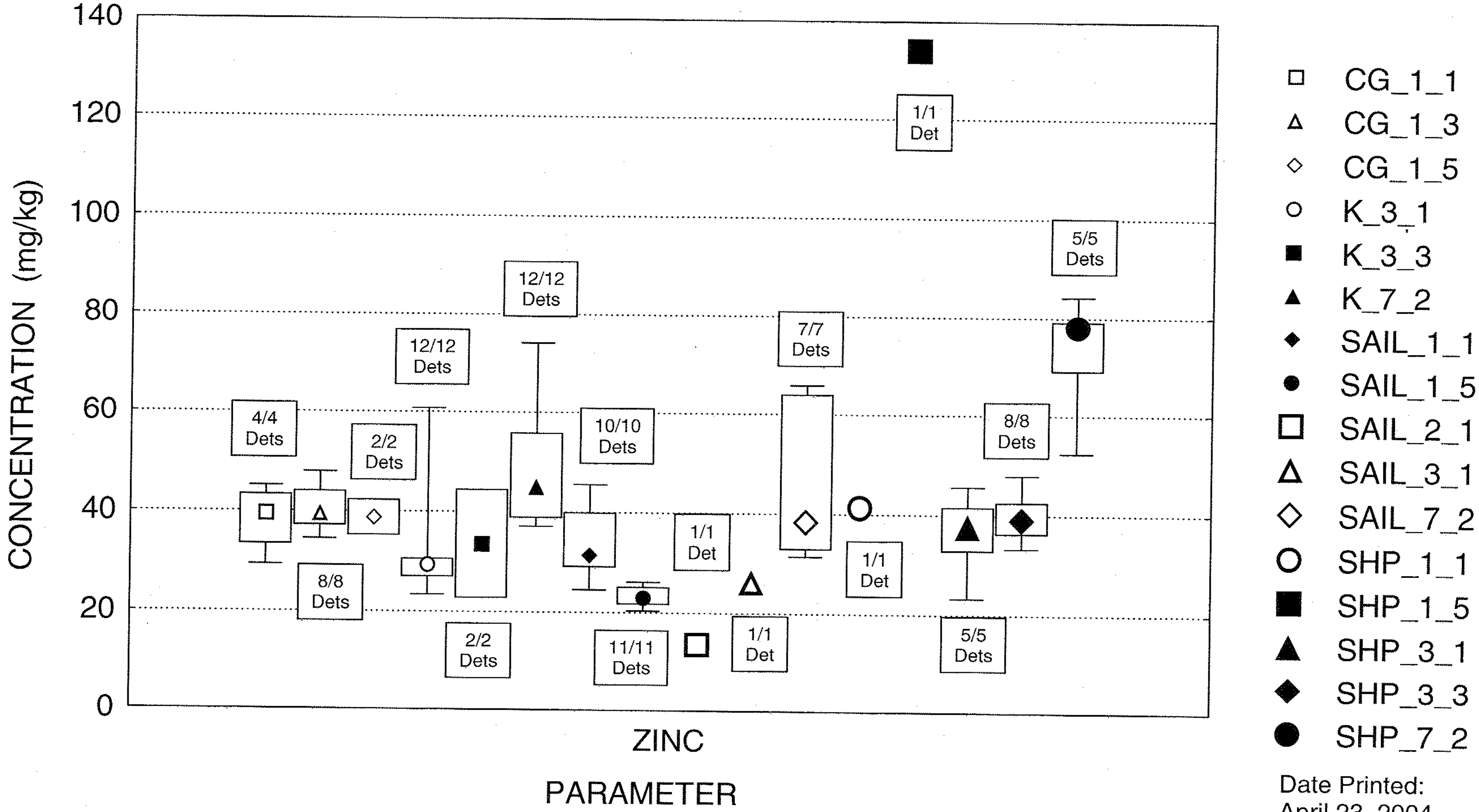


Date Printed:
April 23, 2004



Date Printed:
April 23, 2004

ZINC
MINNOWS
Median; Box: 25%, 75%; Whisker: Min, Max



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APPENDIX B.A-2

STATISTICAL BOX AND WHISKER PLOTS
TURTLE GRASS DATA SET

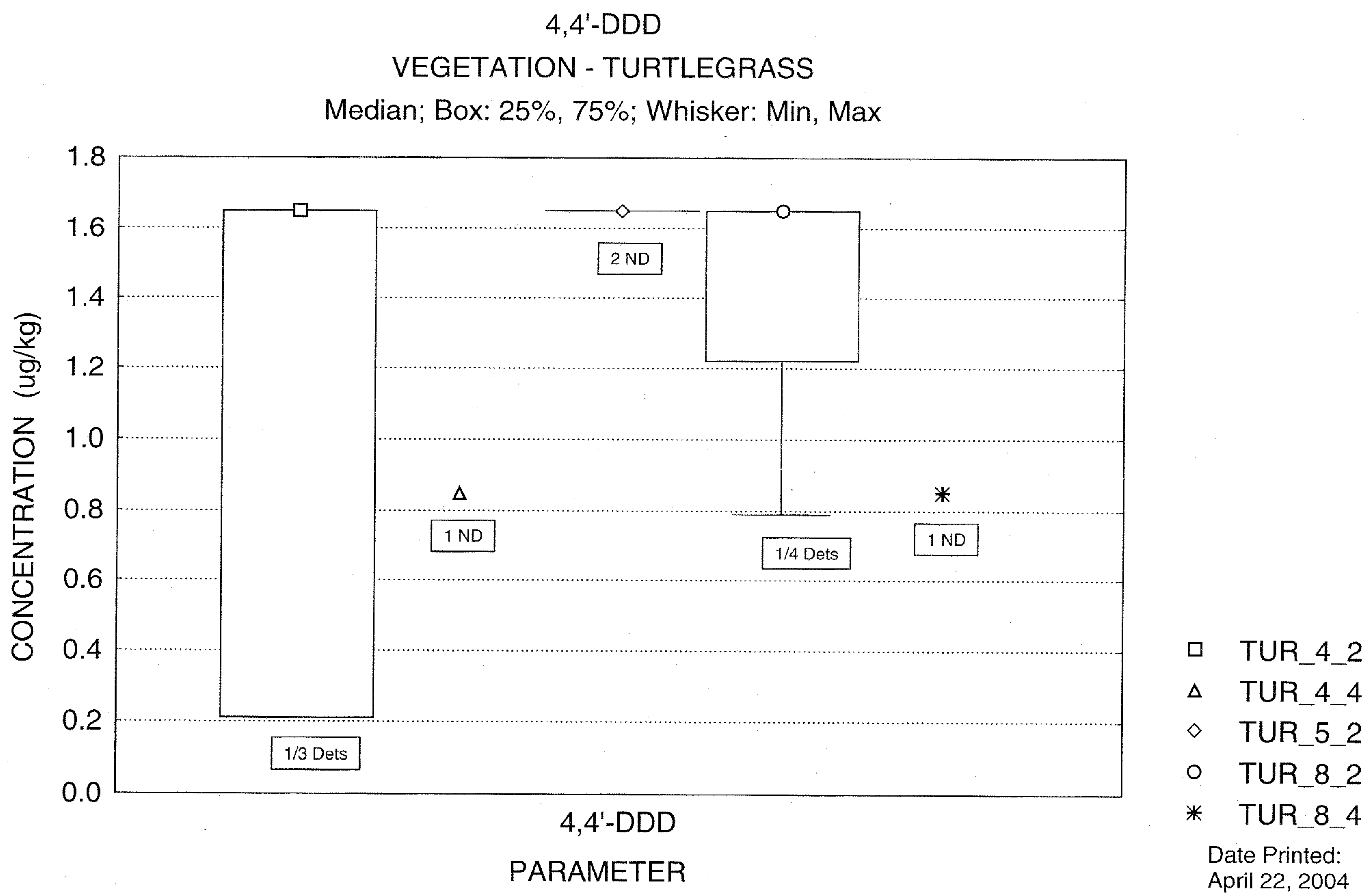
STATISTICAL BOX AND WHISKER PLOTS – TURTLE GRASS DATA SET

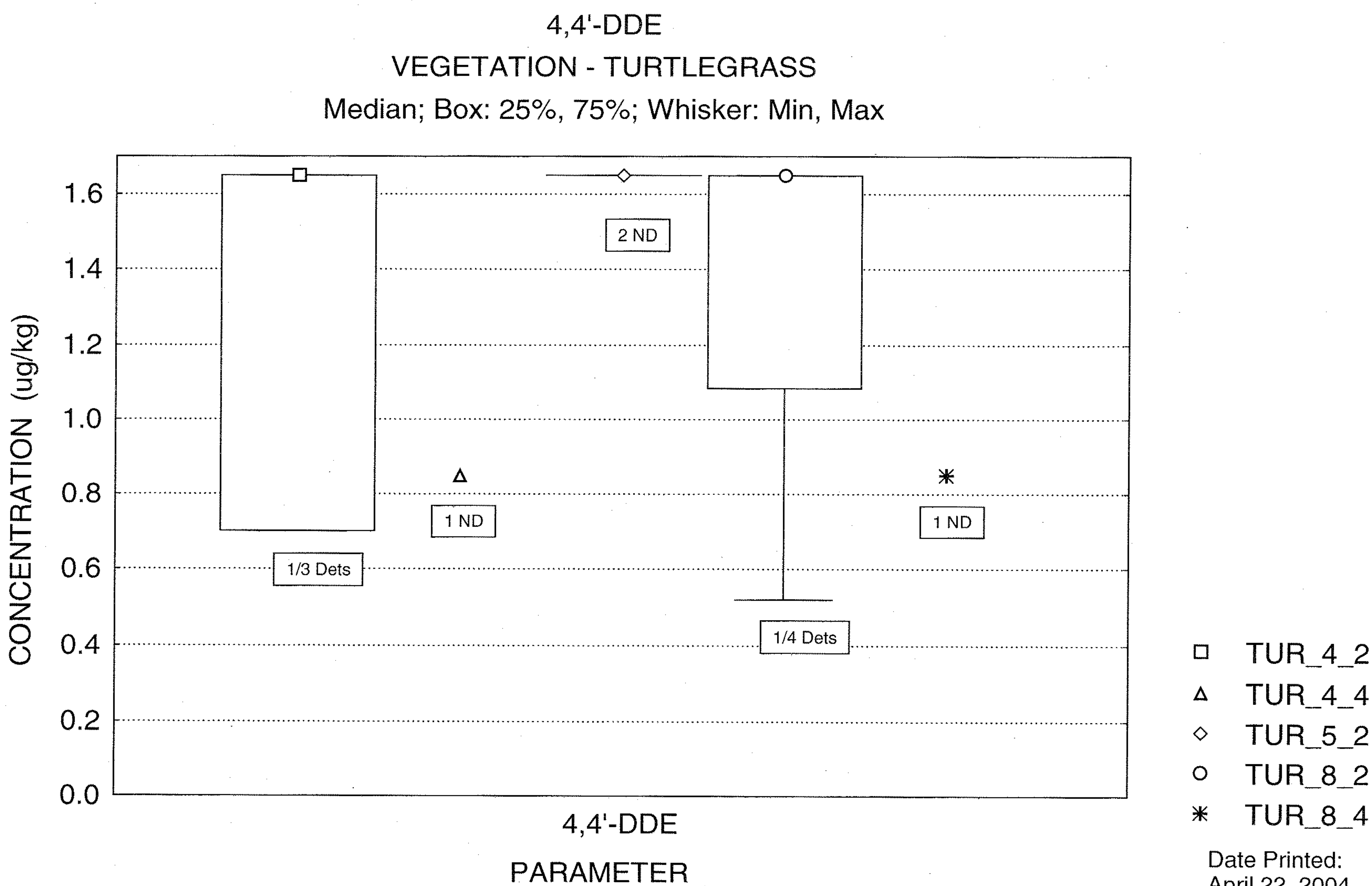
The turtle grass data set represents a single species (*Thalassia testudinum*) collected at three locations (BG 4, BG 5, and BG 8) in two sampling rounds (rounds 2 and 4). The different combinations of location and round resulted in five "sampling events" for turtle grass data (Table A-2). Box and whisker plots were utilized to provide a graphical representation of concentrations of analytes detected in each sampling event. A description of how to interpret the plots was provided at the beginning of Appendix B.A-1.

TABLE A-2

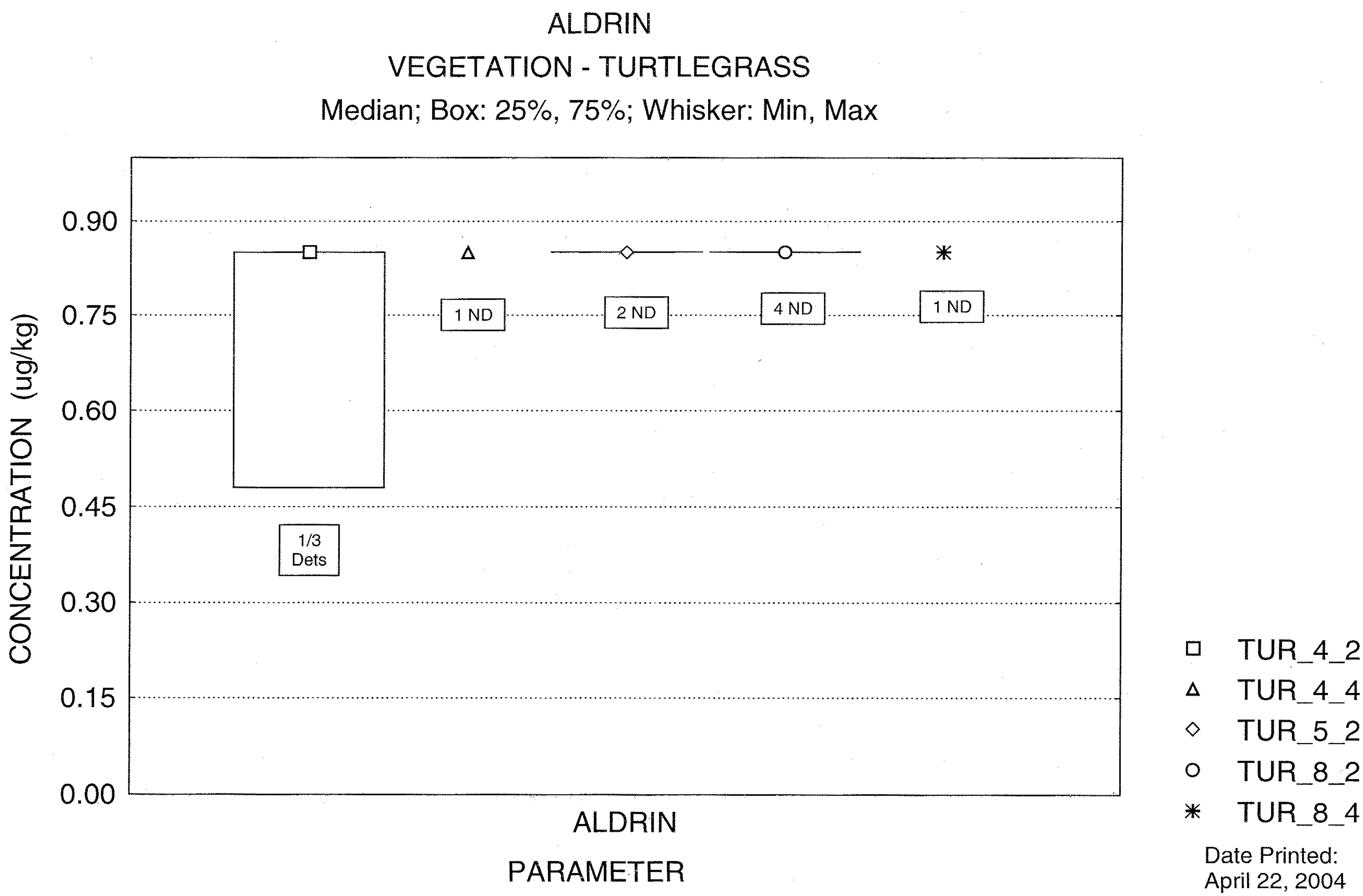
BACKGROUND TURTLE GRASS SAMPLING EVENTS

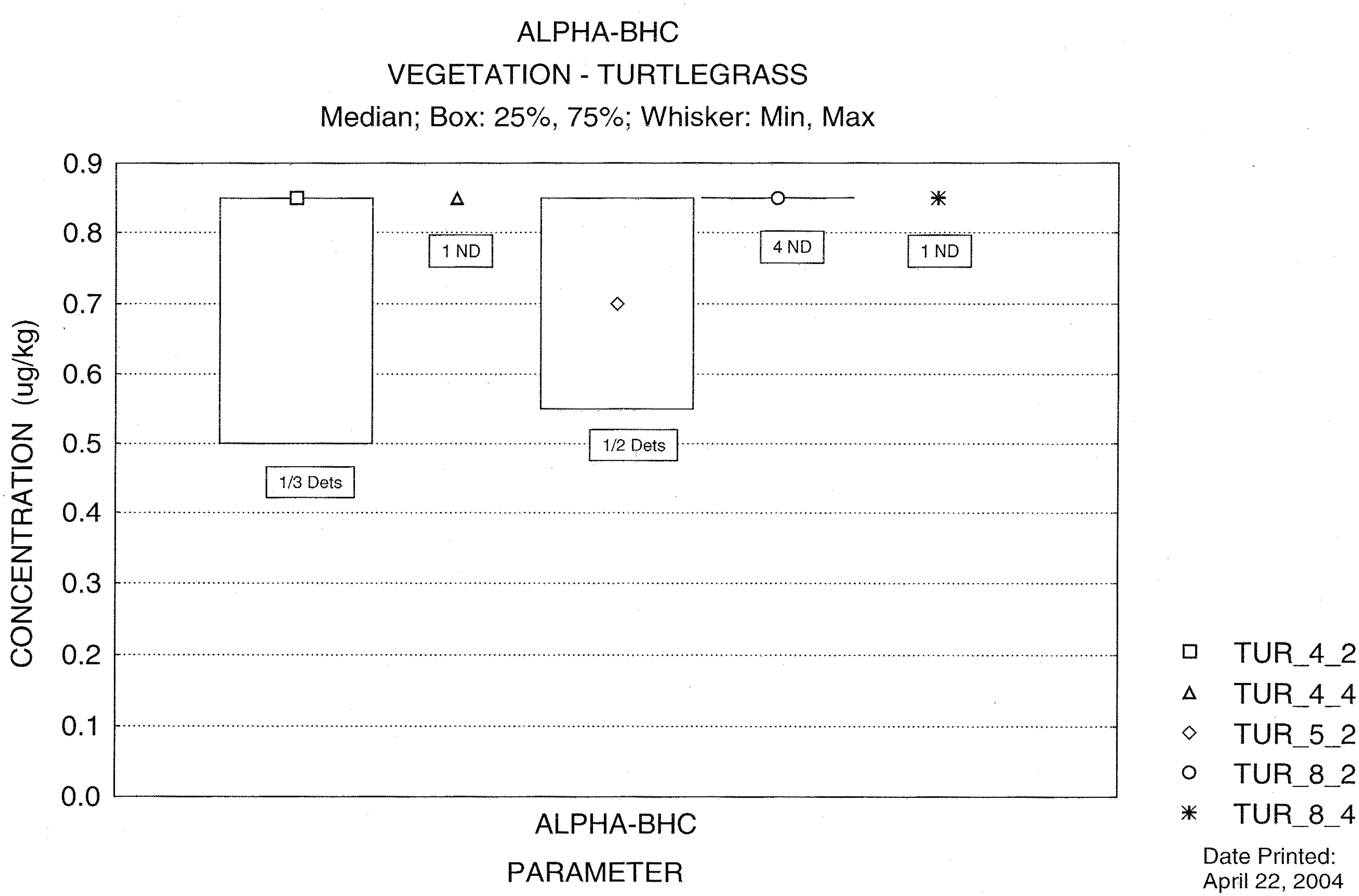
Event	Event Description
TUR_4_2	Turtle Grass, BG 4, Round 2
TUR_4_4	Turtle Grass, BG 4, Round 4
TUR_5_2	Turtle Grass, BG 5, Round 2
TUR_8_2	Turtle Grass, BG 8, Round 2
TUR_8_4	Turtle Grass, BG 8, Round 4


4,4'-DDD
VEGETATION - TURTLEGRASS
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (ug/kg)
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
2 ND
1 ND
1/4 Dets
1 ND
1/3 Dets
4,4'-DDD
PARAMETER
TUR_4_2
TUR_4_4
TUR_5_2
TUR_8_2
TUR_8_4
Date Printed:
April 22, 2004

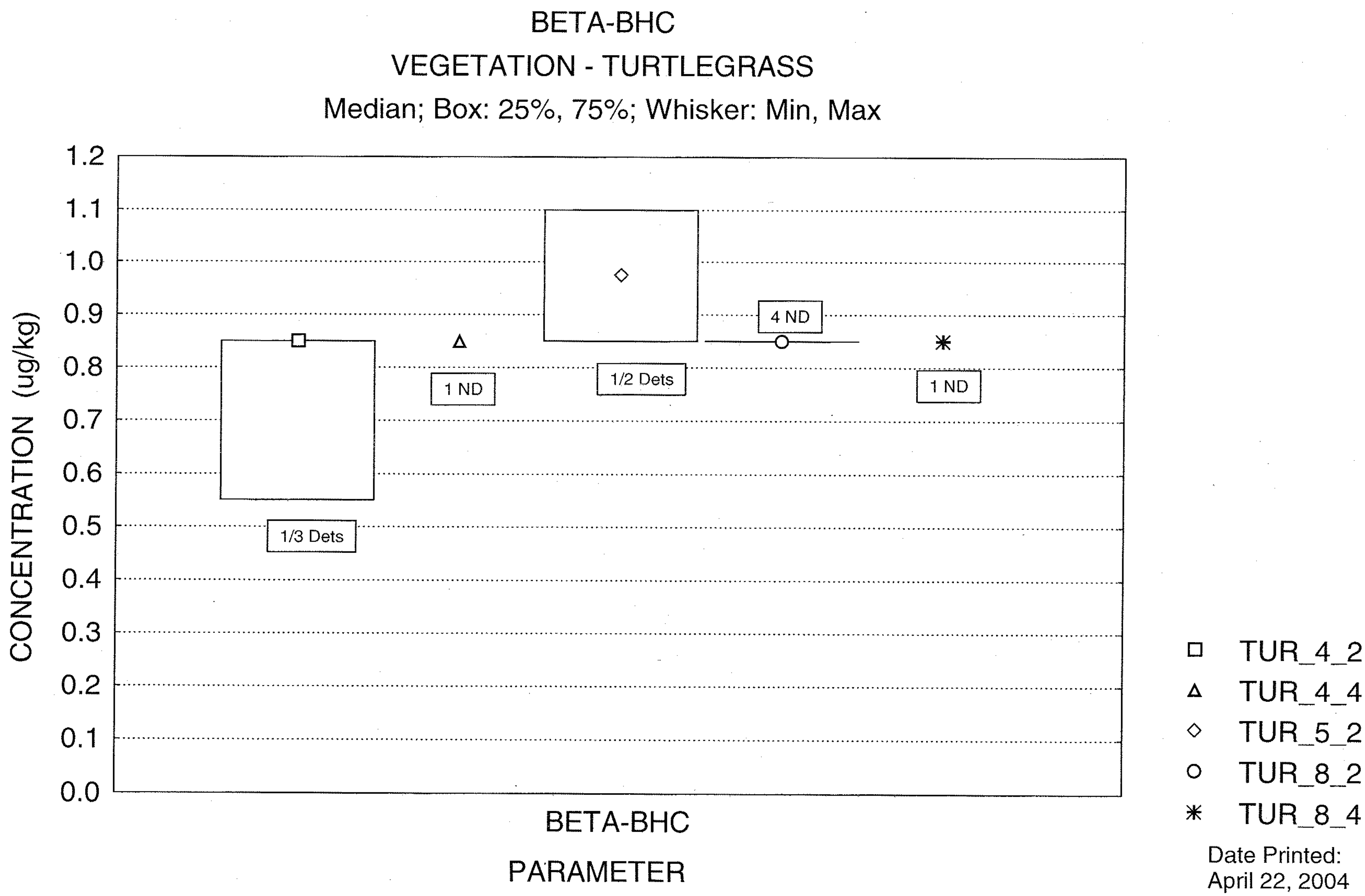


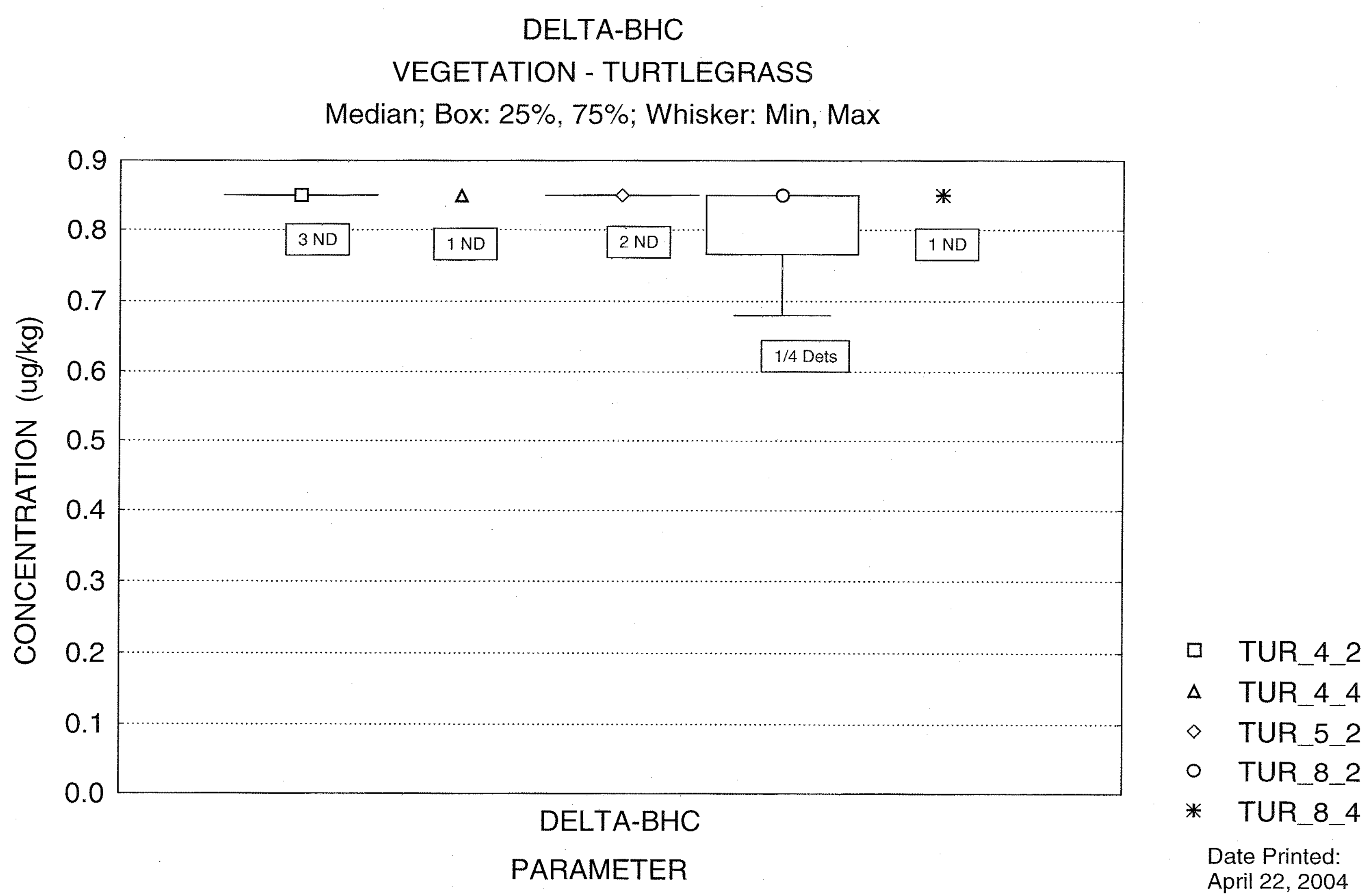
Date Printed:
April 22, 2004

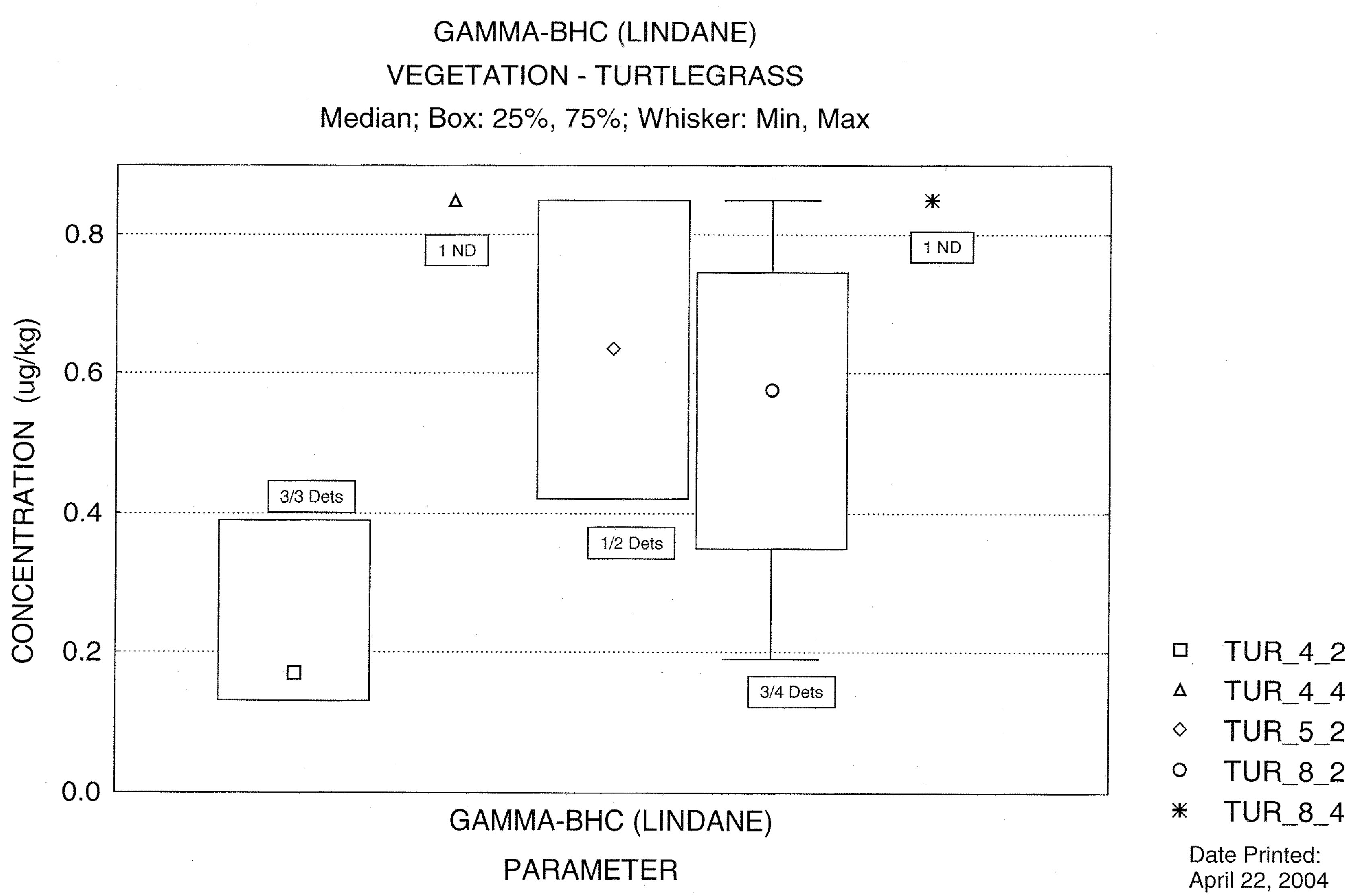

ALDRIN
VEGETATION - TURTLEGRASS
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (ug/kg)
0.90
0.75
0.60
0.45
0.30
0.15
0.00
1/3 Dets
1 ND
2 ND
4 ND
1 ND
ALDRIN
PARAMETER
TUR_4_2
TUR_4_4
TUR_5_2
TUR_8_2
TUR_8_4
Date Printed:
April 22, 2004



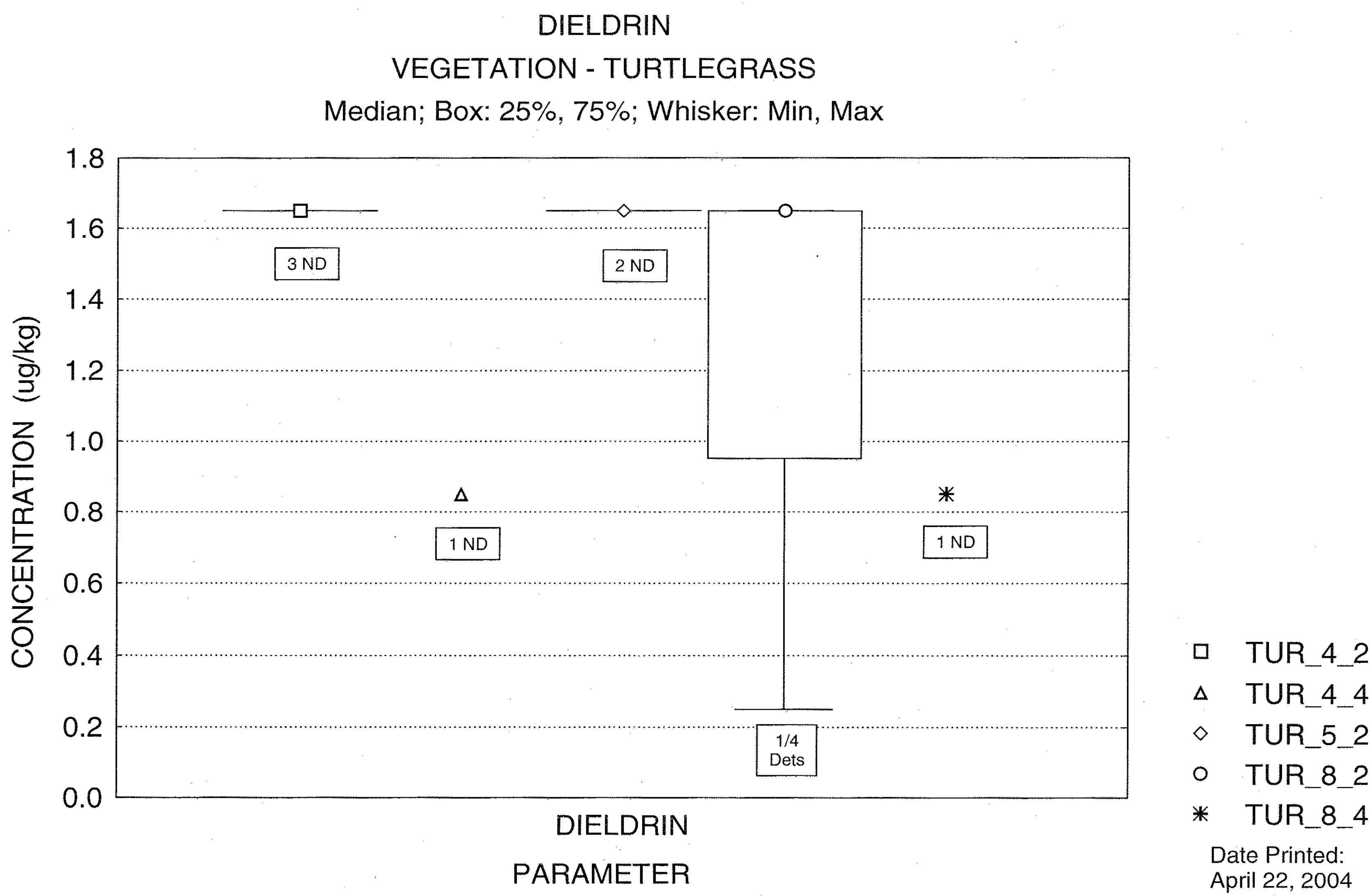
Date Printed:
April 22, 2004


BETA-BHC
VEGETATION - TURTLEGRASS
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (ug/kg)
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1/3 Dets
1 ND
1/2 Dets
4 ND
1 ND
BETA-BHC
PARAMETER
TUR_4_2
TUR_4_4
TUR_5_2
TUR_8_2
TUR_8_4
Date Printed:
April 22, 2004

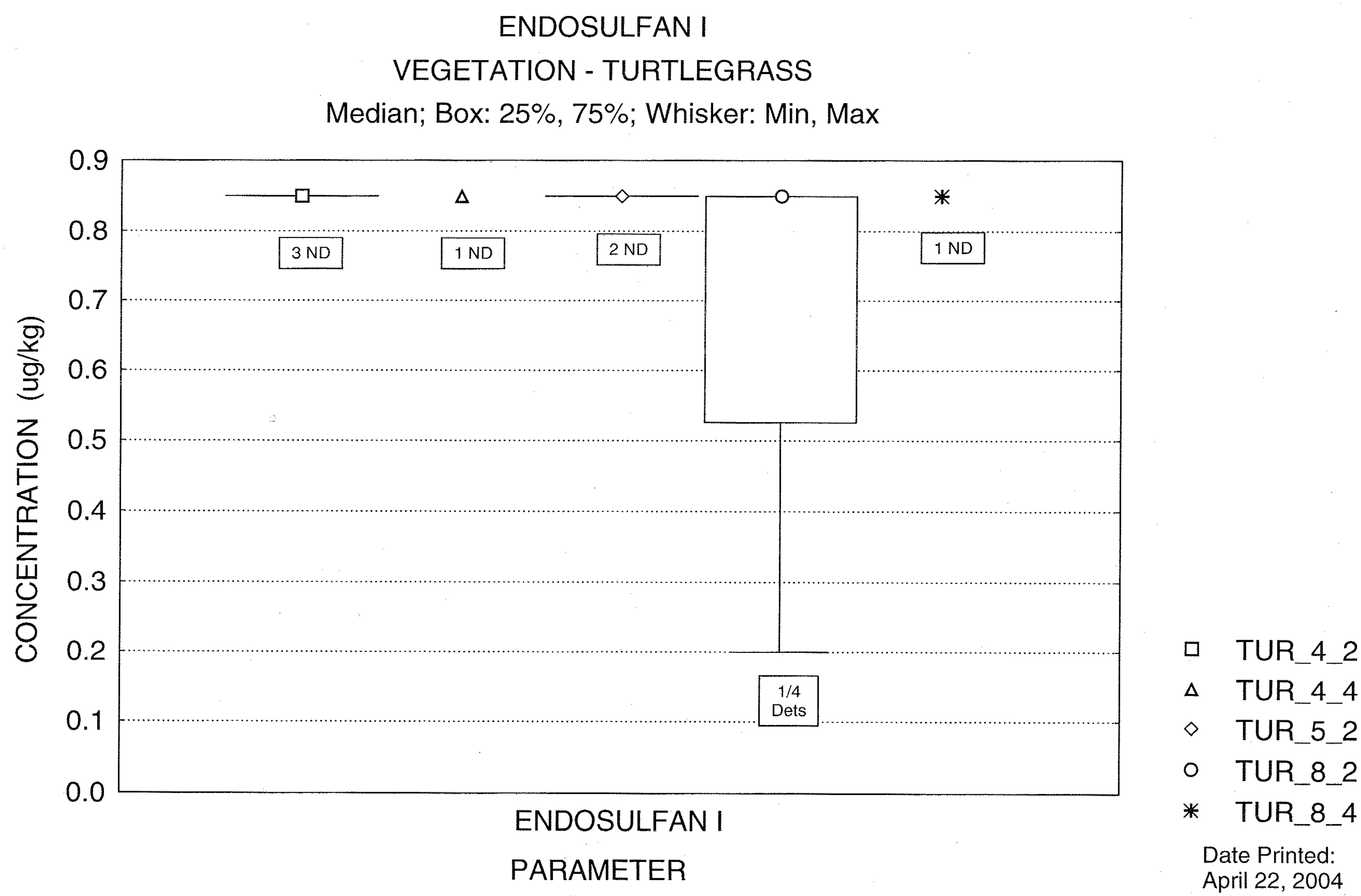

DELTA-BHC
VEGETATION - TURTLEGRASS
Median; Box: 25%, 75%; Whisker: Min, Max
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
CONCENTRATION (ug/kg)
3 ND
1 ND
2 ND
1/4 Dets
1 ND
DELTA-BHC
PARAMETER
TUR_4_2
TUR_4_4
TUR_5_2
TUR_8_2
TUR_8_4
Date Printed:
April 22, 2004



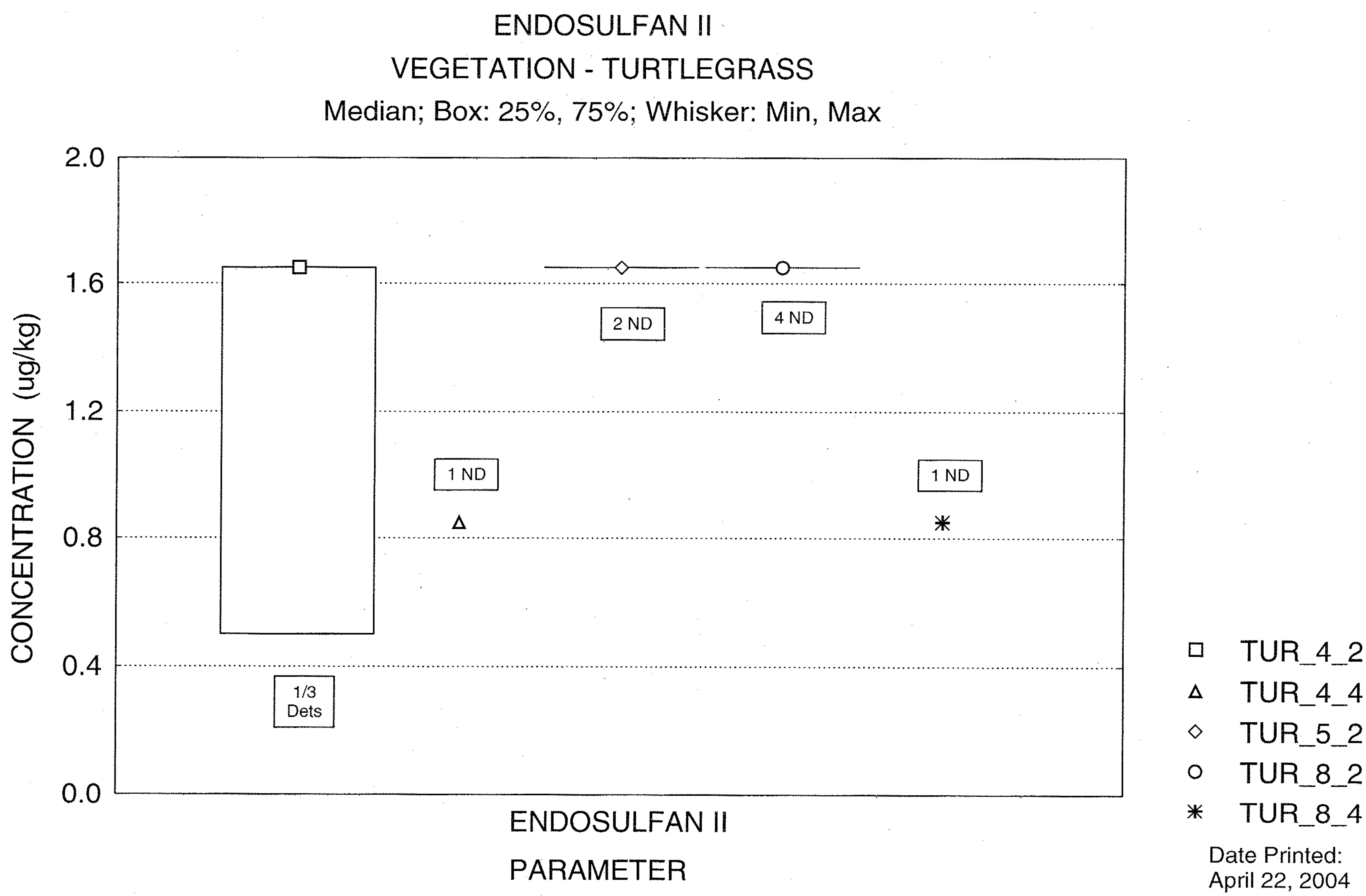
Date Printed:
April 22, 2004

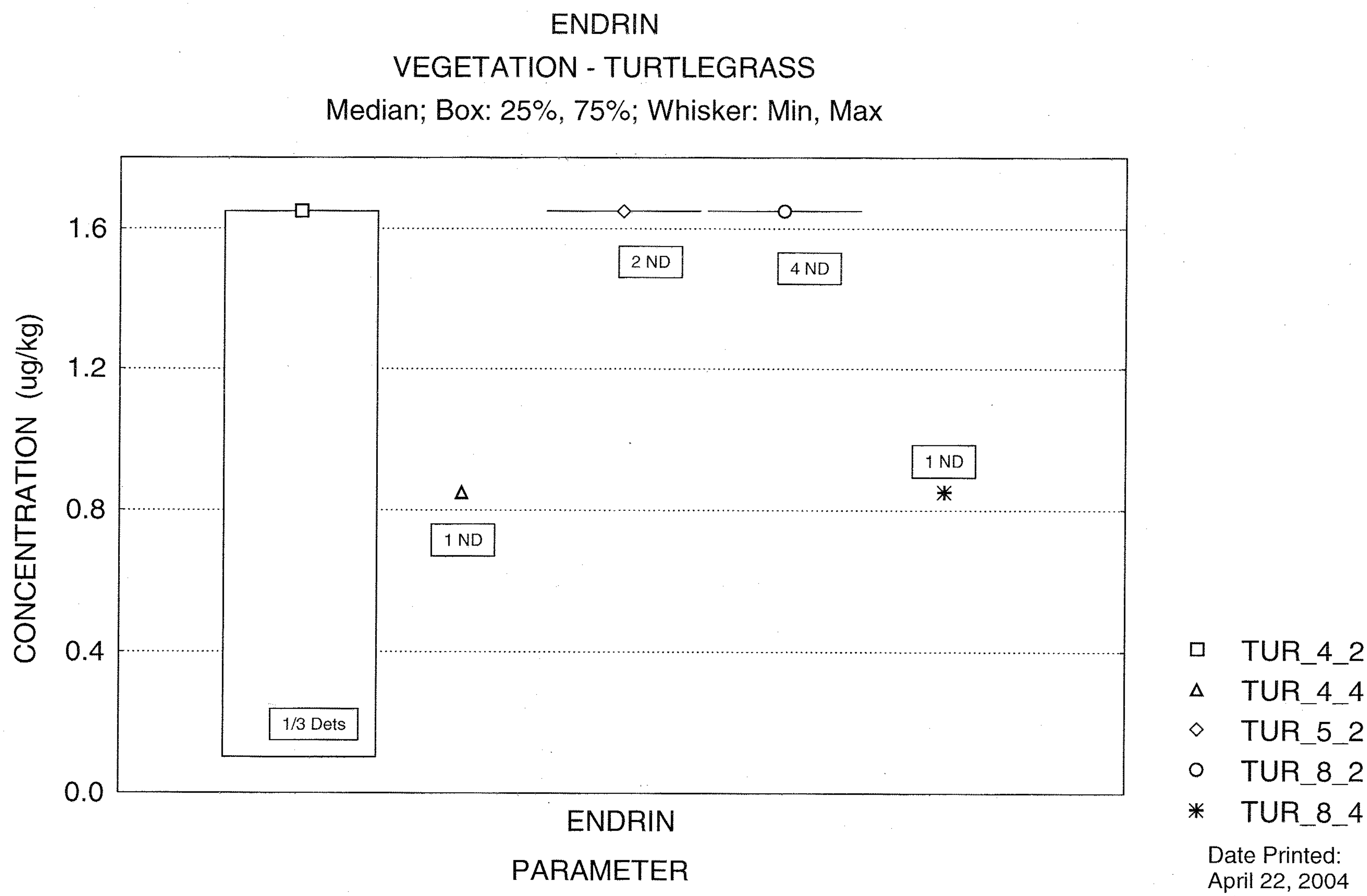


DIELDRIN
VEGETATION - TURTLEGRASS
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (ug/kg)
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
3 ND
2 ND
1 ND
1 ND
1/4 Dets
DIELDRIN
PARAMETER
TUR_4_2
TUR_4_4
TUR_5_2
TUR_8_2
TUR_8_4
Date Printed: April 22, 2004



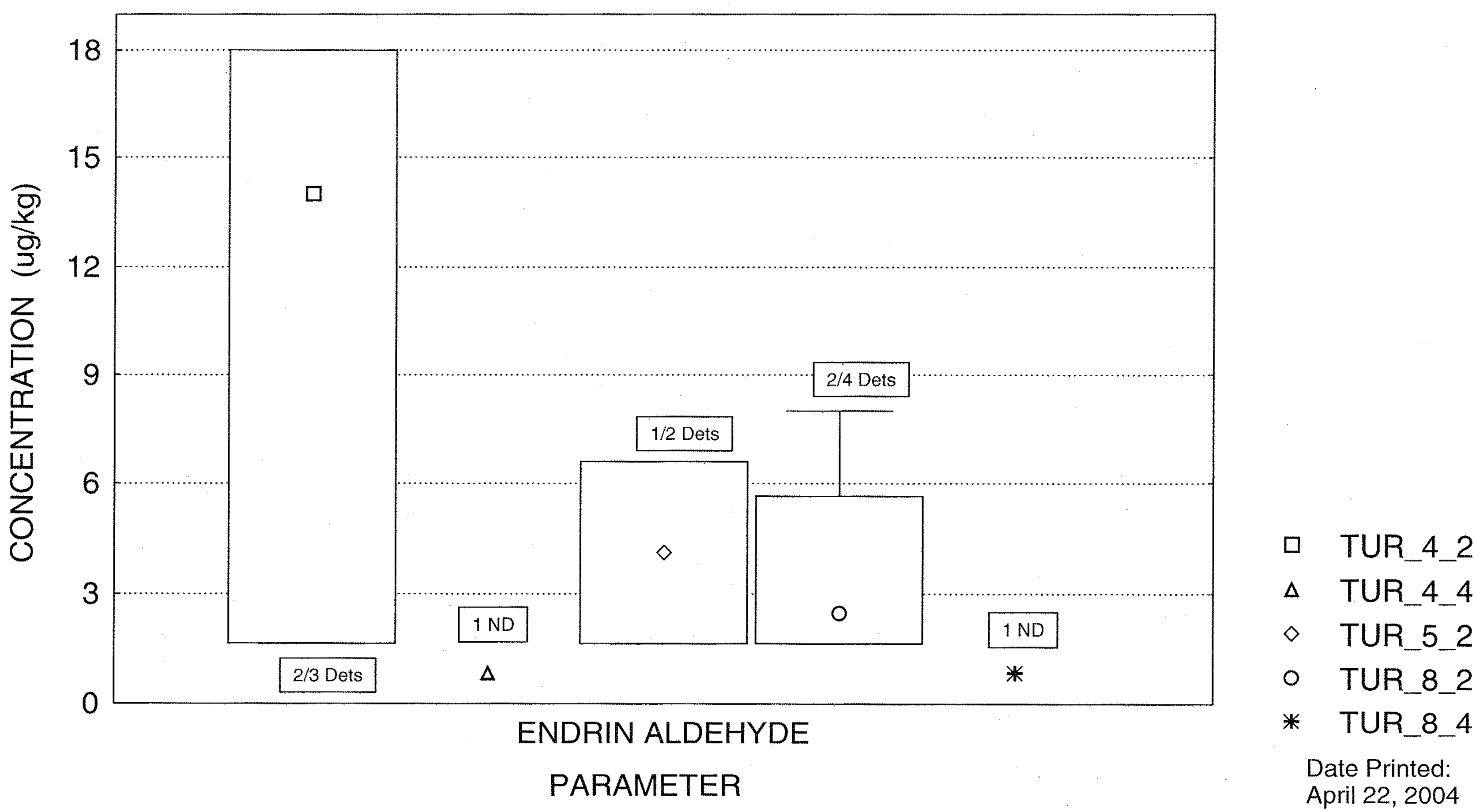
ENDOSULFAN I
VEGETATION - TURTLEGRASS
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (ug/kg)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
3 ND
1 ND
2 ND
1 ND
1/4 Dets
ENDOSULFAN I
PARAMETER
TUR_4_2
TUR_4_4
TUR_5_2
TUR_8_2
TUR_8_4
Date Printed: April 22, 2004

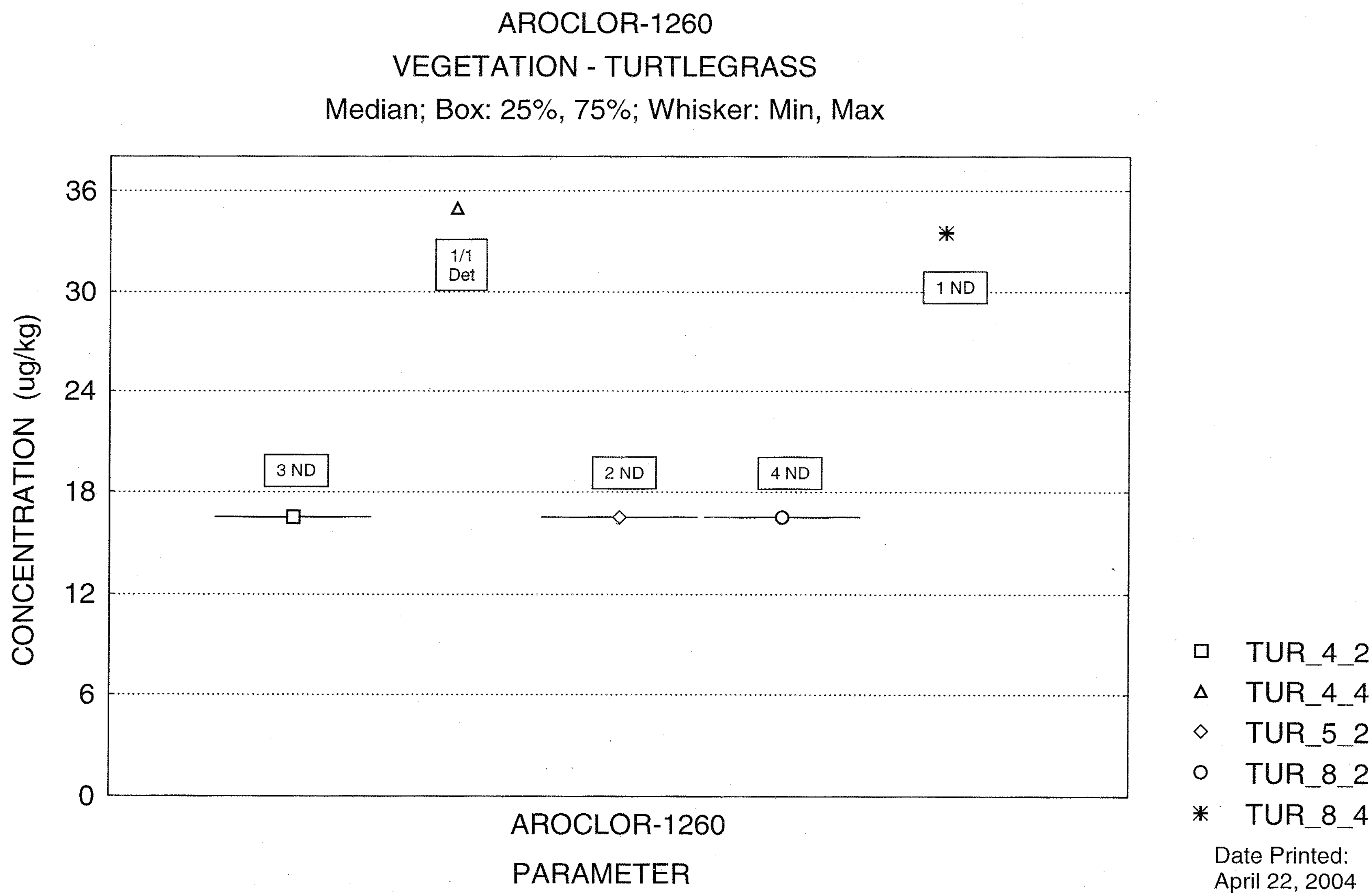

ENDOSULFAN II
VEGETATION - TURTLEGRASS
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (ug/kg)
2.0
1.6
1.2
0.8
0.4
0.0
1/3 Dets
1 ND
2 ND
4 ND
1 ND
ENDOSULFAN II
PARAMETER
TUR_4_2
TUR_4_4
TUR_5_2
TUR_8_2
TUR_8_4
Date Printed:
April 22, 2004

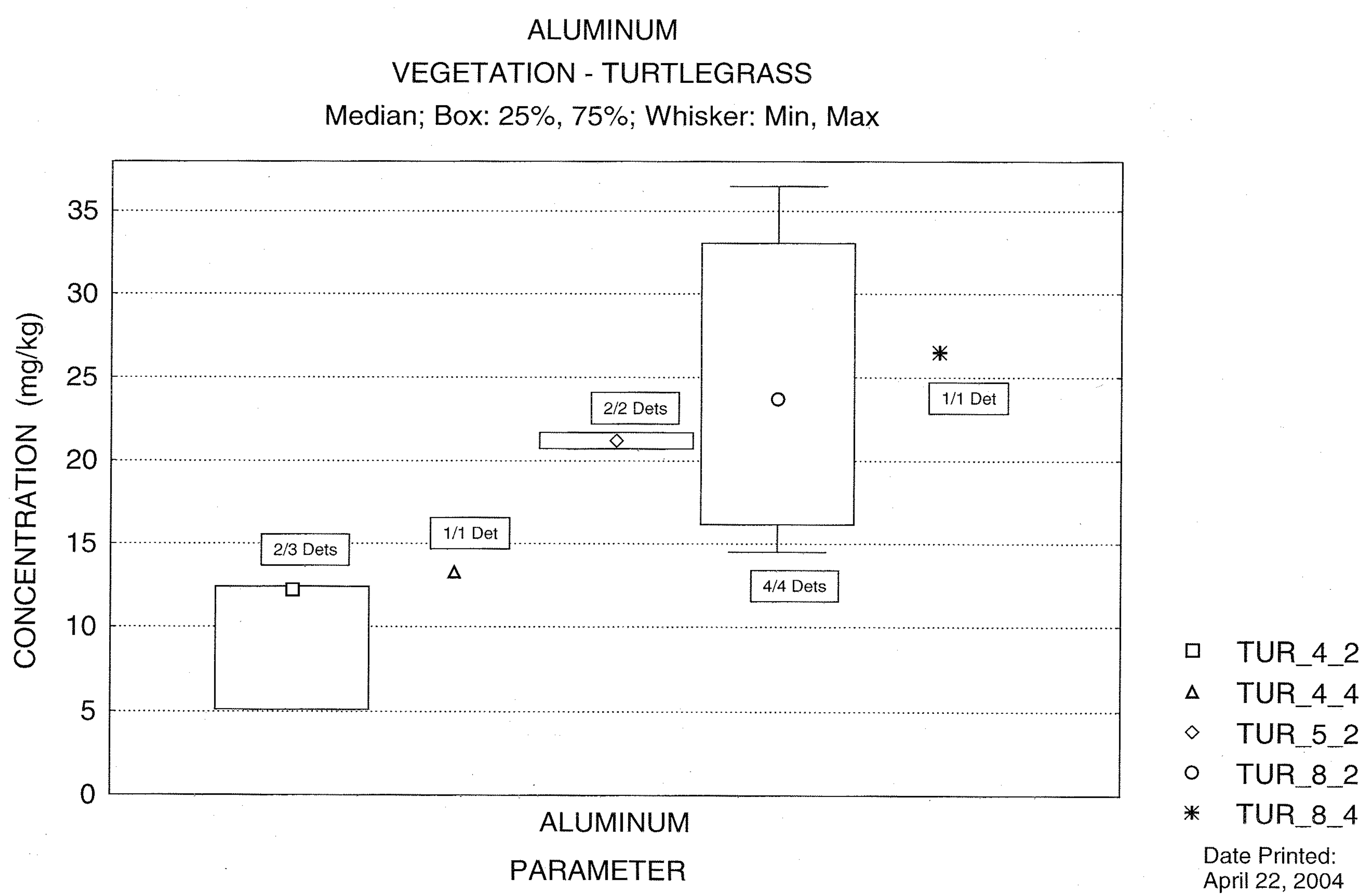


Date Printed:
April 22, 2004

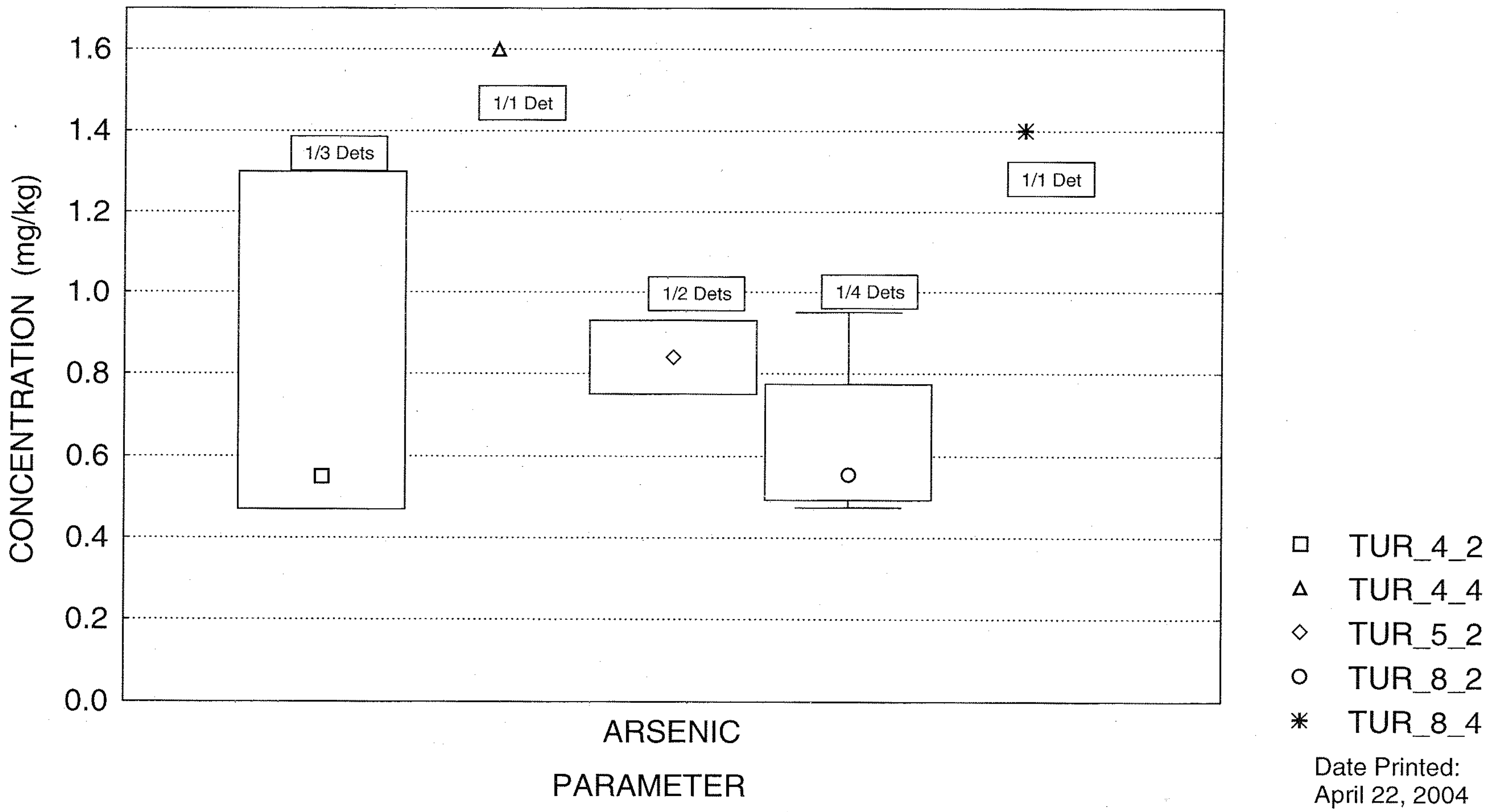
ENDRIN ALDEHYDE
VEGETATION - TURTLEGRASS
Median; Box: 25%, 75%; Whisker: Min, Max



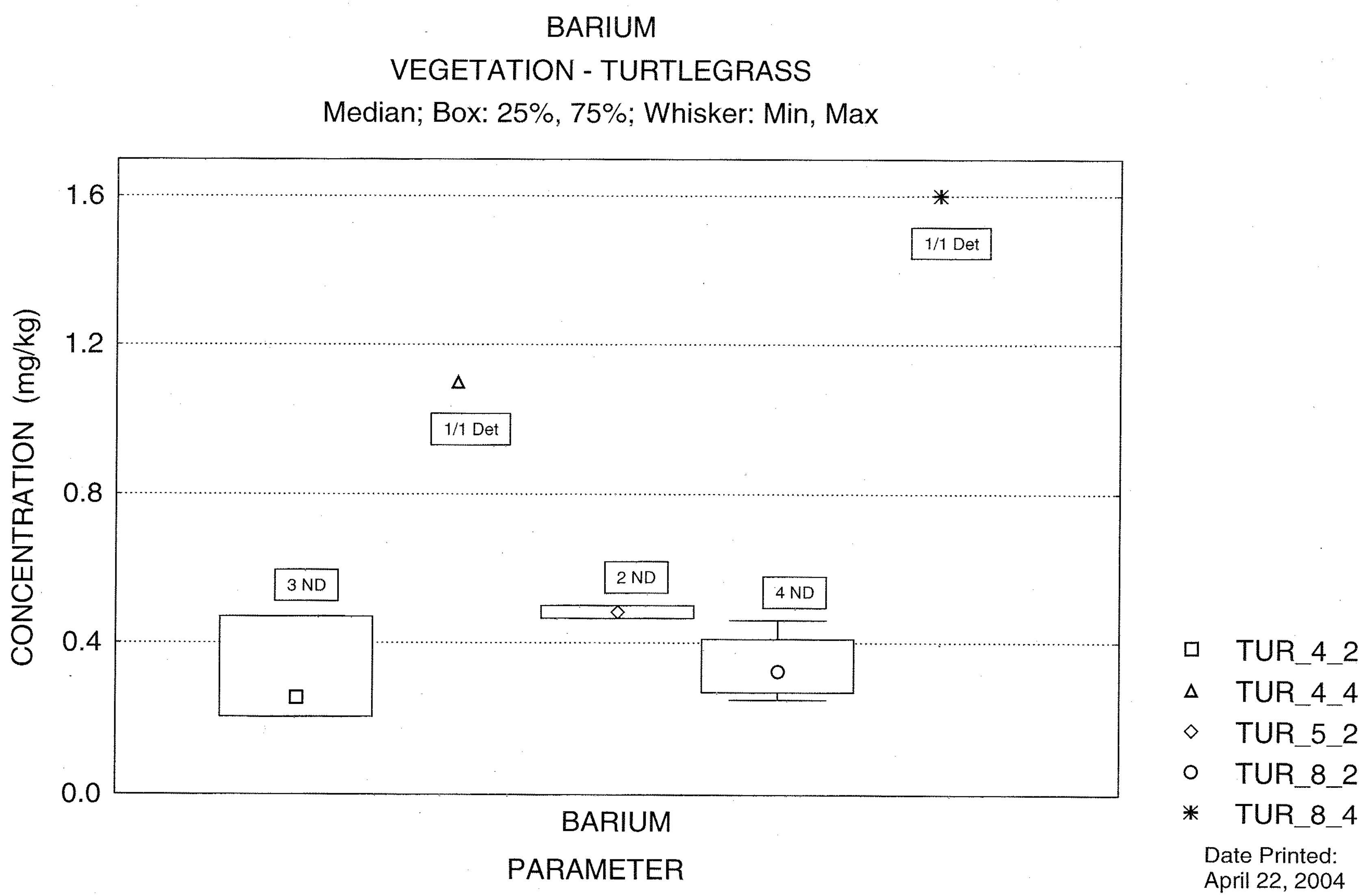

AROCLOR-1260
VEGETATION - TURTLEGRASS
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (ug/kg)
36
30
24
18
12
6
0
1/1 Det
1 ND
3 ND
2 ND
4 ND
AROCLOR-1260
PARAMETER
TUR_4_2
TUR_4_4
TUR_5_2
TUR_8_2
TUR_8_4
Date Printed:
April 22, 2004


ALUMINUM
VEGETATION - TURTLEGRASS
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (mg/kg)
35
30
25
20
15
10
5
0
2/3 Dets
1/1 Det
2/2 Dets
4/4 Dets
1/1 Det
ALUMINUM
PARAMETER
TUR_4_2
TUR_4_4
TUR_5_2
TUR_8_2
TUR_8_4
Date Printed:
April 22, 2004

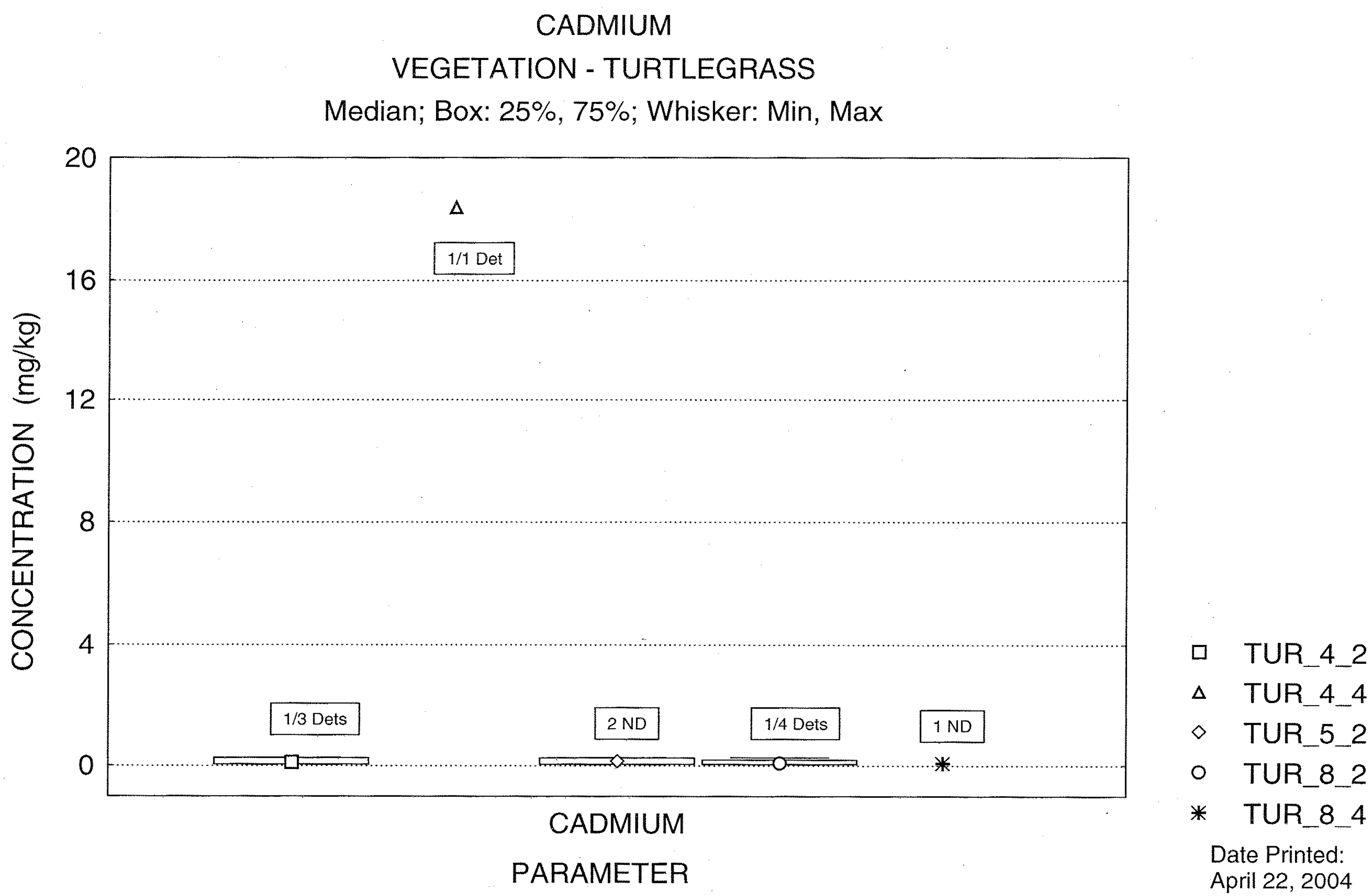
ARSENIC
VEGETATION - TURTLEGRASS
Median; Box: 25%, 75%; Whisker: Min, Max



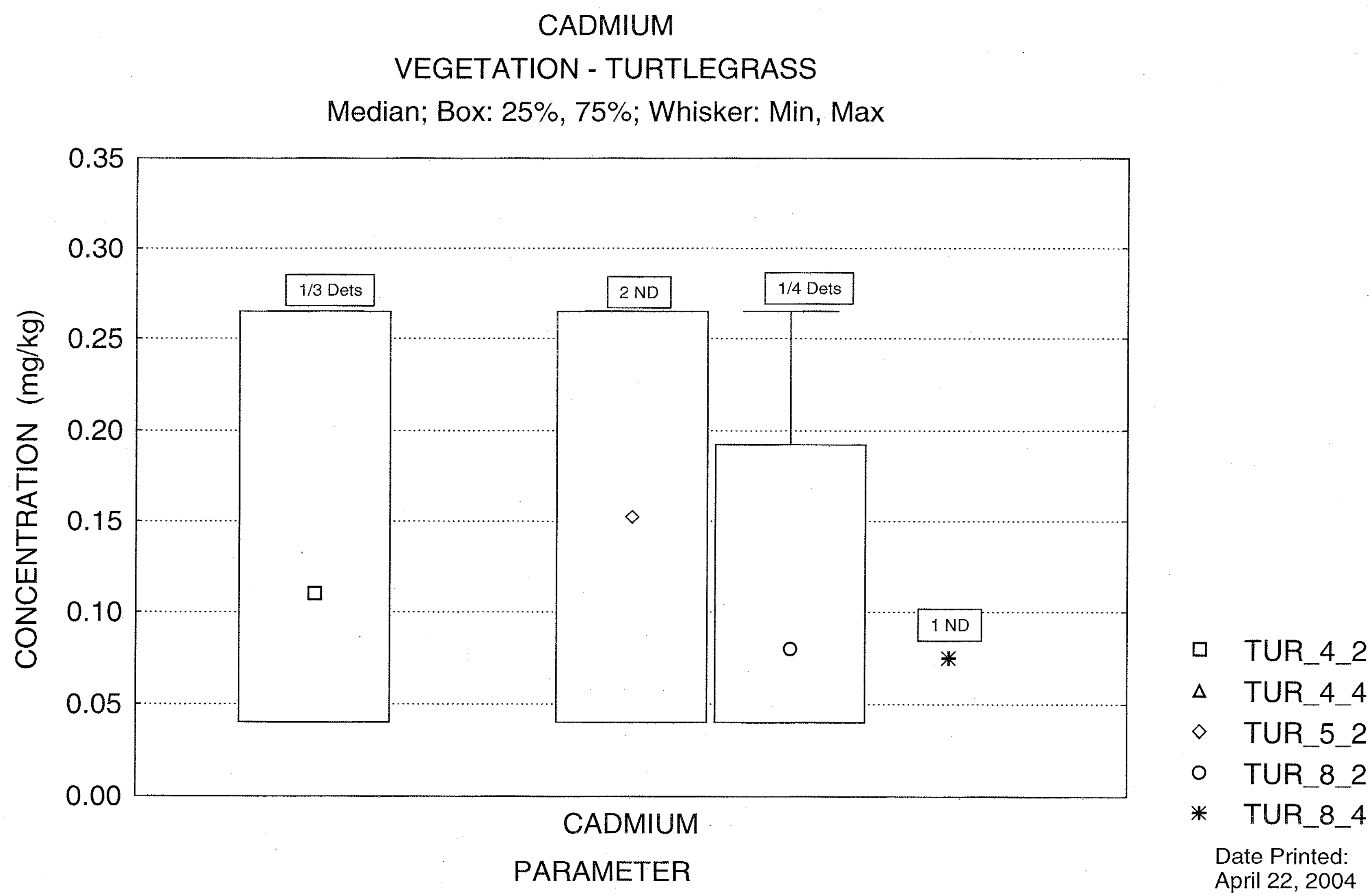
Date Printed:
April 22, 2004

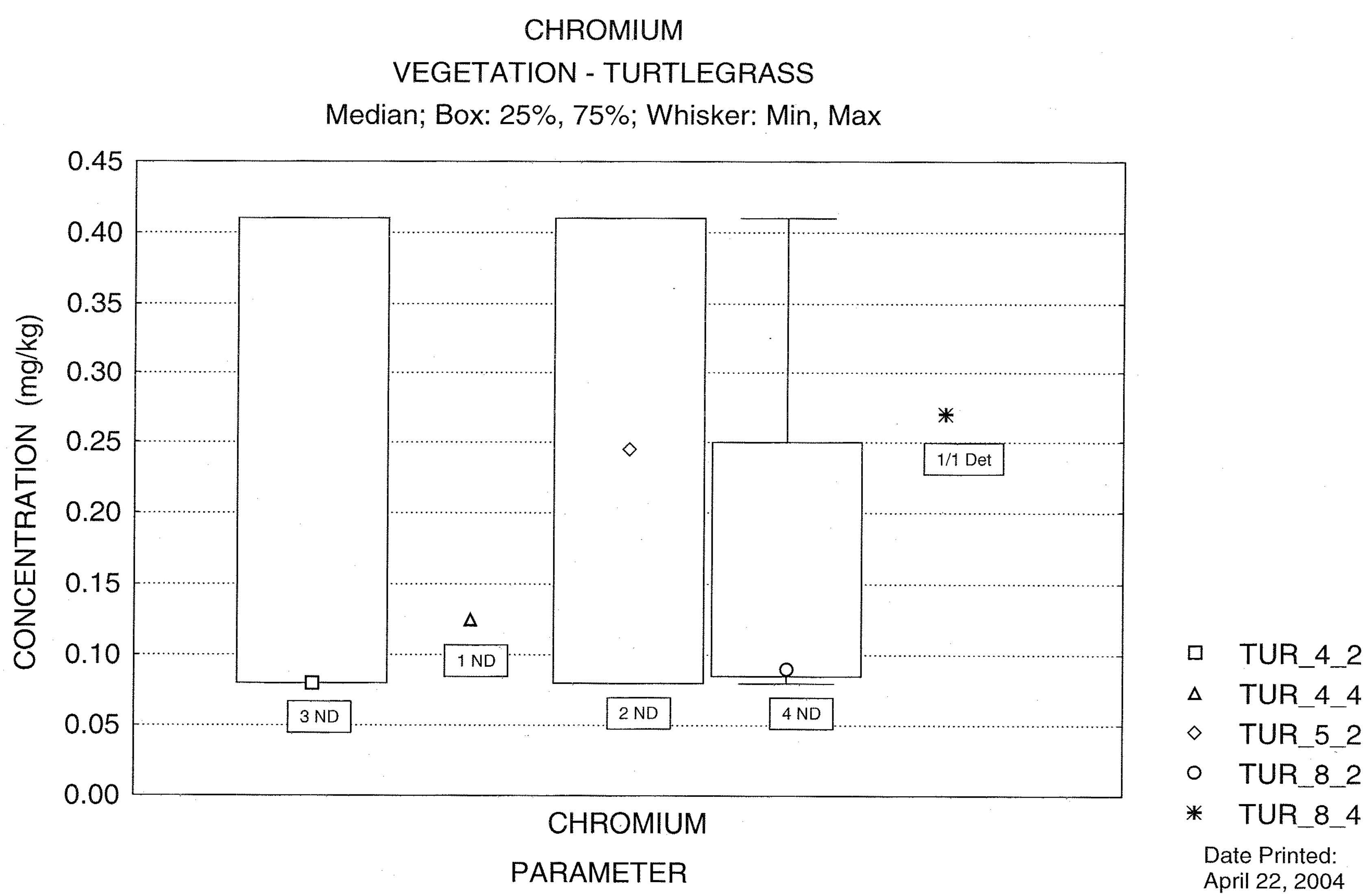


BARIUM
VEGETATION - TURTLEGRASS
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (mg/kg)
1.6
1.2
0.8
0.4
0.0
1/1 Det
1/1 Det
3 ND
2 ND
4 ND
BARIUM
PARAMETER
TUR_4_2
TUR_4_4
TUR_5_2
TUR_8_2
TUR_8_4
Date Printed:
April 22, 2004

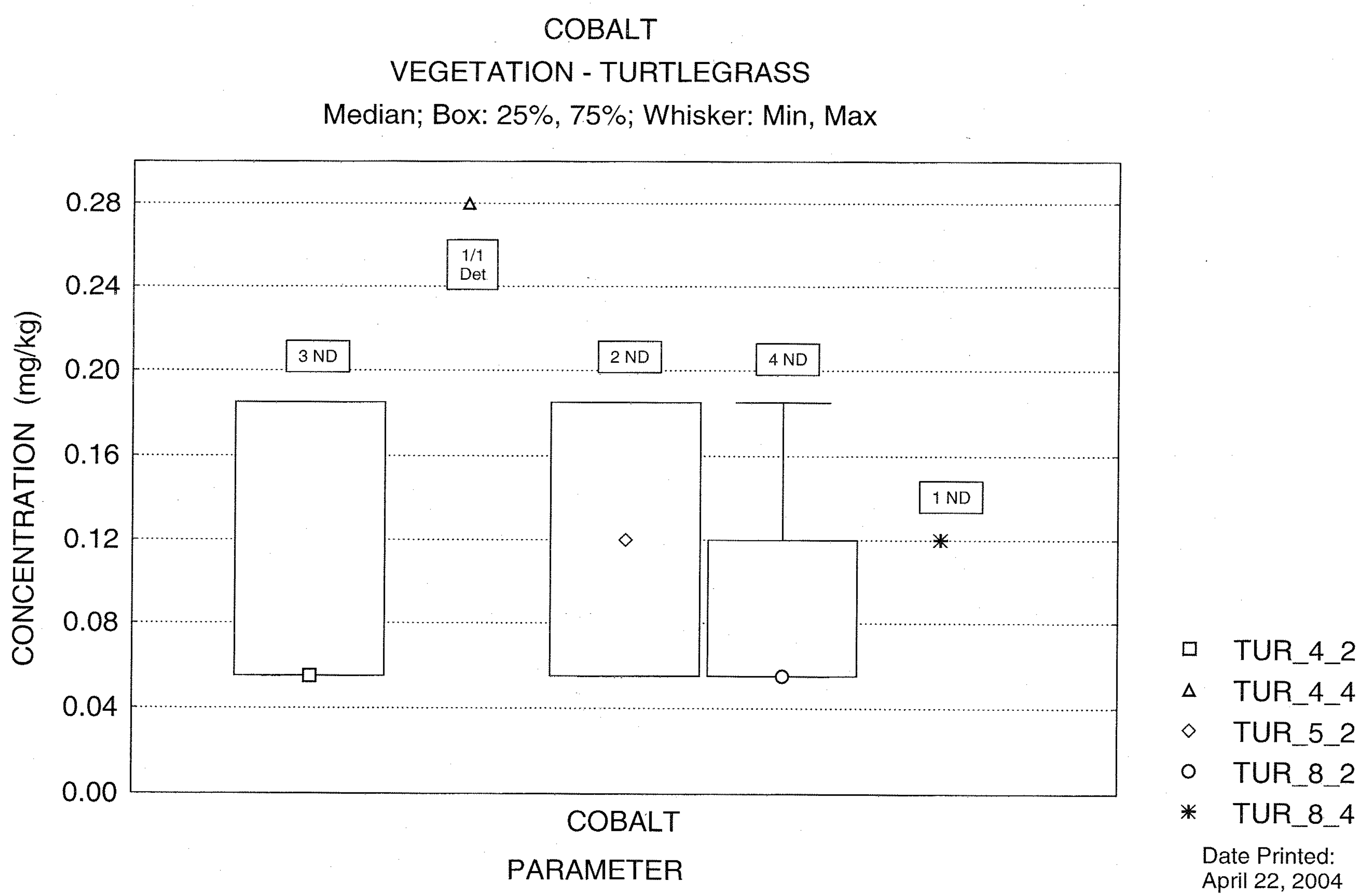


CADMIUM
VEGETATION - TURTLEGRASS
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (mg/kg)
20
16
12
8
4
0
1/1 Det
1/3 Dets
2 ND
1/4 Dets
1 ND
CADMIUM
PARAMETER
TUR_4_2
TUR_4_4
TUR_5_2
TUR_8_2
TUR_8_4
Date Printed:
April 22, 2004

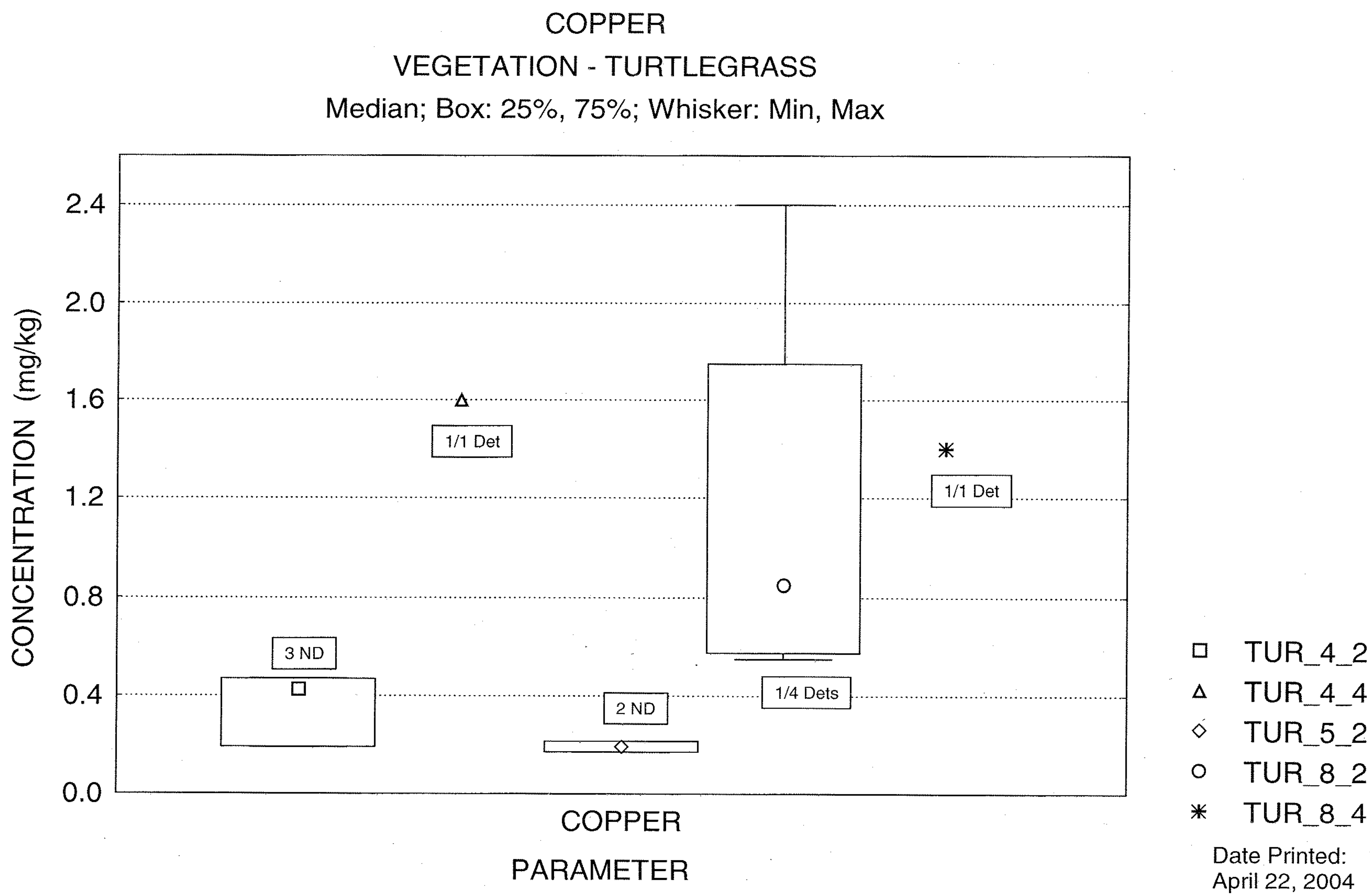

CADMIUM
VEGETATION - TURTLEGRASS
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (mg/kg)
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1/3 Dets
2 ND
1/4 Dets
1 ND
CADMIUM
PARAMETER
TUR_4_2
TUR_4_4
TUR_5_2
TUR_8_2
TUR_8_4
Date Printed:
April 22, 2004

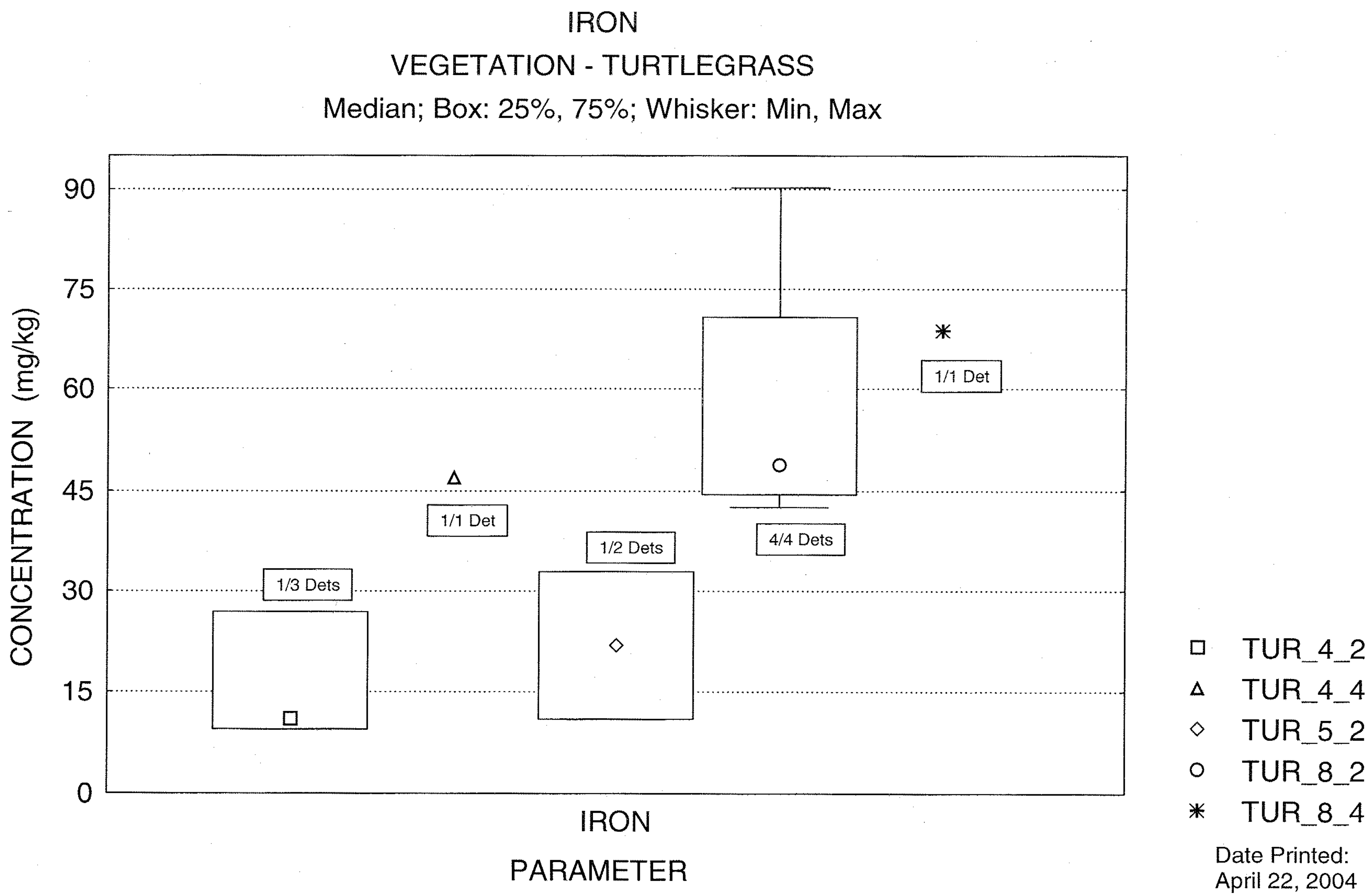


CHROMIUM
VEGETATION - TURTLEGRASS
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (mg/kg)
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
3 ND
1 ND
2 ND
4 ND
1/1 Det
CHROMIUM
PARAMETER
TUR_4_2
TUR_4_4
TUR_5_2
TUR_8_2
TUR_8_4
Date Printed:
April 22, 2004

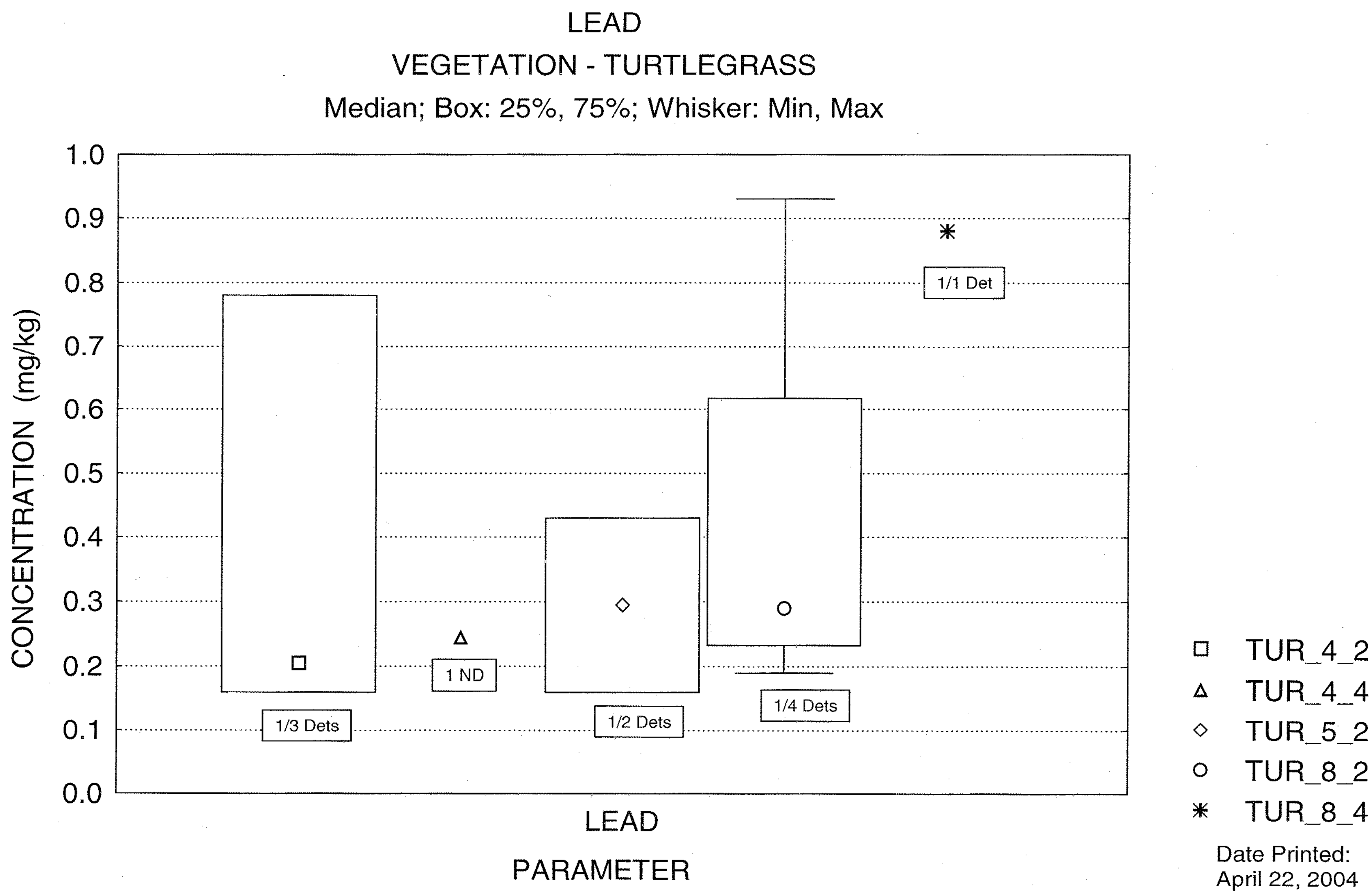


COBALT
VEGETATION - TURTLEGRASS
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (mg/kg)
0.28
0.24
0.20
0.16
0.12
0.08
0.04
0.00
1/1 Det
3 ND
2 ND
4 ND
1 ND
COBALT
PARAMETER
TUR_4_2
TUR_4_4
TUR_5_2
TUR_8_2
TUR_8_4
Date Printed: April 22, 2004

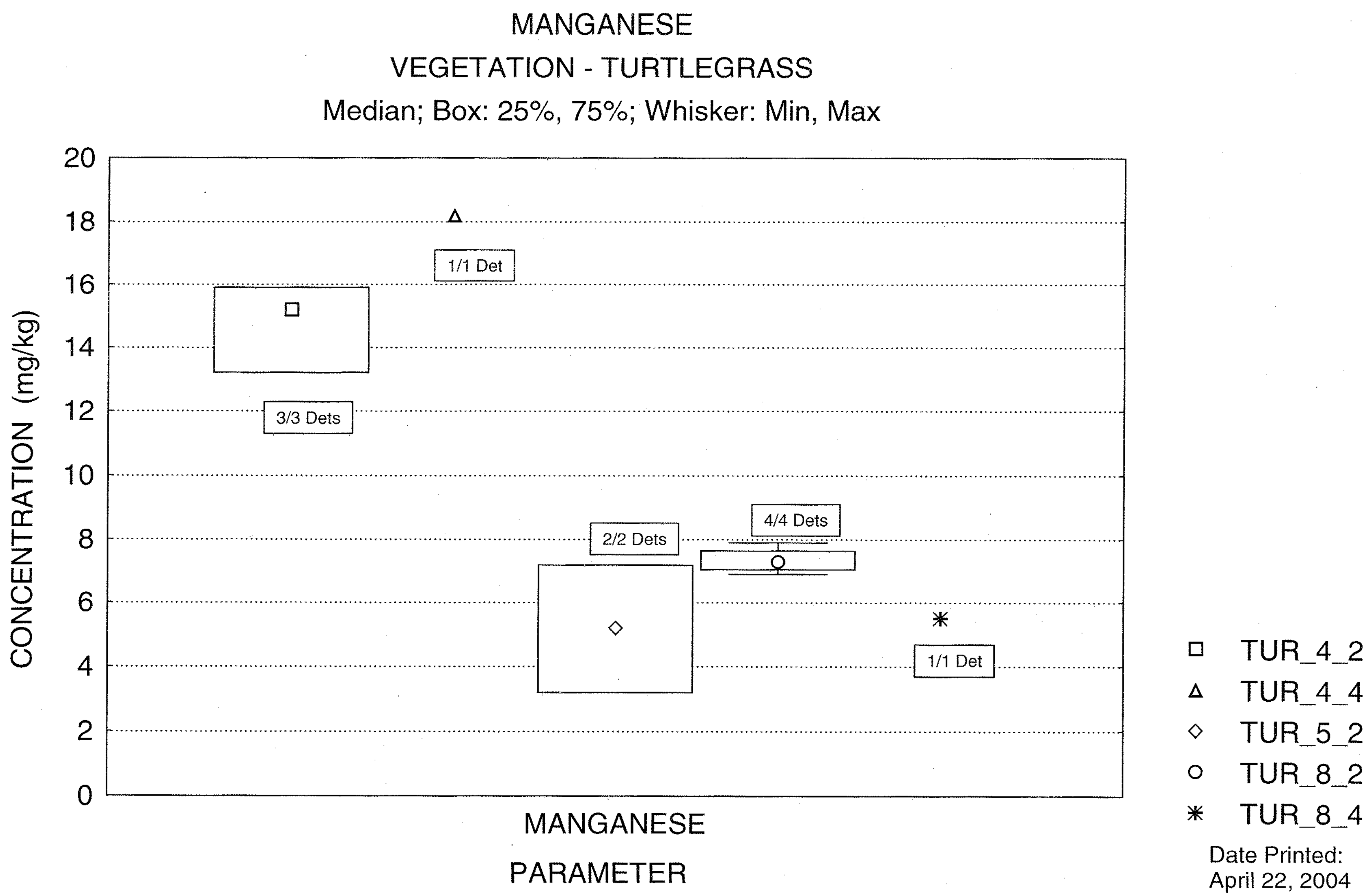

COPPER
VEGETATION - TURTLEGRASS
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (mg/kg)
2.4
2.0
1.6
1.2
0.8
0.4
0.0
1/1 Det
3 ND
2 ND
1/4 Dets
1/1 Det
COPPER
PARAMETER
TUR_4_2
TUR_4_4
TUR_5_2
TUR_8_2
TUR_8_4
Date Printed:
April 22, 2004



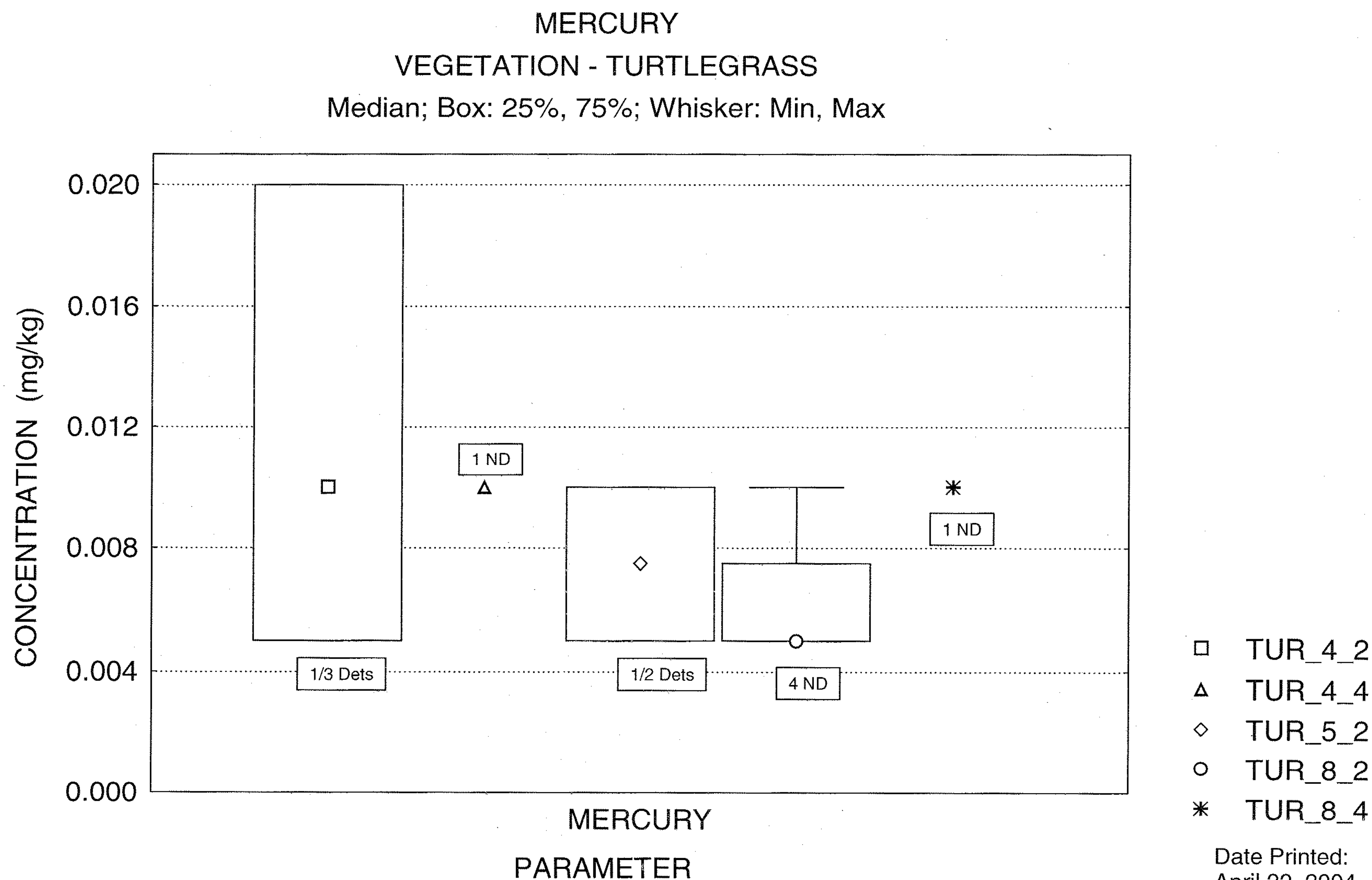
Date Printed:
April 22, 2004



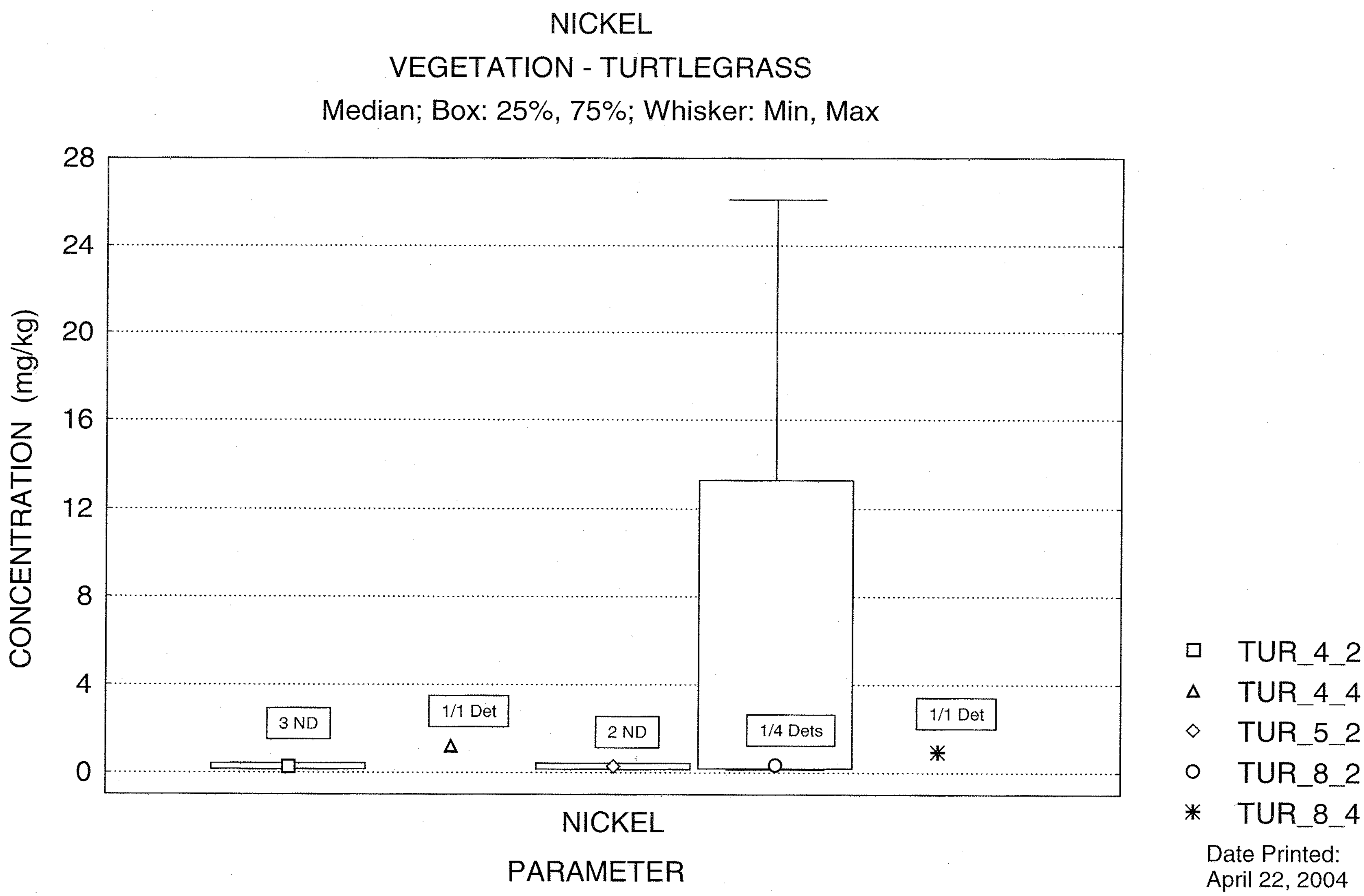
LEAD
VEGETATION - TURTLEGRASS
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (mg/kg)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1/3 Dets
1 ND
1/2 Dets
1/4 Dets
1/1 Det
LEAD
PARAMETER
TUR_4_2
TUR_4_4
TUR_5_2
TUR_8_2
TUR_8_4
Date Printed:
April 22, 2004

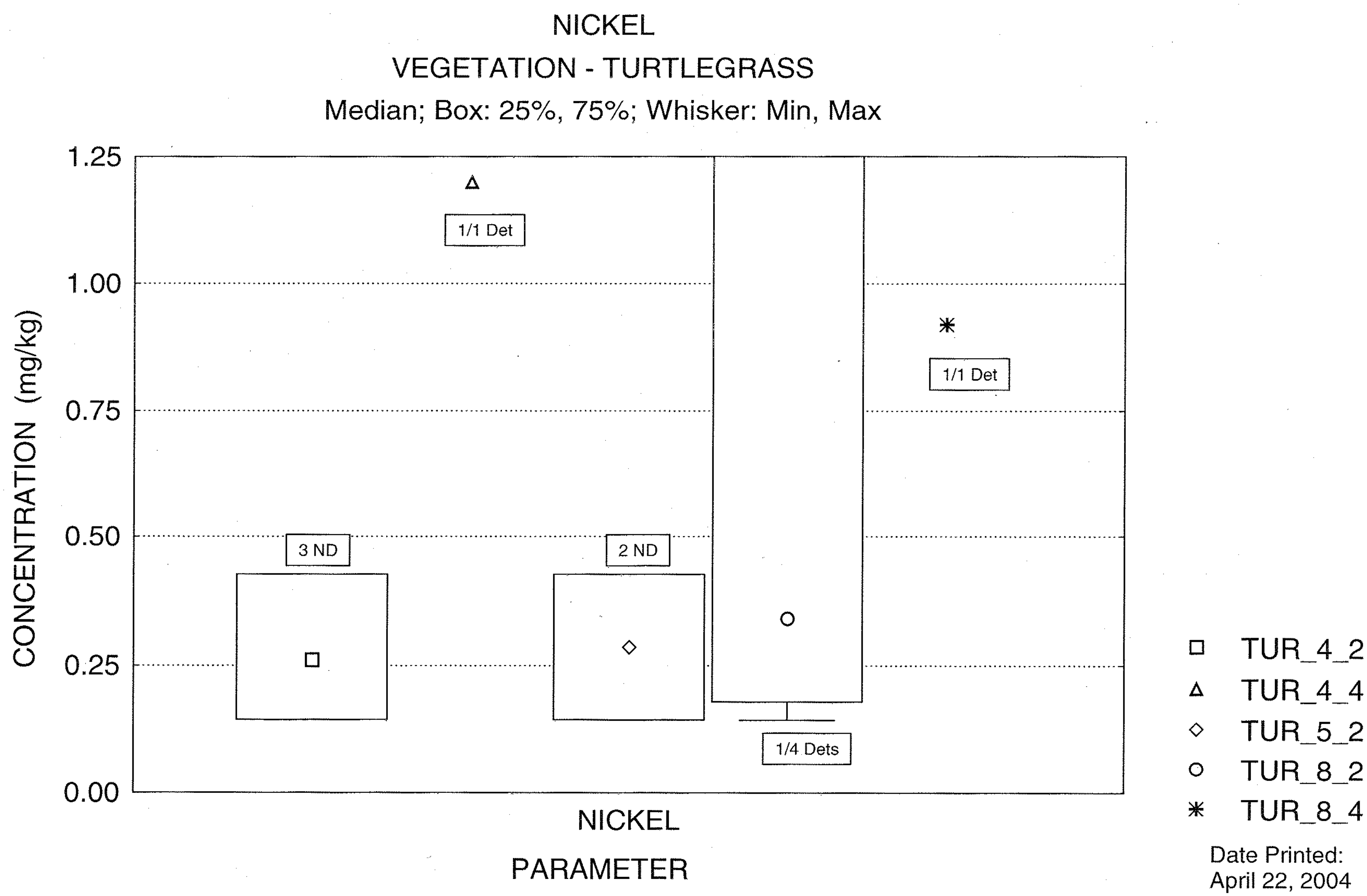


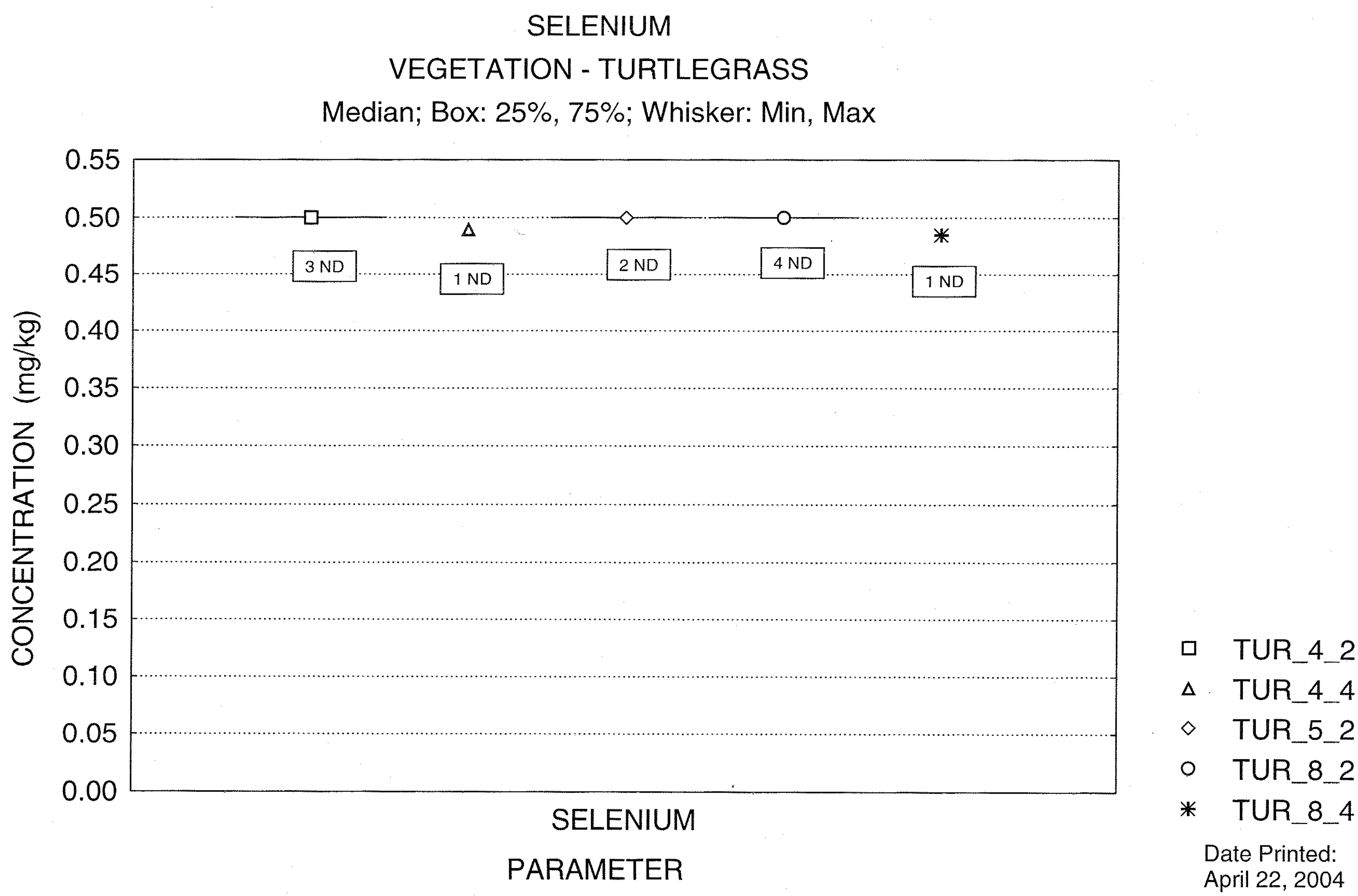
MANGANESE
VEGETATION - TURTLEGRASS
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (mg/kg)
20
18
16
14
12
10
8
6
4
2
0
1/1 Det
3/3 Dets
2/2 Dets
4/4 Dets
1/1 Det
MANGANESE
PARAMETER
TUR_4_2
TUR_4_4
TUR_5_2
TUR_8_2
TUR_8_4
Date Printed:
April 22, 2004



Date Printed:
April 22, 2004

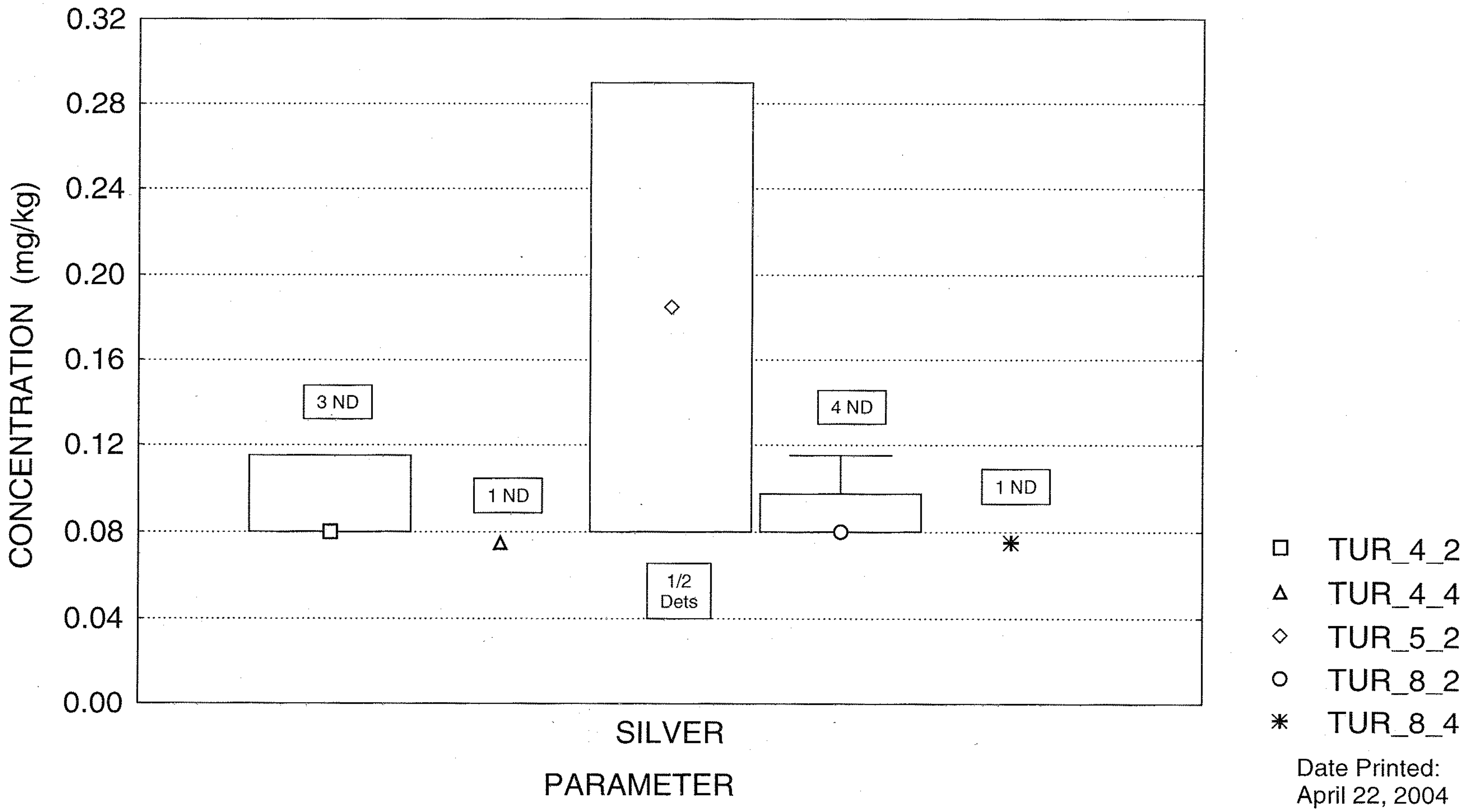

NICKEL
VEGETATION - TURTLEGRASS
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (mg/kg)
28
24
20
16
12
8
4
0
3 ND
1/1 Det
2 ND
1/4 Dets
1/1 Det
NICKEL
PARAMETER
TUR_4_2
TUR_4_4
TUR_5_2
TUR_8_2
TUR_8_4
Date Printed:
April 22, 2004


NICKEL
VEGETATION - TURTLEGRASS
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (mg/kg)
1.25
1.00
0.75
0.50
0.25
0.00
1/1 Det
3 ND
2 ND
1/4 Dets
1/1 Det
NICKEL
PARAMETER
TUR_4_2
TUR_4_4
TUR_5_2
TUR_8_2
TUR_8_4
Date Printed:
April 22, 2004

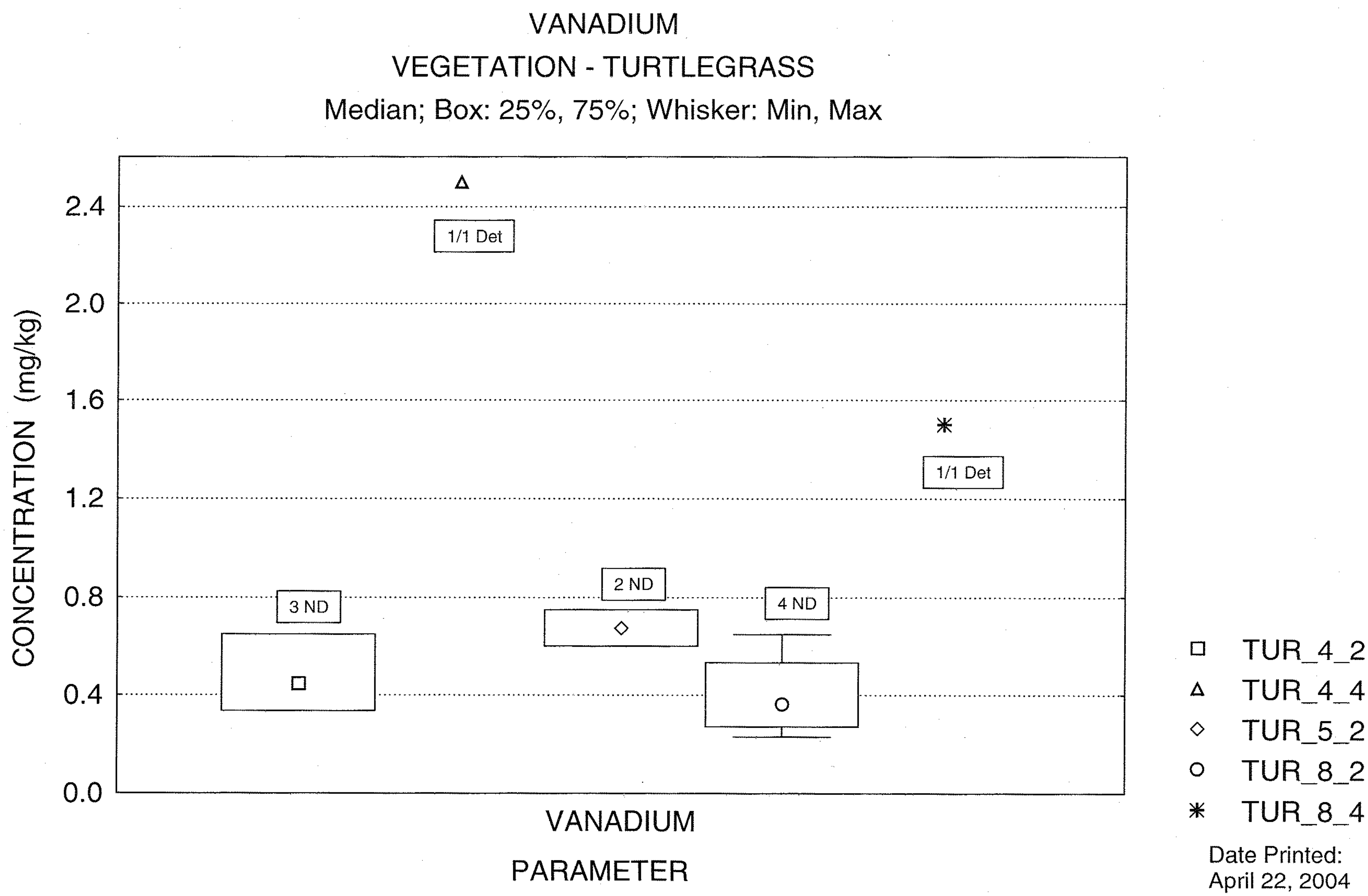


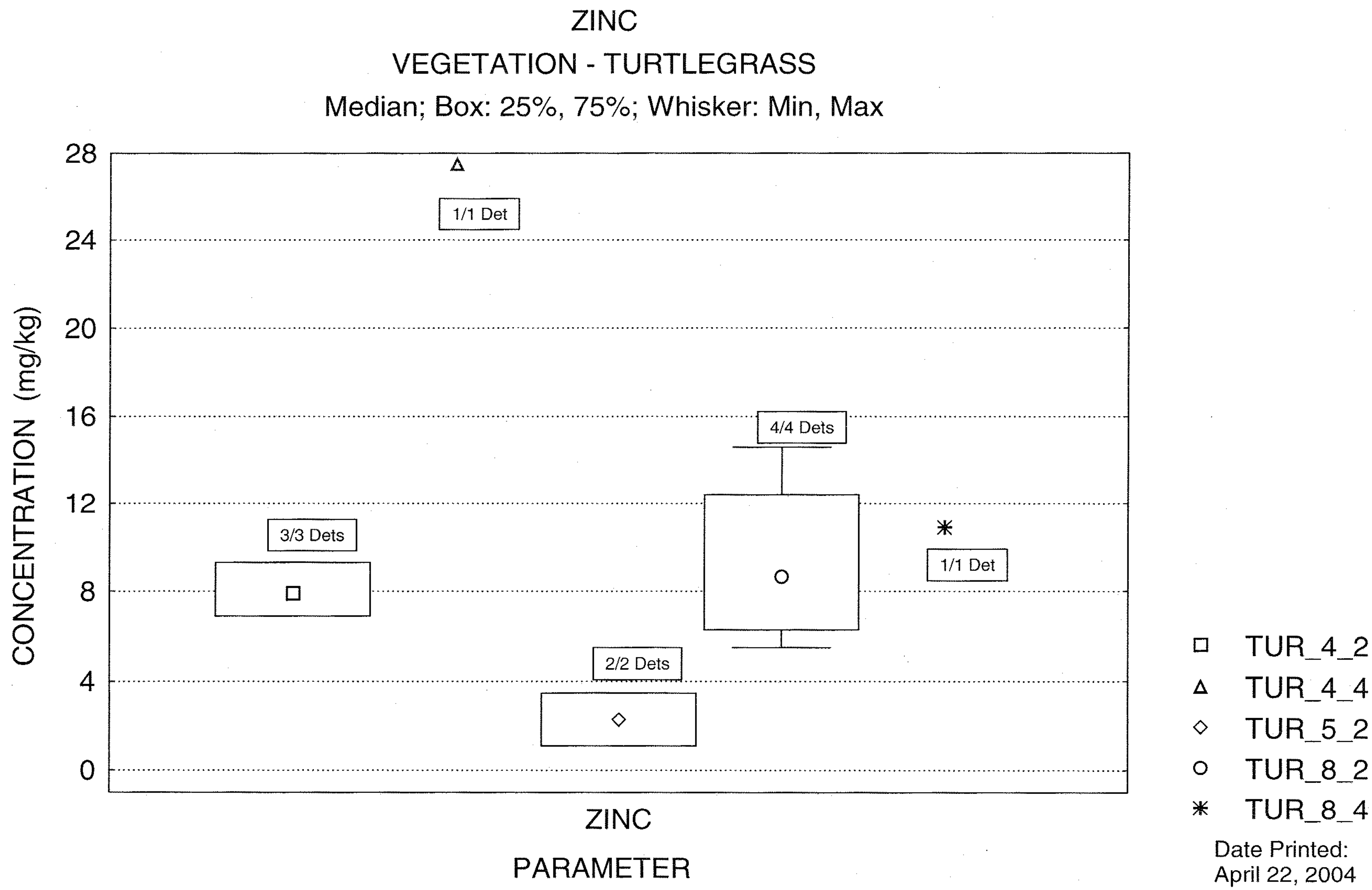
Date Printed:
April 22, 2004

SILVER
VEGETATION - TURTLEGRASS
Median; Box: 25%, 75%; Whisker: Min, Max



Date Printed:
April 22, 2004


VANADIUM
VEGETATION - TURTLEGRASS
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (mg/kg)
2.4
2.0
1.6
1.2
0.8
0.4
0.0
1/1 Det
1/1 Det
3 ND
2 ND
4 ND
VANADIUM
PARAMETER
TUR_4_2
TUR_4_4
TUR_5_2
TUR_8_2
TUR_8_4
Date Printed:
April 22, 2004



ZINC
VEGETATION - TURTLEGRASS
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (mg/kg)
28
24
20
16
12
8
4
0
1/1 Det
3/3 Dets
2/2 Dets
4/4 Dets
1/1 Det
ZINC
PARAMETER
TUR_4_2
TUR_4_4
TUR_5_2
TUR_8_2
TUR_8_4
Date Printed:
April 22, 2004

APPENDIX B.A-3

STATISTICAL BOX AND WHISKER PLOTS
SEA OXEYE DAISY DATA SET

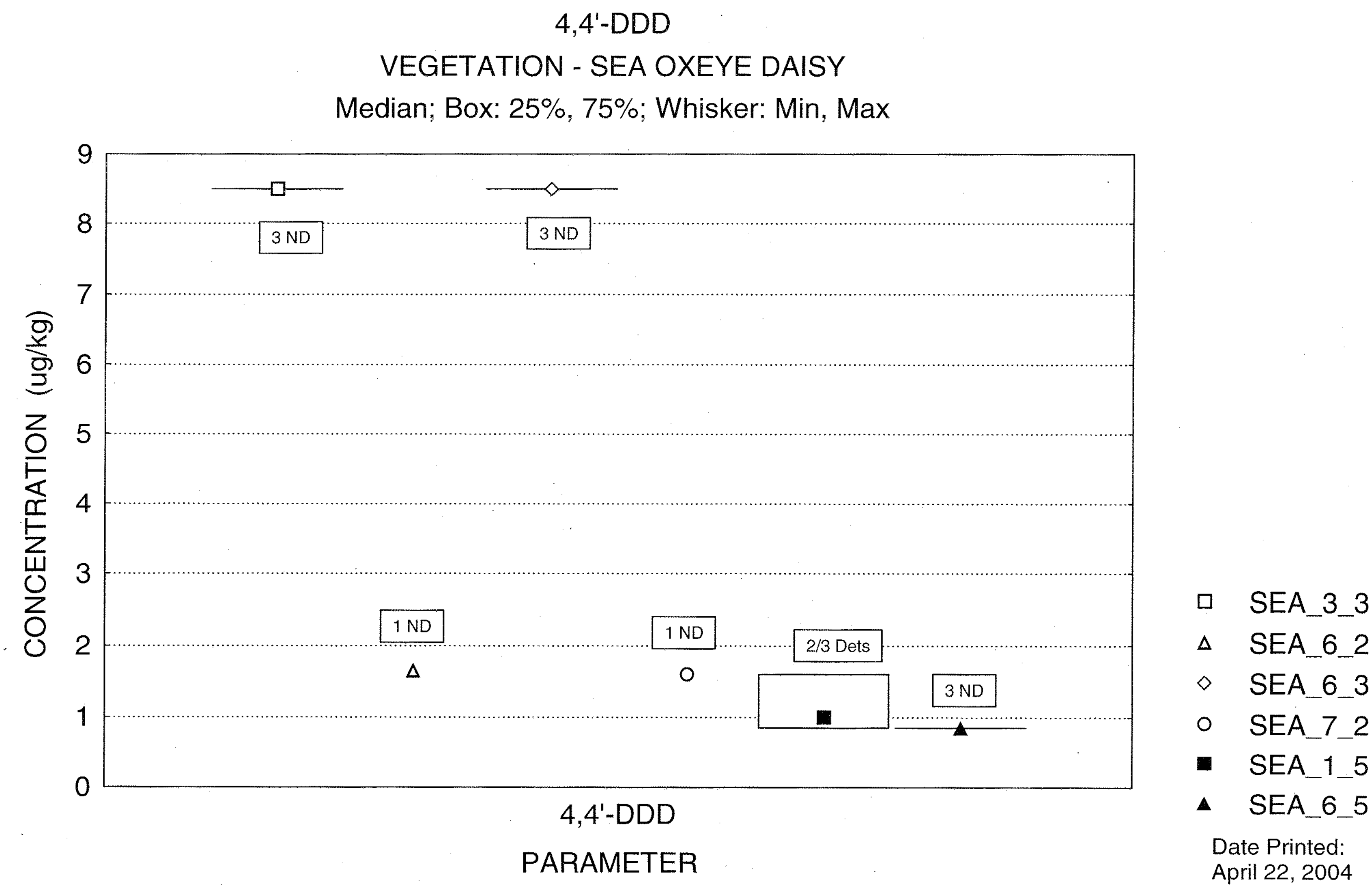
STATISTICAL BOX AND WHISKER PLOTS – SEA OXEYE DAISY DATA SET

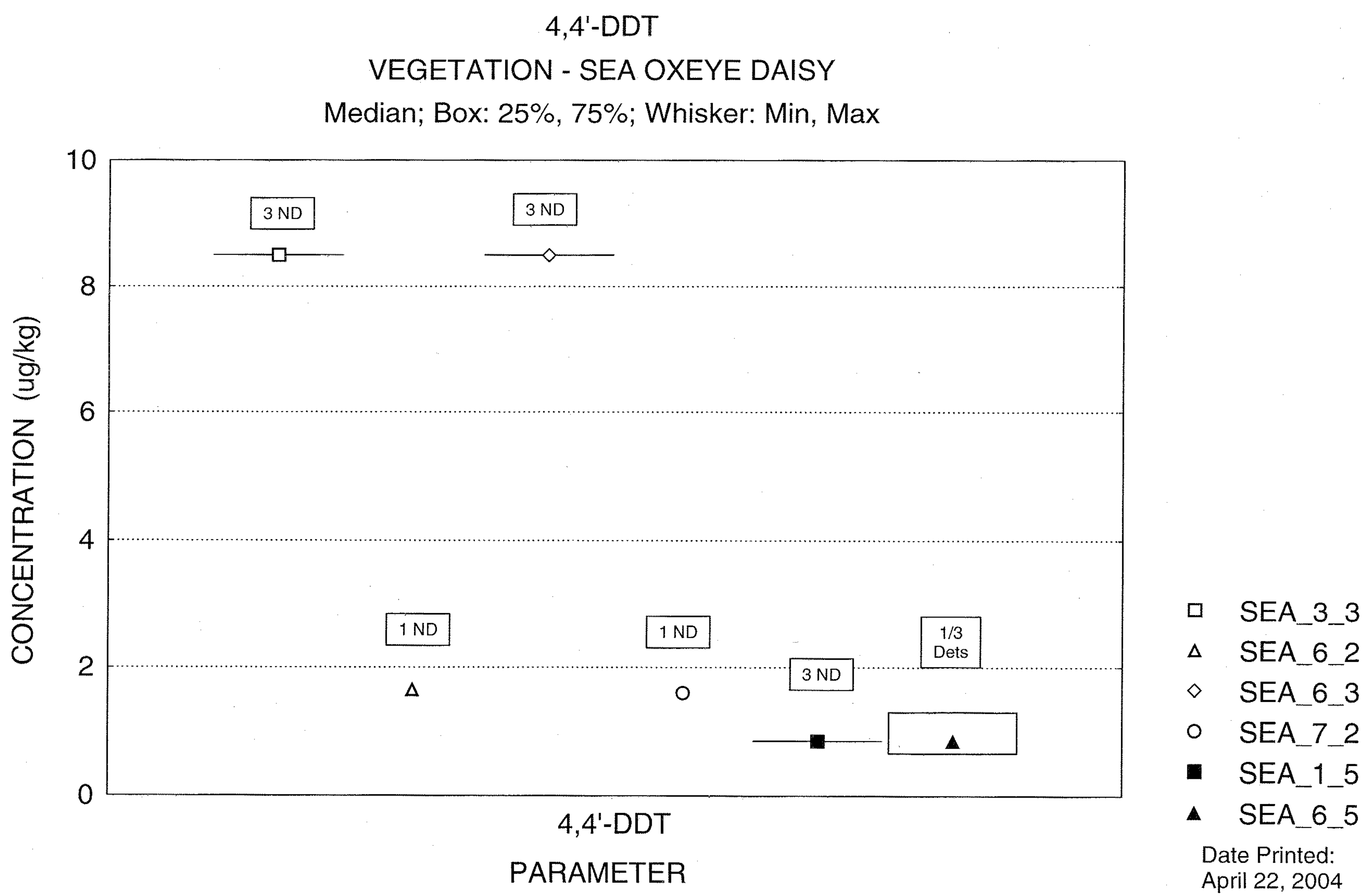
The sea oxeye daisy data set represents a single species *(Borrichia frutescens*) collected at four locations (BG 1, BG 3, BG 6, and BG 7) in three sampling rounds (rounds 2, 3, and 5). The different combinations of location and round resulted in six “sampling events” for sea oxeye daisy data (Table A-3). Box and whisker plots were utilized to provide a graphical representation of concentrations of analytes detected in each sampling event. A description of how to interpret the plots was provided at the beginning of Appendix B.A-1.

TABLE A-3

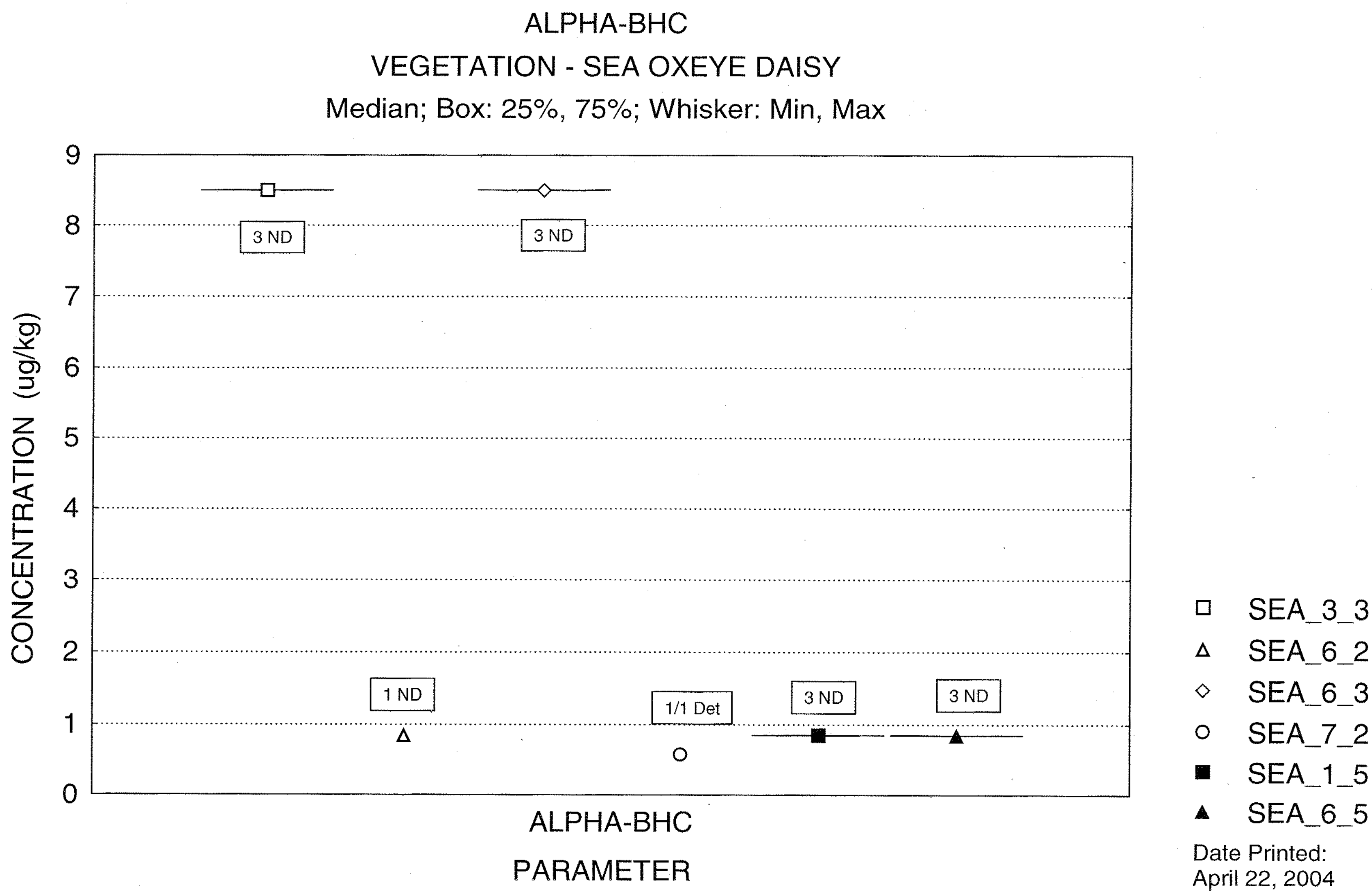
BACKGROUND SEA OXEYE DAISY SAMPLING EVENTS

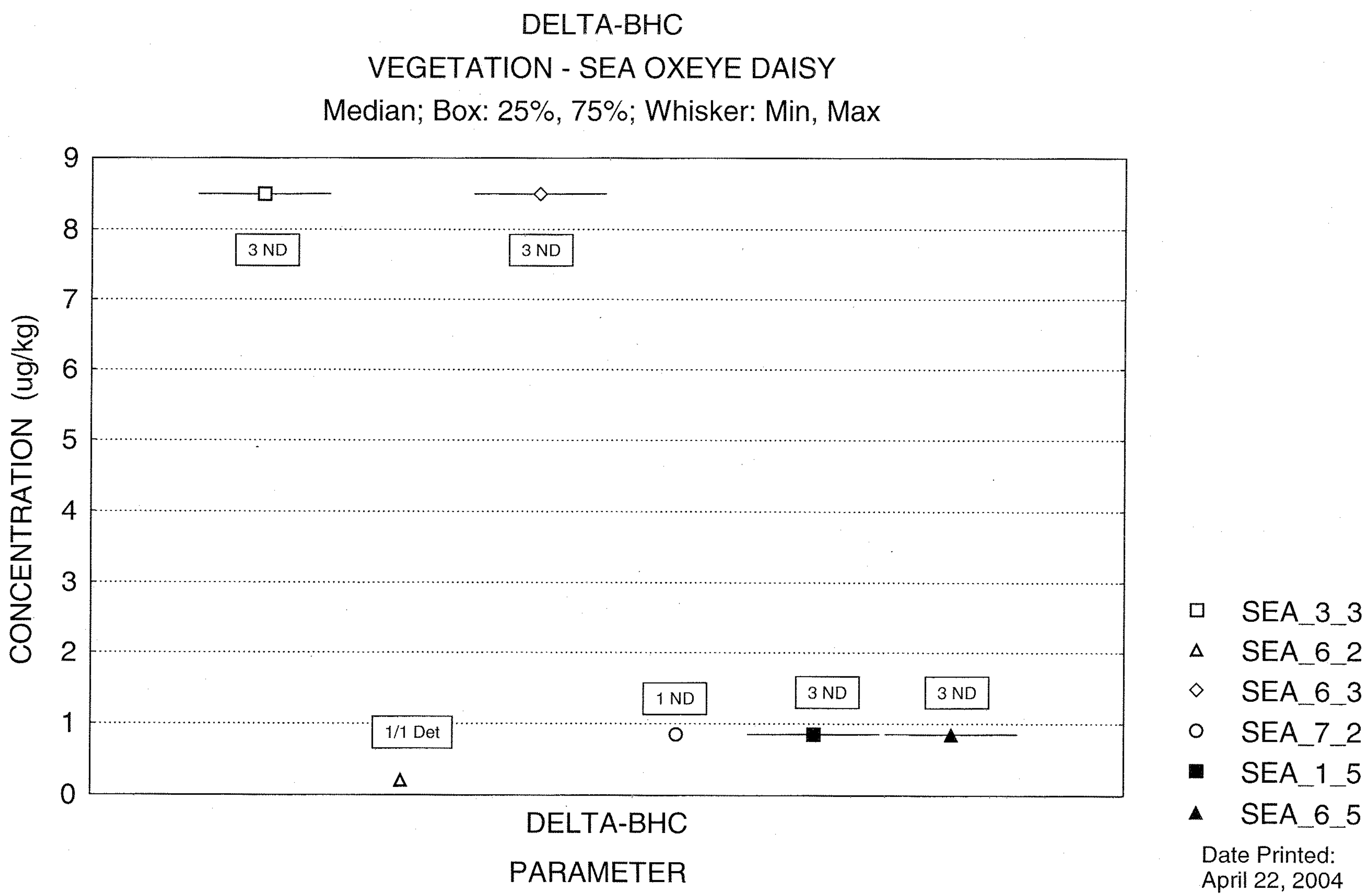
Event	Event Description
SEA_3_3	Sea oxeye daisy, BG 3, Round 3
SEA_6_2	Sea oxeye daisy, BG 6, Round 2
SEA_6_3	Sea oxeye daisy, BG 6, Round 3
SEA_7_2	Sea oxeye daisy, BG 7, Round 2
SEA_1_5	Sea oxeye daisy, BG 1, Round 5
SEA_6_5	Sea oxeye daisy, BG 6, Round 5


4,4'-DDD
VEGETATION - SEA OXEYE DAISY
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (ug/kg)
9
8
7
6
5
4
3
2
1
0
3 ND
3 ND
1 ND
1 ND
2/3 Dets
3 ND
4,4'-DDD
PARAMETER
SEA_3_3
SEA_6_2
SEA_6_3
SEA_7_2
SEA_1_5
SEA_6_5
Date Printed:
April 22, 2004

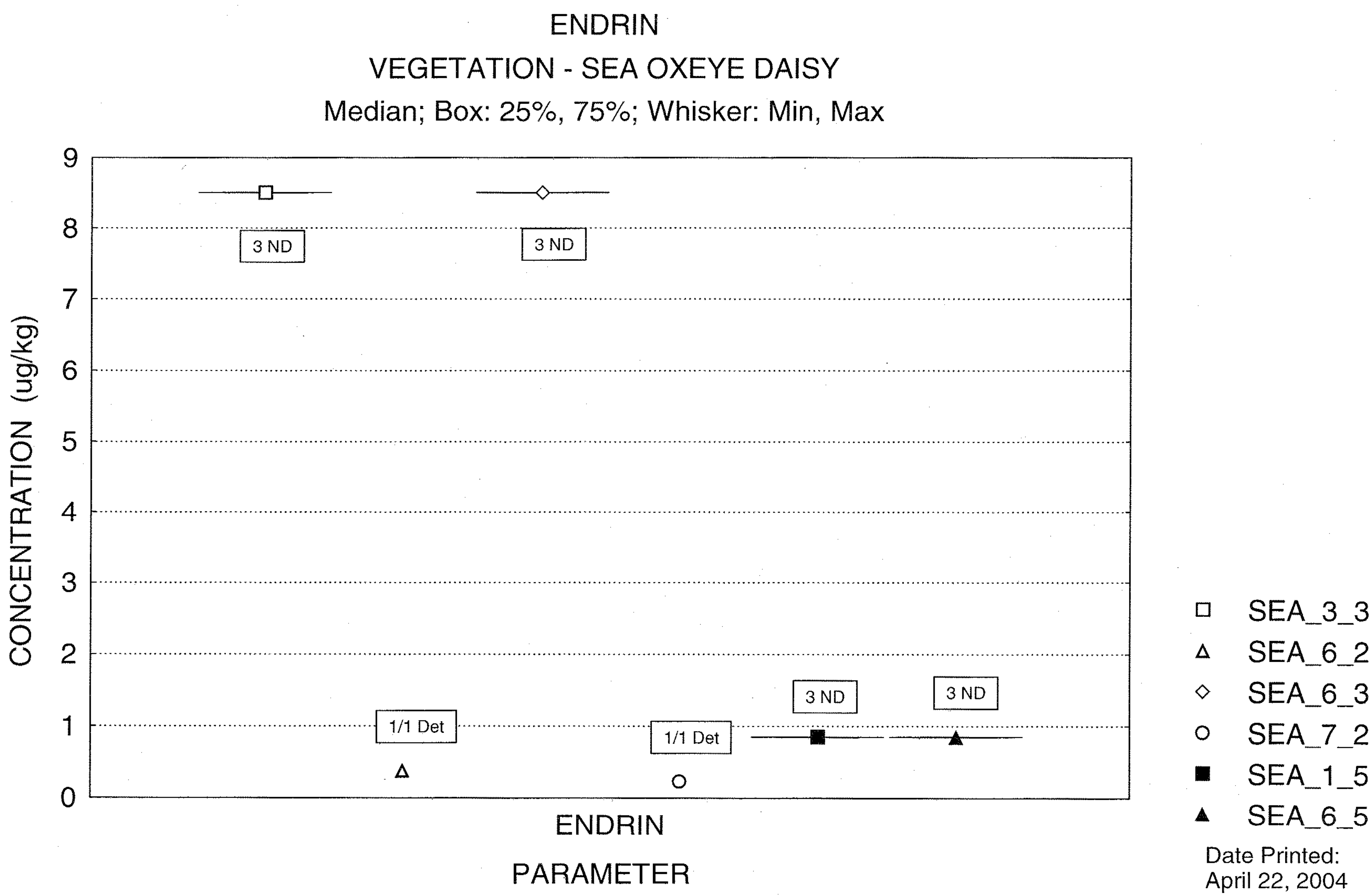


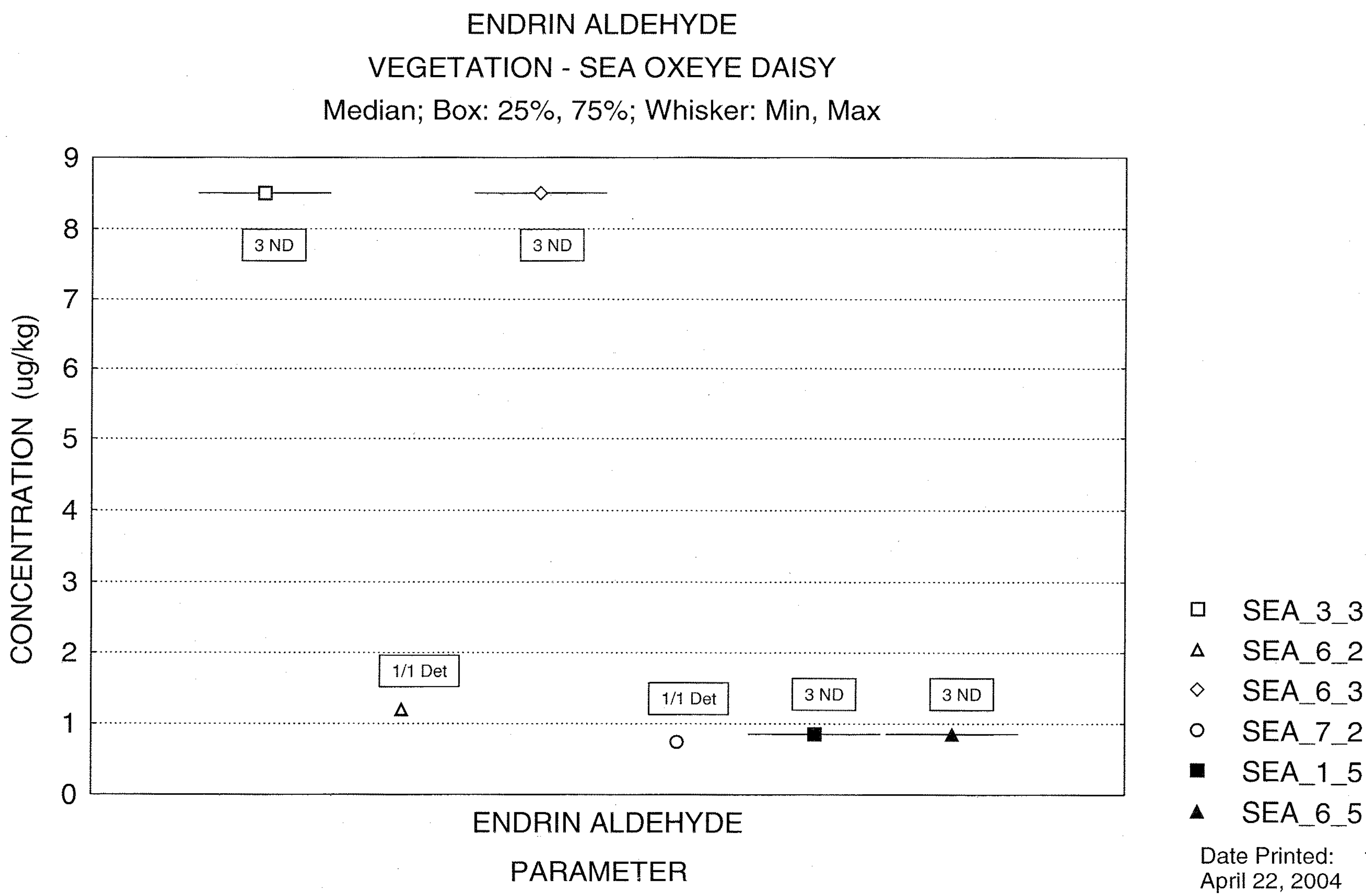
4,4'-DDT
VEGETATION - SEA OXEYE DAISY
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (ug/kg)
10
8
6
4
2
0
3 ND
3 ND
1 ND
1 ND
3 ND
1/3 Dets
4,4'-DDT
PARAMETER
SEA_3_3
SEA_6_2
SEA_6_3
SEA_7_2
SEA_1_5
SEA_6_5
Date Printed: April 22, 2004


ALPHA-BHC
VEGETATION - SEA OXEYE DAISY
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (ug/kg)
0
1
2
3
4
5
6
7
8
9
3 ND
3 ND
1 ND
1/1 Det
3 ND
3 ND
ALPHA-BHC
PARAMETER
SEA_3_3
SEA_6_2
SEA_6_3
SEA_7_2
SEA_1_5
SEA_6_5
Date Printed:
April 22, 2004



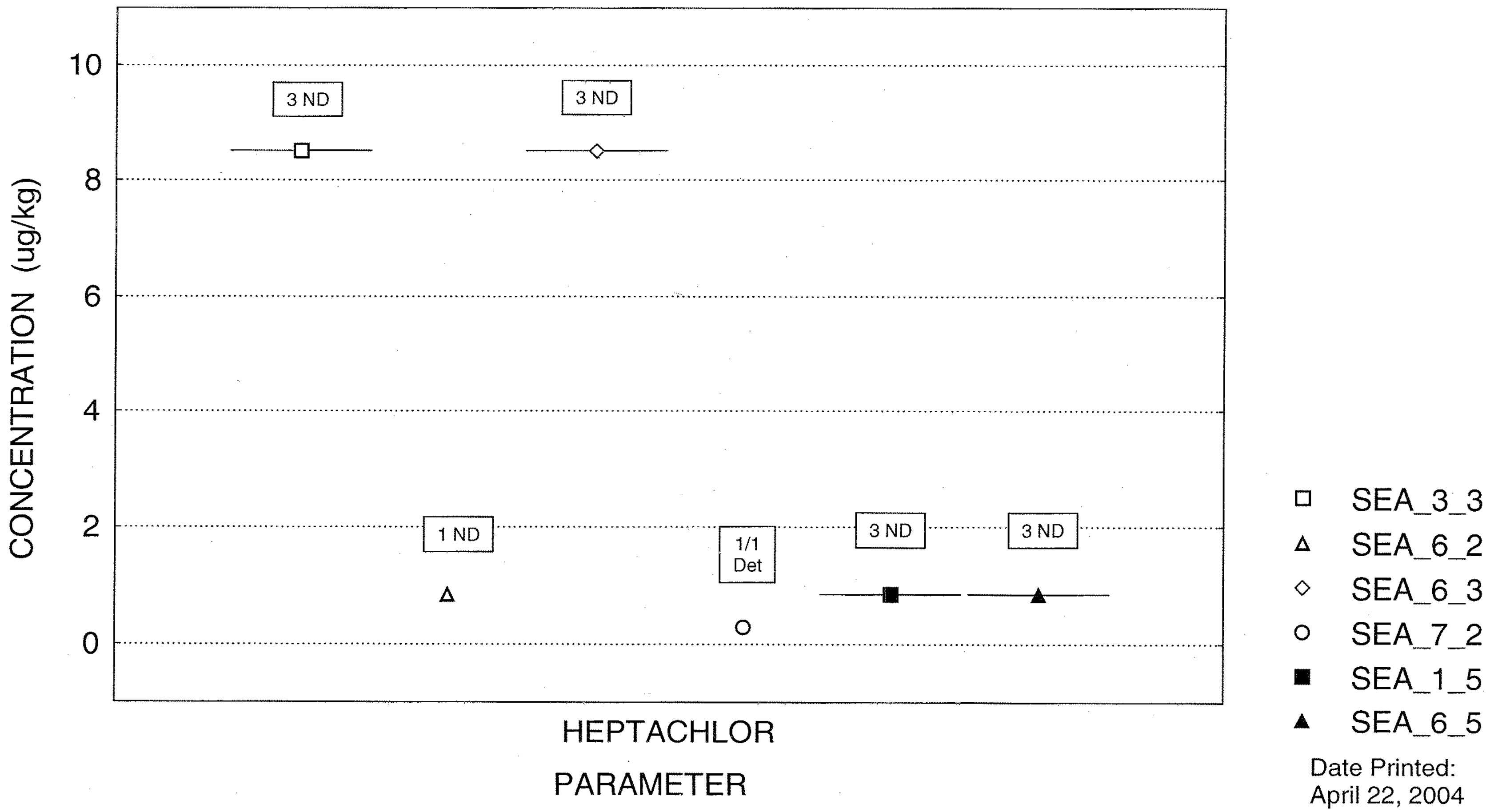
DELTA-BHC
VEGETATION - SEA OXEYE DAISY
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (ug/kg)
9
8
7
6
5
4
3
2
1
0
3 ND
3 ND
1/1 Det
1 ND
3 ND
3 ND
DELTA-BHC
PARAMETER
SEA_3_3
SEA_6_2
SEA_6_3
SEA_7_2
SEA_1_5
SEA_6_5
Date Printed:
April 22, 2004


ENDRIN
VEGETATION - SEA OXEYE DAISY
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (ug/kg)
9
8
7
6
5
4
3
2
1
0
3 ND
3 ND
1/1 Det
1/1 Det
3 ND
3 ND
ENDRIN
PARAMETER
SEA_3_3
SEA_6_2
SEA_6_3
SEA_7_2
SEA_1_5
SEA_6_5
Date Printed:
April 22, 2004

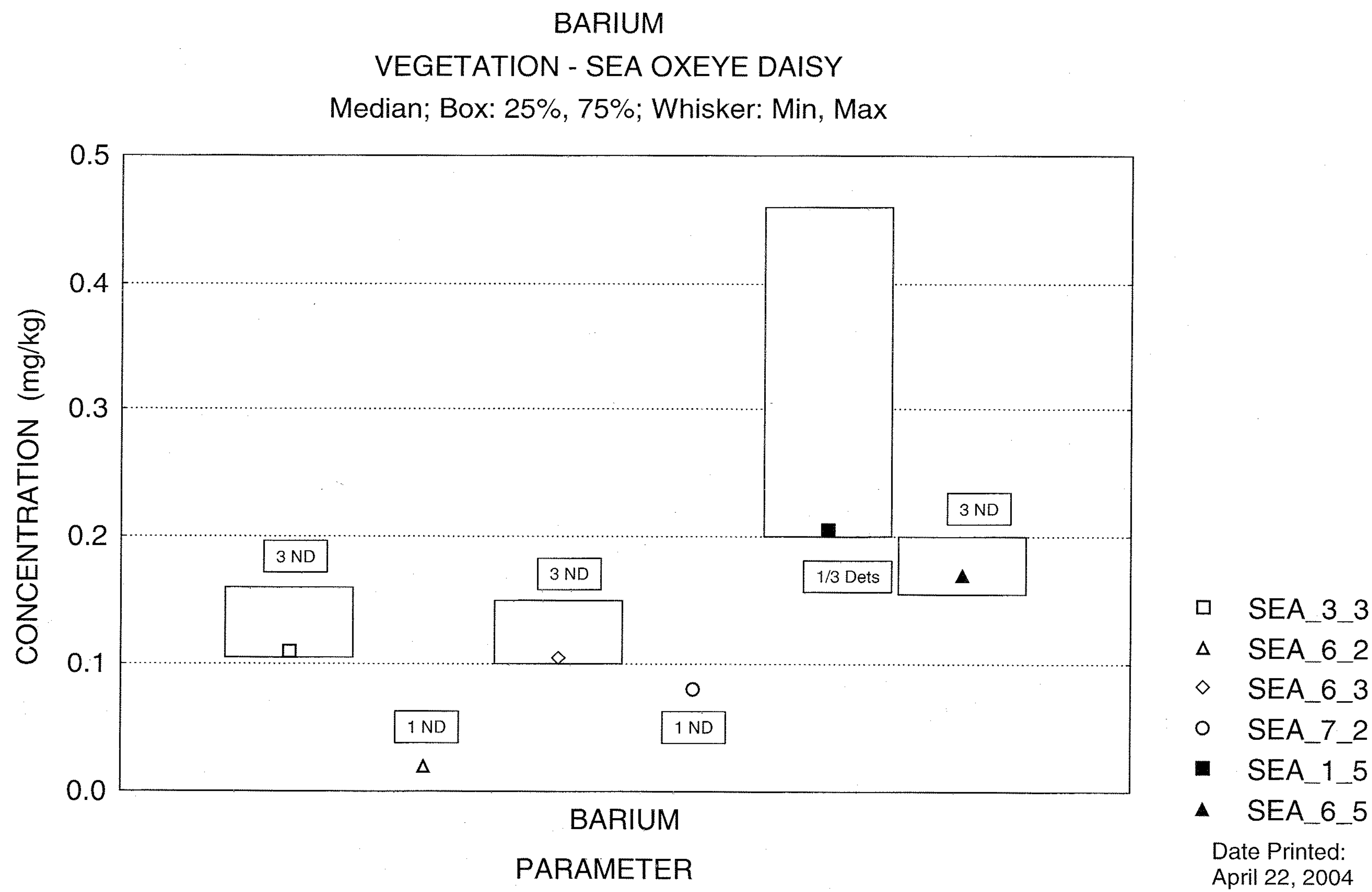


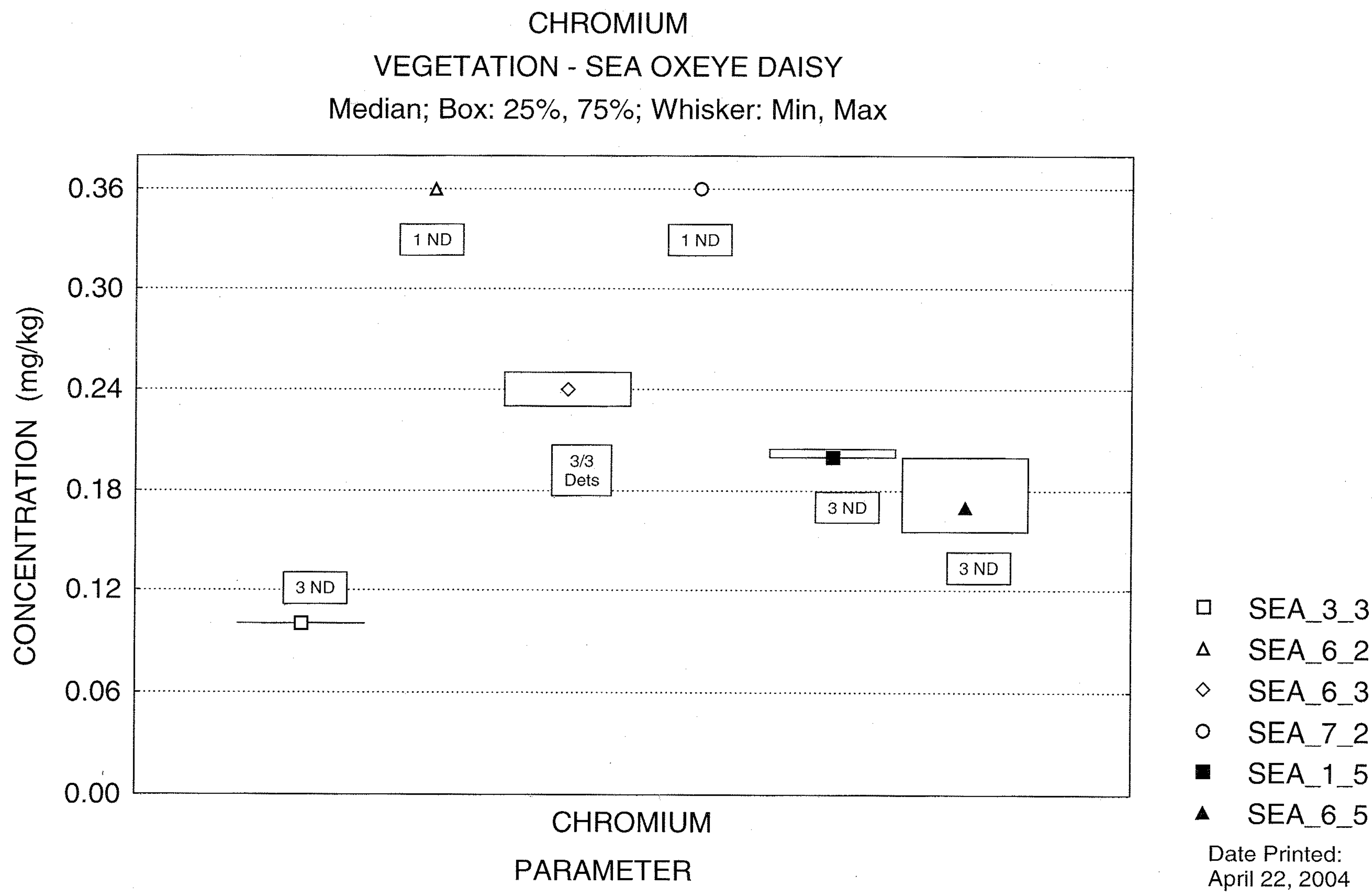
ENDRIN ALDEHYDE
VEGETATION - SEA OXEYE DAISY
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (ug/kg)
0
1
2
3
4
5
6
7
8
9
3 ND
3 ND
1/1 Det
1/1 Det
3 ND
3 ND
ENDRIN ALDEHYDE
PARAMETER
SEA_3_3
SEA_6_2
SEA_6_3
SEA_7_2
SEA_1_5
SEA_6_5
Date Printed:
April 22, 2004

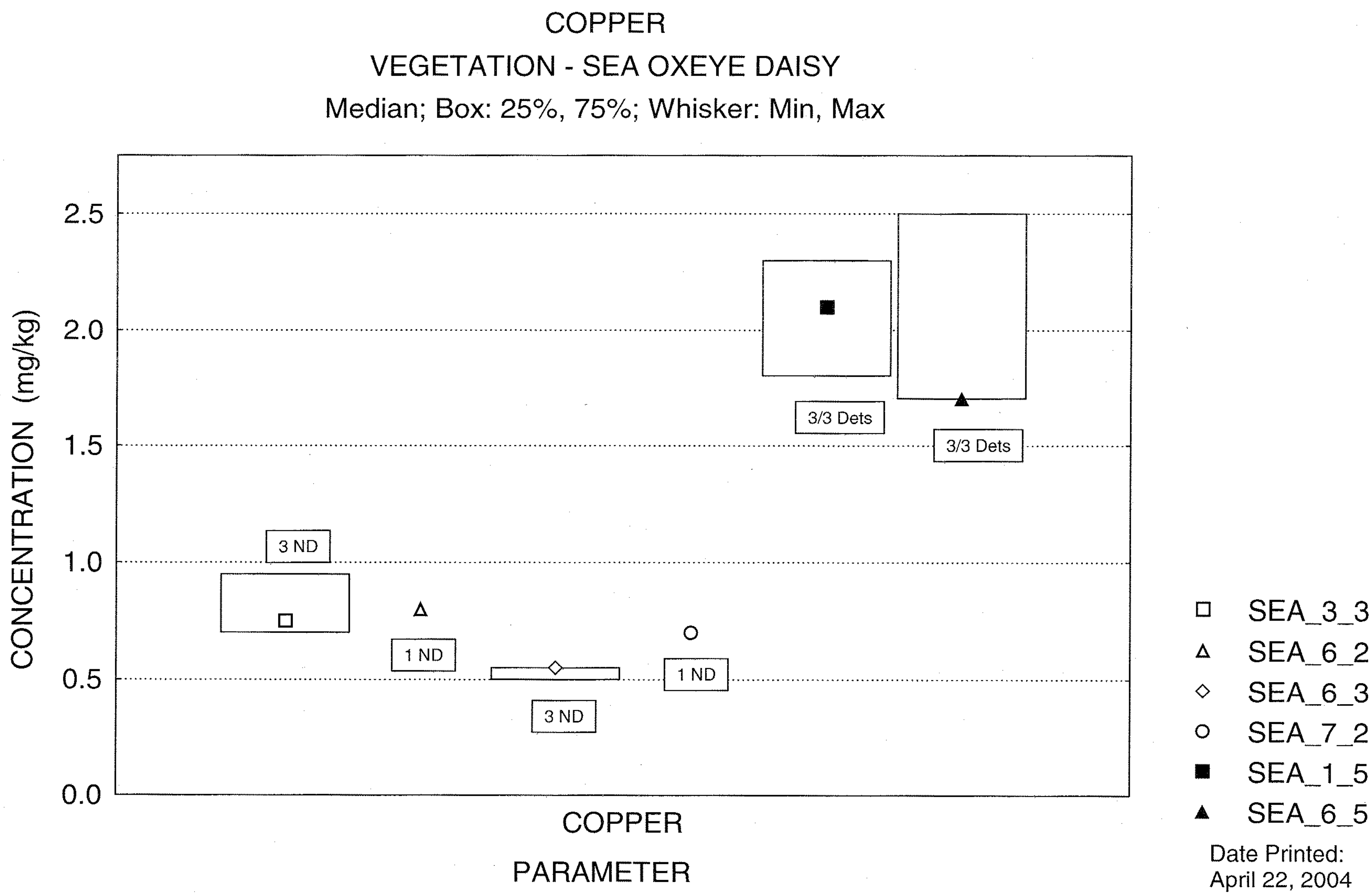
HEPTACHLOR
VEGETATION - SEA OXEYE DAISY
Median; Box: 25%, 75%; Whisker: Min, Max

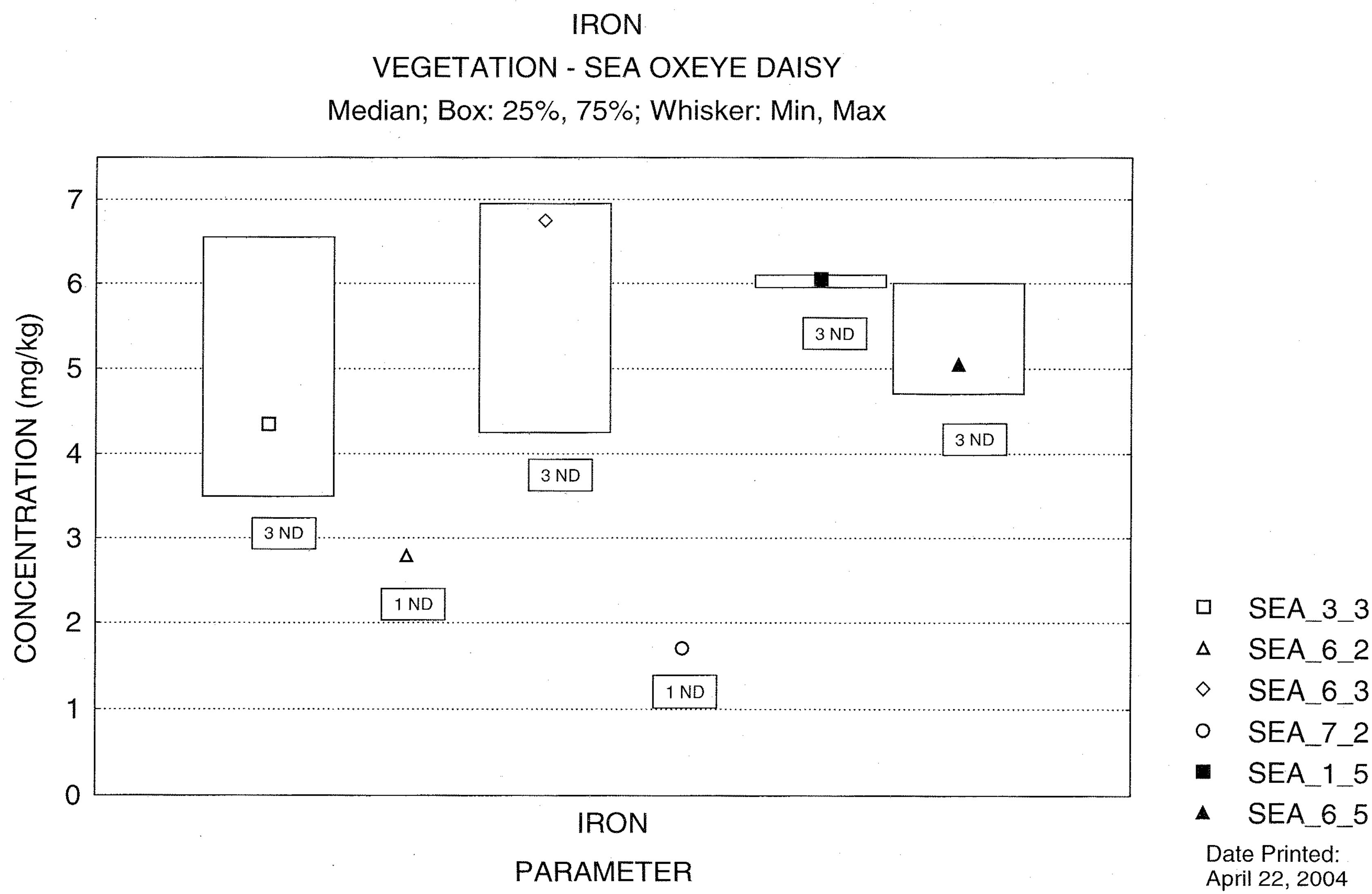


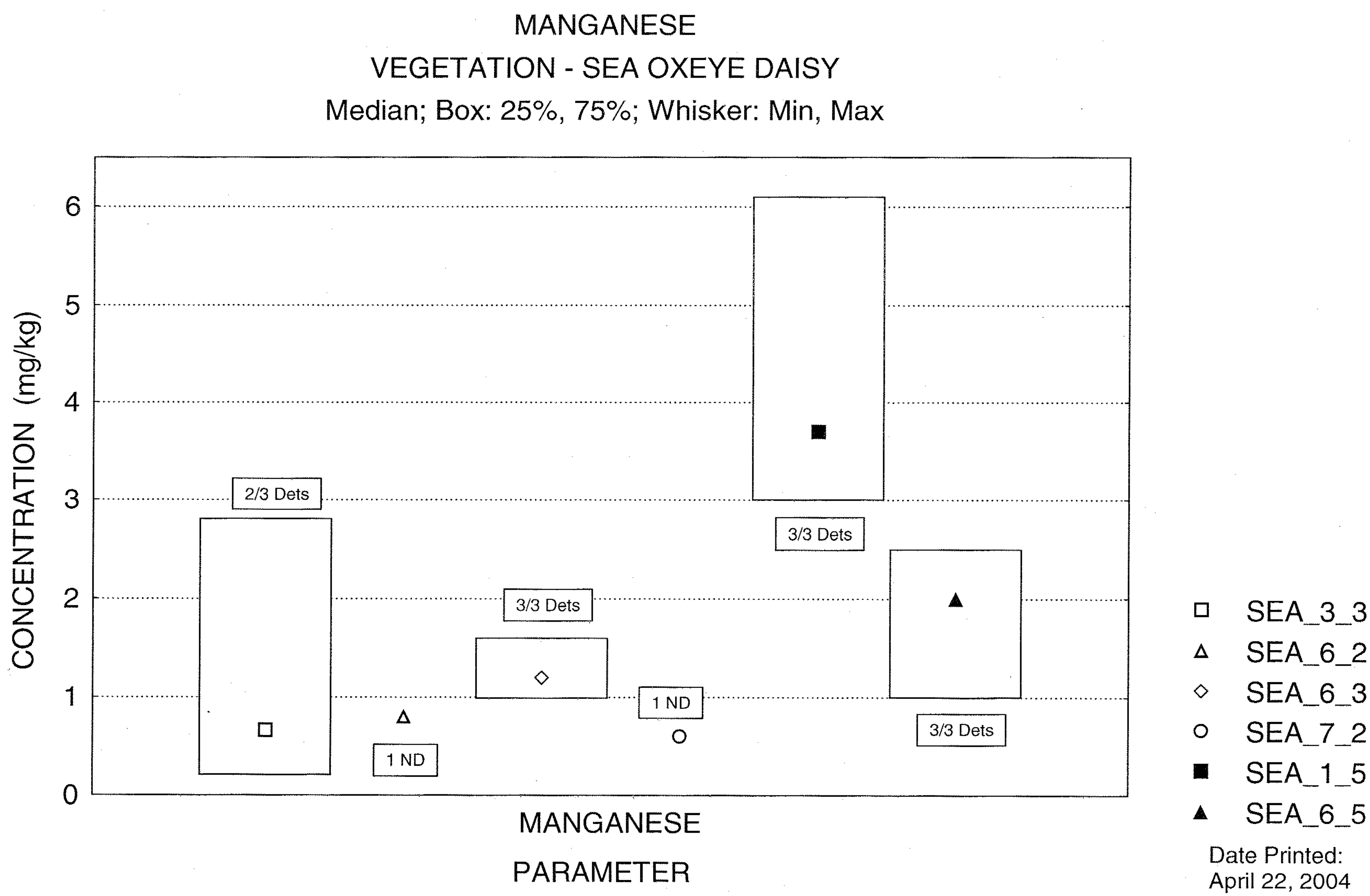
Date Printed:
April 22, 2004


BARIUM
VEGETATION - SEA OXEYE DAISY
Median; Box: 25%, 75%; Whisker: Min, Max
0.5
0.4
0.3
0.2
0.1
0.0
CONCENTRATION (mg/kg)
3 ND
1 ND
3 ND
1 ND
1/3 Dets
3 ND
BARIUM
PARAMETER
SEA_3_3
SEA_6_2
SEA_6_3
SEA_7_2
SEA_1_5
SEA_6_5
Date Printed:
April 22, 2004

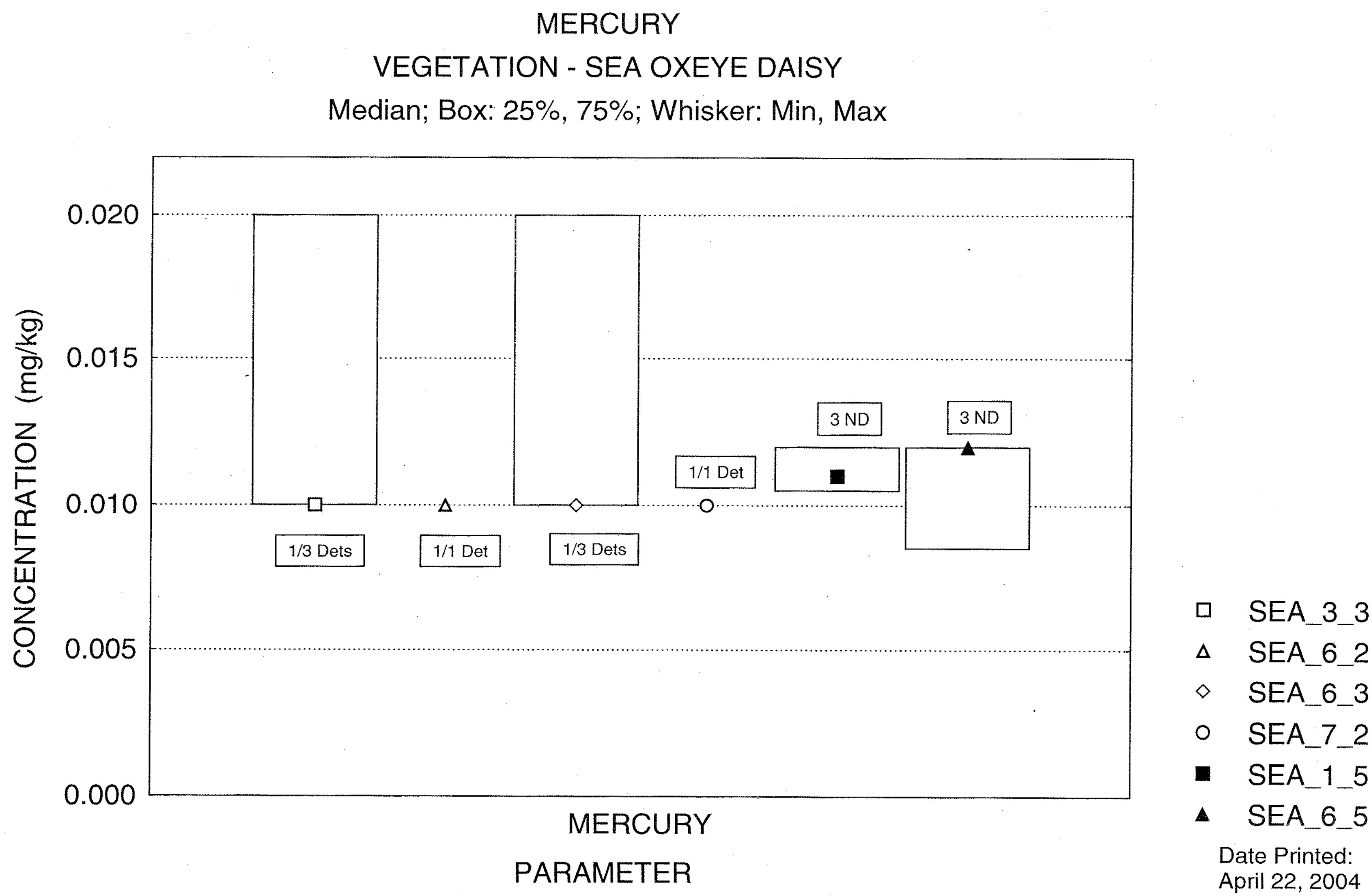

CHROMIUM
VEGETATION - SEA OXEYE DAISY
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (mg/kg)
0.36
0.30
0.24
0.18
0.12
0.06
0.00
1 ND
1 ND
3/3 Dets
3 ND
3 ND
3 ND
CHROMIUM
PARAMETER
SEA_3_3
SEA_6_2
SEA_6_3
SEA_7_2
SEA_1_5
SEA_6_5
Date Printed: April 22, 2004

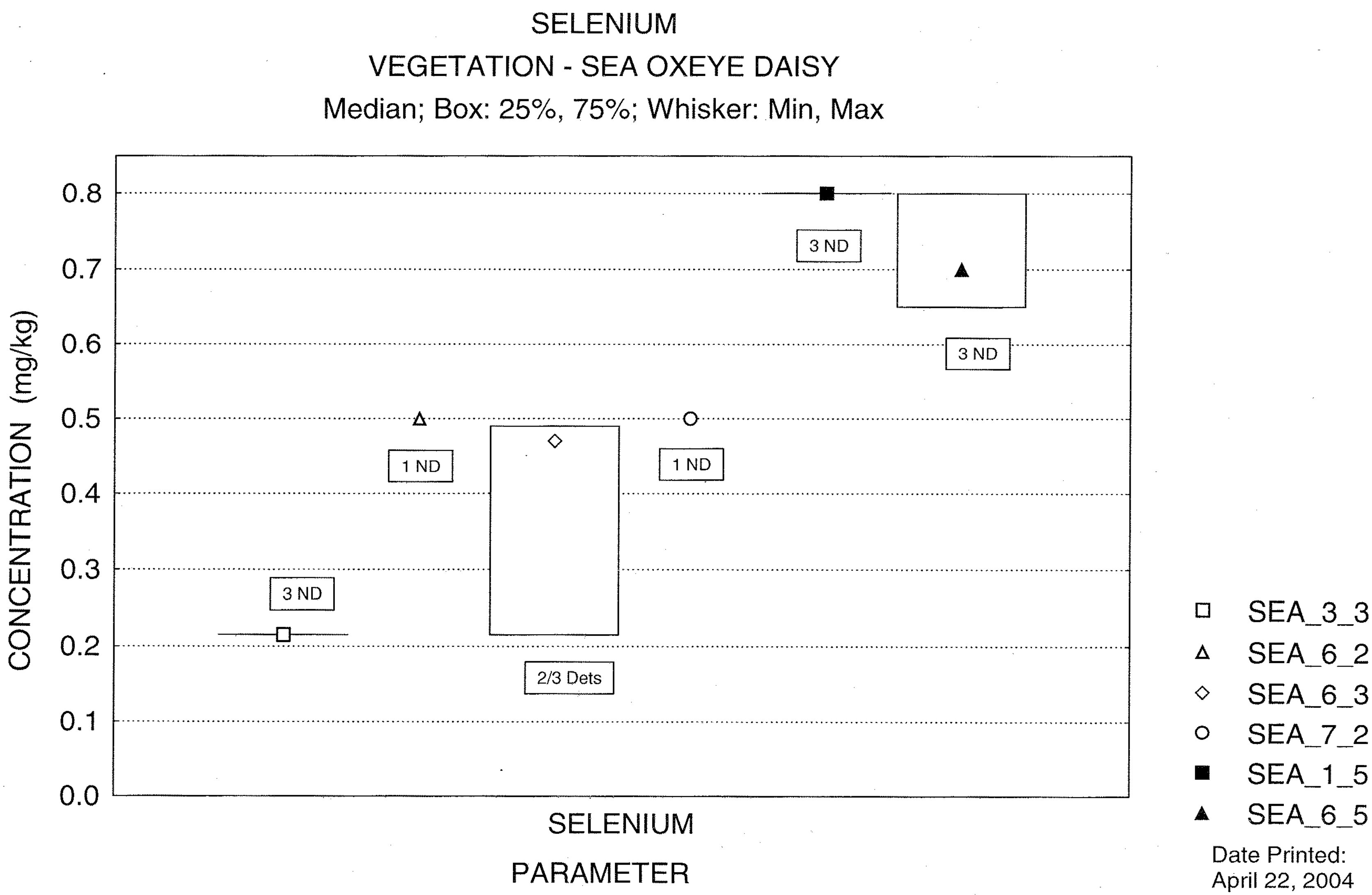

COPPER
VEGETATION - SEA OXEYE DAISY
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (mg/kg)
2.5
2.0
1.5
1.0
0.5
0.0
3 ND
1 ND
3 ND
1 ND
3/3 Dets
3/3 Dets
COPPER
PARAMETER
SEA_3_3
SEA_6_2
SEA_6_3
SEA_7_2
SEA_1_5
SEA_6_5
Date Printed:
April 22, 2004

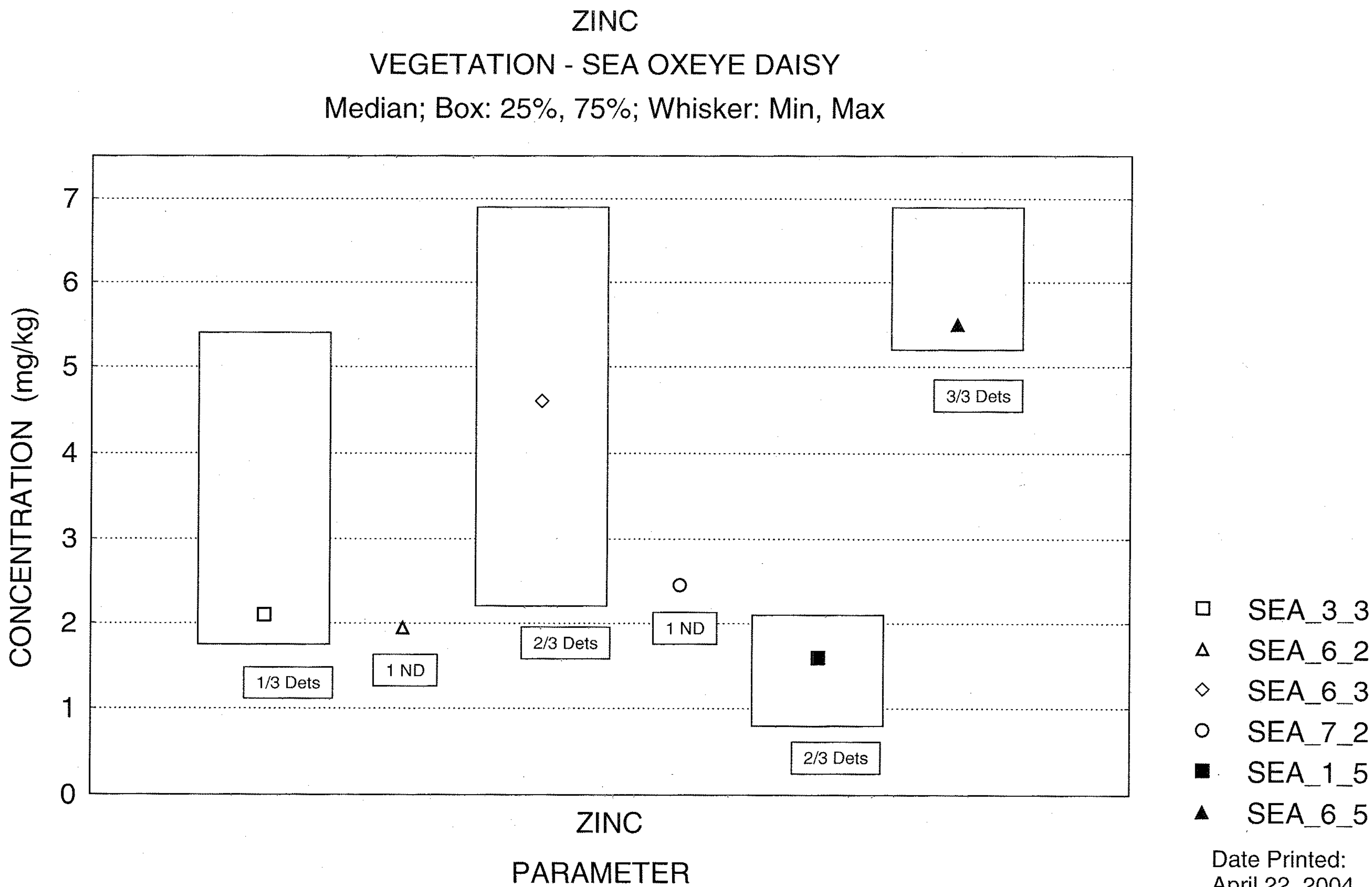

IRON
VEGETATION - SEA OXEYE DAISY
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (mg/kg)
0
1
2
3
4
5
6
7
3 ND
1 ND
3 ND
1 ND
3 ND
3 ND
IRON
PARAMETER
SEA_3_3
SEA_6_2
SEA_6_3
SEA_7_2
SEA_1_5
SEA_6_5
Date Printed:
April 22, 2004



MANGANESE
VEGETATION - SEA OXEYE DAISY
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (mg/kg)
0
1
2
3
4
5
6
2/3 Dets
1 ND
3/3 Dets
1 ND
3/3 Dets
3/3 Dets
MANGANESE
PARAMETER
SEA_3_3
SEA_6_2
SEA_6_3
SEA_7_2
SEA_1_5
SEA_6_5
Date Printed:
April 22, 2004


MERCURY
VEGETATION - SEA OXEYE DAISY
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (mg/kg)
0.020
0.015
0.010
0.005
0.000
1/3 Dets
1/1 Det
1/3 Dets
1/1 Det
3 ND
3 ND
MERCURY
PARAMETER
SEA_3_3
SEA_6_2
SEA_6_3
SEA_7_2
SEA_1_5
SEA_6_5
Date Printed:
April 22, 2004


SELENIUM
VEGETATION - SEA OXEYE DAISY
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (mg/kg)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
3 ND
1 ND
2/3 Dets
1 ND
3 ND
3 ND
SELENIUM
PARAMETER
SEA_3_3
SEA_6_2
SEA_6_3
SEA_7_2
SEA_1_5
SEA_6_5
Date Printed:
April 22, 2004



ZINC
VEGETATION - SEA OXEYE DAISY
Median; Box: 25%, 75%; Whisker: Min, Max
CONCENTRATION (mg/kg)
0
1
2
3
4
5
6
7
1/3 Dets
1 ND
2/3 Dets
1 ND
2/3 Dets
3/3 Dets
ZINC
PARAMETER
SEA_3_3
SEA_6_2
SEA_6_3
SEA_7_2
SEA_1_5
SEA_6_5
Date Printed:
April 22, 2004

APPENDIX C

NAS KEY WEST ACTION LEVELS

NAS KEY WEST ACTION LEVELS

The action level selection process was developed and document in the Site Investigation Work Plan for Nine BRAC Parcels (B&RE, 1998b) as part of the Data Quality Objectives (DQO) Process. Various sources of action levels were evaluated, and media-specific tables were developed (Tables C-1 through C-4). For each parameter in a given medium, the selected action level and the source of that value are identified in the final columns of the tables. Several considerations contributed to the selection process. Legally binding requirements, guidance values, and potentially applicable guidance values from other media were all evaluated as part of the selection process. For inorganic and pesticide compounds, both commonly found in background samples from the NAS Key West vicinity, background concentrations were considered in the action level selection process. The decision logic used compare these various values and to select the action levels is shown in Figure C-1.

Figure C-1. Decision Logic For Action Level Selection

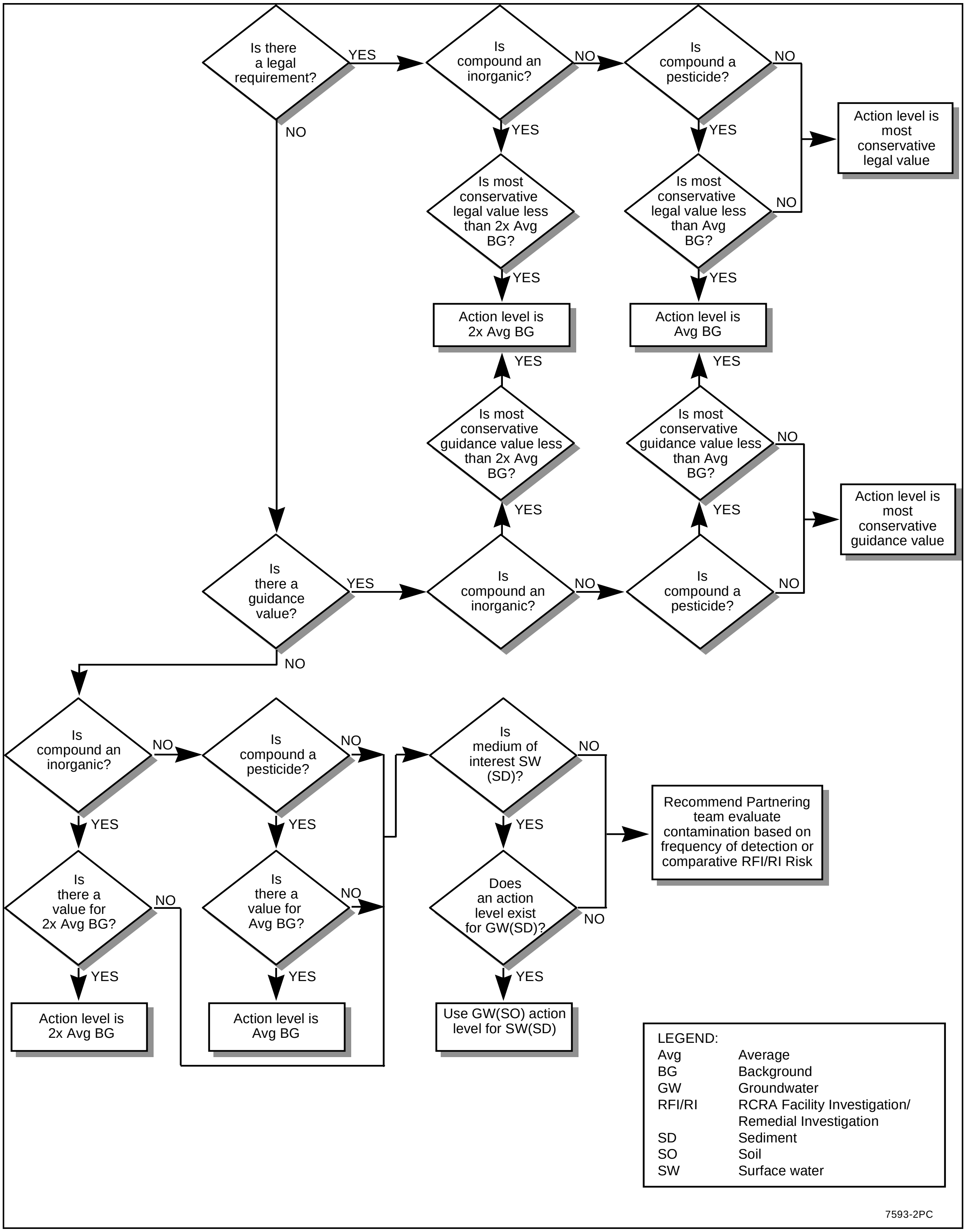


TABLE C-1

GROUNDWATER ACTION LEVELS
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

Fraction	Parameter	CAS No.	MCL	FL MCL	Tap Water RBC	FL GCTL	BG	ACTION LEVEL	units	SOURCE
M	Aluminum	7429-90-5	0	0	37000	200	0	37000	ug/L	Tap Water RBC
M	Antimony	7440-36-0	6	6	15	6	0	6	ug/L	Federal MCL
M	Arsenic	7440-38-2	10	50	0.045	50	9.9	10	ug/L	Federal MCL
M	Barium	7440-39-3	2000	2000	2600	0	19.16	2000	ug/L	Federal MCL
M	Beryllium	7440-41-7	4	4	73	4	0	4	ug/L	Federal MCL
M	Cadmium	7440-43-9	5	5	18	5	0	5	ug/L	Federal MCL
M	Calcium	7440-70-2	0	0	0	0	0	0	ug/L	NA
M	Chromium	7440-47-3	100	100	0	100	1.92	100	ug/L	Federal MCL
M	Cobalt	7440-48-4	0	0	730	420	0	730	ug/L	Tap Water RBC
M	Copper	7440-50-8	1300	0	1500	1000	3.36	1300	ug/L	Federal MCL
M	Cyanide	57-12-5	200	200	730	0	0	200	ug/L	Federal MCL
M	Iron	7439-89-6	0	0	11000	300	83.44	11000	ug/L	Tap Water RBC
M	Lead	7439-92-1	15	15	0	15	0	15	ug/L	Federal MCL
M	Magnesium	7439-95-4	0	0	0	0	0	0	ug/L	NA
M	Manganese	7439-96-5	0	0	730	50	7.56	730	ug/L	Tap Water RBC
M	Mercury	7439-97-6	2	2	0	2	0.2	2	ug/L	Federal MCL
M	Nickel	7440-02-0	0	100	730	100	0	100	ug/L	FL MCL
M	Potassium	7440-09-7	0	0	0	0	0	0	ug/L	NA
M	Selenium	7782-49-2	50	50	180	50	4.3	50	ug/L	Federal MCL
M	Silver	7440-22-4	0	0	180	100	2.06	180	ug/L	Tap Water RBC
M	Sodium	7440-23-5	0	160000	0	160000	0	160000	ug/L	FL MCL
M	Thallium	7440-28-0	2	2	2.6	2	4.62	4.62	ug/L	Background
M	Tin	7440-31-5	0	0	22000	4200	0	22000	ug/L	Tap Water RBC
M	Vanadium	7440-62-2	0	0	260	49	3.8	260	ug/L	Tap Water RBC
M	Zinc	7440-66-6	0	0	11000	5000	2.34	11000	ug/L	Tap Water RBC
MISC	ACETIC ACID	64-19-7	0	0	0	0	0	0	ug/L	NA
MISC	BUTANOIC ACID	107-92-6	0	0	0	0	0	0	ug/L	NA
MISC	Carbon Dioxide	124-38-9	0	0	0	0	0	0	ug/L	NA
MISC	Chloride	16887-00-6	250000	250000	0	250000	0	250000	ug/L	Federal MCL
MISC	Hydrogen	1333-74-0	0	0	0	0	0	0	ug/L	NA
MISC	LACTIC ACID	50-21-5	0	0	0	0	0	0	ug/L	NA
MISC	Nitrate	14797-55-8	10000	10000	58000	10000	0	10000	ug/L	Federal MCL
MISC	Nitrite	14797-65-0	1000	1000	3700	1000	0	1000	ug/L	Federal MCL
MISC	Nitrogen	7727-37-9	1000	1000	3700	1000	0	1000	ug/L	Federal MCL
MISC	Ortho-phosphate-p	14265-44-2	0	0	0	0	0	0	ug/L	NA
MISC	Oxygen	7782-44-7	0	0	0	0	0	0	ug/L	NA
MISC	PROPIONIC ACID	79-09-4	0	0	0	0	0	0	ug/L	NA
MISC	PYRUVIC ACID	127-17-3	0	0	0	0	0	0	ug/L	NA
MISC	Sulfate	14808-79-8	0	0	0	250000	0	250000	ug/L	FL GCTL
MISC	SULFIDE	18496-25-8	0	0	0	0	0	0	ug/L	NA
MISC	TOTAL DISSOLVED SOLIDS	0000	500000	500000	0	0	0	500000	ug/L	Federal MCL
MISC	Total Organic Carbon	TTNUS003	0	0	0	0	0	0	ug/L	NA
OS	1,2,4,5-TETRACHLOROBENZENE	95-94-3	0	0	11	2.1	0	11	ug/L	Tap Water RBC

TABLE C-1

GROUNDWATER ACTION LEVELS
FIVE YEAR REVIEW REPORT
NAVAL AIR STATION
KEY WEST, FLORIDA

Fraction	Parameter	CAS No.	MCL	FL MCL	Tap Water RBC	FL GCTL	BG	ACTION LEVEL	units	SOURCE
OS	1,2,4-trichlorobenzene	120-82-1	70	70	7.2	70	0	70	ug/L	Federal MCL
OS	1,2-dichlorobenzene	95-50-1	600	600	270	600	0	600	ug/L	Federal MCL
OS	1,2-DIPHENYLHYDRAZINE	122-66-7	0	0	0.084	10	0	0.084	ug/L	Tap Water RBC
OS	1,3,5-TRINITROBENZENE	99-35-4	0	0	1100	210	0	1100	ug/L	Tap Water RBC
OS	1,3-dichlorobenzene	541-73-1	0	0	180	10	0	180	ug/L	Tap Water RBC
OS	1,3-DINITROBENZENE	99-65-0	0	0	15	8	0	15	ug/L	Tap Water RBC
OS	1,4-BENZENEDIAMINE	106-50-3	0	0	0	1330	0	1330	ug/L	FL GCTL
OS	1,4-dichlorobenzene	106-46-7	75	75	0.47	75	0	75	ug/L	Federal MCL
OS	1,4-NAPHTHOQUINONE	130-15-4	0	0	0	0	0	0	ug/L	NA
OS	1-METHYLNAPHTHALENE	90-12-0	0	0	0	20	0	20	ug/L	FL GCTL
OS	1-NAPHTHYLAMINE	134-32-7	0	0	0	0	0	0	ug/L	NA
OS	2,3,4,6-TETRACHLOROPHENOL	58-90-2	0	0	1100	210	0	1100	ug/L	Tap Water RBC
OS	2,4,5-trichlorophenol	95-95-4	0	0	3700	4	0	3700	ug/L	Tap Water RBC
OS	2,4,6-trichlorophenol	88-06-2	0	0	6.1	3.2	0	6.1	ug/L	Tap Water RBC
OS	2,4-dichlorophenol	120-83-2	0	0	110	0.5	0	110	ug/L	Tap Water RBC
OS	2,4-dimethylphenol	105-67-9	0	0	730	140	0	730	ug/L	Tap Water RBC
OS	2,4-dinitrophenol	51-28-5	0	0	73	14	0	73	ug/L	Tap Water RBC
OS	2,4-dinitrotoluene	121-14-2	0	0	73	0.1	0	73	ug/L	Tap Water RBC
OS	2,6-DICHLOROPHENOL	87-65-0	0	0	0	4	0	4	ug/L	FL GCTL
OS	2,6-dinitrotoluene	606-20-2	0	0	37	0.1	0	37	ug/L	Tap Water RBC
OS	2-ACETYLAMINOFLUORENE	53-96-3	0	0	0	0	0	0	ug/L	NA
OS	2-chloronaphthalene	91-58-7	0	0	490	560	0	490	ug/L	Tap Water RBC
OS	2-chlorophenol	95-57-8	0	0	30	35	0	30	ug/L	Tap Water RBC
OS	2-methyl-4,6-dinitrophenol	534-52-1	0	0	3.7	0	0	3.7	ug/L	Tap Water RBC
OS	2-methylnaphthalene	91-57-6	0	0	120	20	0	120	ug/L	Tap Water RBC
OS	2-methylphenol	95-48-7	0	0	1800	35	0	1800	ug/L	Tap Water RBC
OS	2-NAPHTHYLAMINE	91-59-8	0	0	0	10	0	10	ug/L	FL GCTL
OS	2-nitroaniline	88-74-4	0	0	0	50	0	50	ug/L	FL GCTL
OS	2-nitrophenol	88-75-5	0	0	0	0	0	0	ug/L	NA
OS	2-PICOLINE	109-06-8	0	0	0	0	0	0	ug/L	NA
OS	3&4-METHYLPHENOL	TTNUS042	0	0	180	3.8	0	180	ug/L	Tap Water RBC
OS	3,3'-dichlorobenzidine	91-94-1	0	0	0.15	12	0	0.15	ug/L	Tap Water RBC
OS	3,3'-DIMETHYLBENZIDINE	119-93-7	0	0	0.0073	160	0	0.0073	ug/L	Tap Water RBC
OS	3-METHYLCHOLANTHRENE	56-49-5	0	0	0	0	0	0	ug/L	NA
OS	3-methylphenol	108-39-4	0	0	1800	35	0	1800	ug/L	Tap Water RBC
OS	3-nitroaniline	99-09-2	0	0	3.3	50	0	3.3	ug/L	Tap Water RBC
OS	4-AMINOBIPHENYL	92-67-1	0	0	0	0	0	0	ug/L	NA
OS	4-bromophenyl phenyl ether	101-55-3	0	0	0	406	0	406	ug/L	FL GCTL
OS	4-chloro-3-methylphenol	59-50-7	0	0	0	63	0	63	ug/L	FL GCTL
OS	4-chloroaniline	106-47-8	0	0	150	28	0	150	ug/L	Tap Water RBC
OS	4-chlorophenyl phenyl ether	7005-72-3	0	0	0	0	0	0	ug/L	NA
OS	4-methylphenol	106-44-5	0	0	180	4	0	180	ug/L	Tap Water RBC
OS	4-nitroaniline	100-01-6	0	0	3.3	21	0	3.3	ug/L	Tap Water RBC

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Fraction	Parameter	CAS No.	MCL	FL MCL	Tap Water RBC	FL GCTL	BG	ACTION LEVEL	units	SOURCE
OS	4-nitrophenol	100-02-7	0	0	290	56	0	290	ug/L	Tap Water RBC
OS	4-NITROQUINOLINE-1-OXIDE	56-57-5	0	0	0	0	0	0	ug/L	NA
OS	5-NITRO-O-TOLUIDINE	99-55-8	0	0	0	10	0	10	ug/L	FL GCTL
OS	7,12-DIMETHYLBENZ(A)ANTHRACENE	57-97-6	0	0	0	0	0	0	ug/L	NA
OS	A,A-DIMETHYLPHENETHYLAMINE	122-09-8	0	0	0	0	0	0	ug/L	NA
OS	Acenaphthene	83-32-9	0	0	2200	20	0	2200	ug/L	Tap Water RBC
OS	Acenaphthylene	208-96-8	0	0	0	210	0	210	ug/L	FL GCTL
OS	ACETOPHENONE	98-86-2	0	0	0.042	700	0	0.042	ug/L	Tap Water RBC
OS	ANILINE	62-53-3	0	0	12	6.1	0	12	ug/L	Tap Water RBC
OS	Anthracene	120-12-7	0	0	1800	2100	0	1800	ug/L	Tap Water RBC
OS	ARAMITE	140-57-8	0	0	0	10	0	10	ug/L	FL GCTL
OS	BENZIDINE	92-87-5	0	0	0.00029	400	0	0.00029	ug/L	Tap Water RBC
OS	Benzo(a)anthracene	56-55-3	0	0	0.092	0.2	0	0.092	ug/L	Tap Water RBC
OS	Benzo(a)pyrene	50-32-8	0.2	0	0.0092	0.2	0	0.2	ug/L	Federal MCL
OS	Benzo(b)fluoranthene	205-99-2	0	0	0.092	0.2	0	0.092	ug/L	Tap Water RBC
OS	Benzo(g,h,i)perylene	191-24-2	0	0	0	210	0	210	ug/L	FL GCTL
OS	Benzo(k)fluoranthene	207-08-9	0	0	0.92	0.5	0	0.92	ug/L	Tap Water RBC
OS	Benzoic acid	65-85-0	0	0	150000	28000	0	150000	ug/L	Tap Water RBC
OS	BENZYL ALCOHOL	100-51-6	0	0	11000	2100	0	11000	ug/L	Tap Water RBC
OS	Bis(2-chloroethoxy)methane	111-91-1	0	0	0	0	0	0	ug/L	NA
OS	Bis(2-chloroethyl)ether	111-44-4	0	0	0.0096	4	0	0.0096	ug/L	Tap Water RBC
OS	Bis(2-ethylhexyl)phthalate	117-81-7	6	6	4.8	6	0	6	ug/L	Federal MCL
OS	Butyl benzyl phthalate	85-68-7	0	0	7300	140	0	7300	ug/L	Tap Water RBC
OS	Carbazole	86-74-8	0	0	3.3	4	0	3.3	ug/L	Tap Water RBC
OS	CHLOROBENZILATE	510-15-6	0	0	0	0.1	0	0.1	ug/L	FL GCTL
OS	Chrysene	218-01-9	0	0	9.2	4.8	0	9.2	ug/L	Tap Water RBC
OS	DIALLATE	2303-16-4	0	0	0	0.6	0	0.6	ug/L	FL GCTL
OS	Dibenzo(a,h)anthracene	53-70-3	0	0	0.0092	0.2	0	0.0092	ug/L	Tap Water RBC
OS	Dibenzofuran	132-64-9	0	0	24	28	0	24	ug/L	Tap Water RBC
OS	Diethylphthalate	84-66-2	0	0	29000	5600	0	29000	ug/L	Tap Water RBC
OS	DIMETHOATE	60-51-5	0	0	0	0.1	0	0.1	ug/L	FL GCTL
OS	Dimethylphthalate	131-11-3	0	0	370000	70000	0	370000	ug/L	Tap Water RBC
OS	Di-n-butyl phthalate	84-74-2	0	0	3700	700	0	3700	ug/L	Tap Water RBC
OS	Di-n-octyl phthalate	117-84-0	0	0	730	140	0	730	ug/L	Tap Water RBC
OS	DIPHENYLAMINE	122-39-4	0	0	910	175	0	910	ug/L	Tap Water RBC
OS	DISULFOTON	298-04-4	0	0	1.5	0.3	0	1.5	ug/L	Tap Water RBC
OS	ETHYL METHANE SULFONATE	62-50-0	0	0	0	0	0	0	ug/L	NA
OS	FAMPHUR	52-85-7	0	0	0	3.5	0	3.5	ug/L	FL GCTL
OS	Fluoranthene	206-44-0	0	0	1500	280	0	1500	ug/L	Tap Water RBC
OS	Fluorene	86-73-7	0	0	240	280	0	240	ug/L	Tap Water RBC
OS	Hexachlorobenzene	118-74-1	1	1	0.042	1	0	1	ug/L	Federal MCL
OS	Hexachlorobutadiene	87-68-3	0	0	0.86	0.5	0	0.86	ug/L	Tap Water RBC
OS	Hexachlorocyclopentadiene	77-47-4	50	50	220	50	0	50	ug/L	Federal MCL

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Fraction	Parameter	CAS No.	MCL	FL MCL	Tap Water RBC	FL GCTL	BG	ACTION LEVEL	units	SOURCE
OS	Hexachloroethane	67-72-1	0	0	4.8	2.5	0	4.8	ug/L	Tap Water RBC
OS	HEXACHLOROPHENE	70-30-4	0	0	11	6	0	11	ug/L	Tap Water RBC
OS	HEXACHLOROPROPENE	1888-71-7	0	0	0	0	0	0	ug/L	NA
OS	Indeno(1,2,3-cd)pyrene	193-39-5	0	0	0.092	0.2	0	0.092	ug/L	Tap Water RBC
OS	ISODRIN	465-73-6	0	0	0	0	0	0	ug/L	NA
OS	Isophorone	78-59-1	0	0	70	37	0	70	ug/L	Tap Water RBC
OS	ISOSAFROLE	120-58-1	0	0	0	0	0	0	ug/L	NA
OS	KEPONE	143-50-0	0	0	0.0084	20	0	0.0084	ug/L	Tap Water RBC
OS	METHAPYRILENE	91-80-5	0	0	0	0	0	0	ug/L	NA
OS	METHYL METHANE SULFONATE	66-27-3	0	0	0	0	0	0	ug/L	NA
OS	Methyl parathion	298-00-0	0	0	9.1	0	0	9.1	ug/L	Tap Water RBC
OS	Naphthalene	91-20-3	0	0	6.5	20	0	6.5	ug/L	Tap Water RBC
OS	Nitrobenzene	98-95-3	0	0	3.5	4	0	3.5	ug/L	Tap Water RBC
OS	N-NITROSODIETHYLAMINE	55-18-5	0	0	0.00045	4	0	0.00045	ug/L	Tap Water RBC
OS	N-NITROSODIMETHYLAMINE	62-75-9	0	0	0.0013	2	0	0.0013	ug/L	Tap Water RBC
OS	N-NITROSO-DI-N-BUTYLAMINE	924-16-3	0	0	0	4	0	4	ug/L	FL GCTL
OS	N-NITROSO-DI-N-PROPYLAMINE	621-64-7	0	0	0.0019	4	0	0.0019	ug/L	Tap Water RBC
OS	n-nitrosodiphenylamine	86-30-6	0	0	14	7.1	0	14	ug/L	Tap Water RBC
OS	N-NITROSOMETHYLETHYLAMINE	10595-95-6	0	0	0.003	8	0	0.003	ug/L	Tap Water RBC
OS	N-NITROSOMORPHOLINE	59-89-2	0	0	0	0	0	0	ug/L	NA
OS	N-NITROSOPIPERIDINE	100-75-4	0	0	0	0	0	0	ug/L	NA
OS	N-NITROSOPYRROLIDINE	930-55-2	0	0	0.032	8	0	0.032	ug/L	Tap Water RBC
OS	O,O,O-TRIETHYL PHOSPHOROTHIOATE	126-68-1	0	0	0	0	0	0	ug/L	NA
OS	O,O-DIETHYL-O-2-PYRAZINYLPHOSPHOROTHIOATE	297-97-2	0	0	0	0	0	0	ug/L	NA
OS	O-TOLUIDINE	95-53-4	0	0	0	50	0	50	ug/L	FL GCTL
OS	P-(DIMETHYLAMINO)AZOBENZENE	60-11-7	0	0	0	0	0	0	ug/L	NA
OS	PENTACHLOROBENZENE	608-93-5	0	0	29	5.6	0	29	ug/L	Tap Water RBC
OS	PENTACHLORONITROBENZENE	82-68-8	0	0	0.26	0.5	0	0.26	ug/L	Tap Water RBC
OS	Pentachlorophenol	87-86-5	1	1	0.56	1	0	1	ug/L	Federal MCL
OS	PHENACETIN	62-44-2	0	0	0	0	0	0	ug/L	NA
OS	Phenanthrene	85-01-8	0	0	0	210	0	210	ug/L	FL GCTL
OS	Phenol	108-95-2	0	0	11000	10	0	11000	ug/L	Tap Water RBC
OS	PRONAMIDE	23950-58-5	0	0	0	53	0	53	ug/L	FL GCTL
OS	Pyrene	129-00-0	0	0	180	210	0	180	ug/L	Tap Water RBC
OS	PYRIDINE	110-86-1	0	0	37	7	0	37	ug/L	Tap Water RBC
OS	SAFROLE	94-59-7	0	0	0	0	0	0	ug/L	NA
OS	SULFOTEP	3689-24-5	0	0	0	3.5	0	3.5	ug/L	FL GCTL
OV	1,1,1,2-TETRACHLOROETHANE	630-20-6	0	0	0.41	1.3	0	0.41	ug/L	Tap Water RBC
OV	1,1,1-trichloroethane	71-55-6	200	200	3200	200	0	200	ug/L	Federal MCL
OV	1,1,2,2-tetrachloroethane	79-34-5	0	0	0.053	0.2	0	0.053	ug/L	Tap Water RBC
OV	1,1,2-trichloroethane	79-00-5	5	5	0.19	5	0	5	ug/L	Federal MCL
OV	1,1-dichloroethane	75-34-3	0	0	800	70	0	800	ug/L	Tap Water RBC
OV	1,1-dichloroethene	75-35-4	7	7	350	7	0	7	ug/L	Federal MCL

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Fraction	Parameter	CAS No.	MCL	FL MCL	Tap Water RBC	FL GCTL	BG	ACTION LEVEL	units	SOURCE
OV	1,2,3-TRICHLOROPROPANE	96-18-4	0	0	0.0053	0.2	0	0.0053	ug/L	Tap Water RBC
OV	1,2-DIBROMO-3-CHLOROPROPANE	96-12-8	0.2	0	0.047	0	0	0.2	ug/L	Federal MCL
OV	1,2-DIBROMOETHANE	106-93-4	0.05	0.02	0.00075	0.02	0	0.02	ug/L	FL MCL
OV	1,2-dichloroethane	107-06-2	5	3	0.12	3	0	3	ug/L	FL MCL
OV	1,2-Dichloroethene	540-59-0	70	70	55	70	0	70	ug/L	Federal MCL
OV	1,2-dichloropropane	78-87-5	5	5	0.16	5	0	5	ug/L	Federal MCL
OV	1,3-dichloropropene	542-75-6	0	0	0	0.2	0	0.2	ug/L	FL GCTL
OV	1,4-DIOXANE	123-91-1	0	0	6.1	5	0	6.1	ug/L	Tap Water RBC
OV	1-chlorohexane	544-10-5	0	0	0	0	0	0	ug/L	NA
OV	2-butanone	78-93-3	0	0	1900	4200	0	1900	ug/L	Tap Water RBC
OV	2-CHLORO-1,3-BUTADIENE	126-99-8	0	0	0	140	0	140	ug/L	FL GCTL
OV	2-CHLOROETHYL VINYL ETHER	110-75-8	0	0	0	175	0	175	ug/L	FL GCTL
OV	2-CHLOROTOLUENE	95-49-8	0	0	120	140	0	120	ug/L	Tap Water RBC
OV	2-hexanone	591-78-6	0	0	1500	280	0	1500	ug/L	Tap Water RBC
OV	3-CHLOROPROPENE	107-05-1	0	0	0	35	0	35	ug/L	FL GCTL
OV	4-methyl-2-pentanone	108-10-1	0	0	140	560	0	140	ug/L	Tap Water RBC
OV	Acetone	67-64-1	0	0	6100	700	0	6100	ug/L	Tap Water RBC
OV	ACETONITRILE	75-05-8	0	0	120	500	0	120	ug/L	Tap Water RBC
OV	ACRYLONITRILE	107-13-1	0	0	0.037	1	0	0.037	ug/L	Tap Water RBC
OV	AZOBENZENE	103-33-3	0	0	0.61	4	0	0.61	ug/L	Tap Water RBC
OV	Benzene	71-43-2	5	1	0.32	1	0	1	ug/L	FL MCL
OV	Bis(2-chloroisopropyl)ether	108-60-1	0	0	0.000048	10	0	0.000048	ug/L	Tap Water RBC
OV	Bromobenzene	108-86-1	0	0	0	0	0	0	ug/L	NA
OV	Bromodichloromethane	75-27-4	0	0	0.17	0.6	0	0.17	ug/L	Tap Water RBC
OV	Bromoform	75-25-2	100	0	8.5	4.4	0	100	ug/L	Federal MCL
OV	Bromomethane	74-83-9	0	0	8.5	9.8	0	8.5	ug/L	Tap Water RBC
OV	Carbon disulfide	75-15-0	0	0	1000	700	0	1000	ug/L	Tap Water RBC
OV	Carbon tetrachloride	56-23-5	5	3	0.16	3	0	3	ug/L	FL MCL
OV	Chlorobenzene	108-90-7	100	100	110	100	0	100	ug/L	Federal MCL
OV	Chloroethane	75-00-3	0	0	3.6	12	0	3.6	ug/L	Tap Water RBC
OV	Chloroform	67-66-3	100	0	0.15	5.7	0	100	ug/L	Federal MCL
OV	Chloromethane	74-87-3	0	0	2.1	2.7	0	2.1	ug/L	Tap Water RBC
OV	Chlorotoluene	25168-05-2	0	0	0	140	0	140	ug/L	FL GCTL
OV	cis-1,2-dichloroethene	156-59-2	70	70	61	70	0	70	ug/L	Federal MCL
OV	cis-1,3-dichloropropene	10061-01-5	0	0	0	0	0	0	ug/L	NA
OV	Dibromochloromethane	124-48-1	0	0	0.13	0.4	0	0.13	ug/L	Tap Water RBC
OV	DIBROMOMETHANE	74-95-3	0	0	0	70	0	70	ug/L	FL GCTL
OV	DICHLORODIFLUOROMETHANE	75-71-8	0	0	0	1400	0	1400	ug/L	FL GCTL
OV	Ethane	74-85-1	0	0	0	0	0	0	ug/L	NA
OV	Ethene	74-84-0	0	0	0	0	0	0	ug/L	NA
OV	ETHYL CYANIDE	107-12-0	0	0	0	0	0	0	ug/L	NA
OV	ETHYL METHACRYLATE	97-63-2	0	0	550	630	0	550	ug/L	Tap Water RBC
OV	Ethylbenzene	100-41-4	700	700	3.3	30	0	700	ug/L	Federal MCL

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Fraction	Parameter	CAS No.	MCL	FL MCL	Tap Water RBC	FL GCTL	BG	ACTION LEVEL	units	SOURCE
OV	IODOMETHANE	74-88-4	0	0	0	0	0	0	ug/L	NA
OV	ISOBUTANOL	78-83-1	0	0	1800	2100	0	1800	ug/L	Tap Water RBC
OV	ISOPROPYL ALCOHOL	67-63-0	0	0	0	0	0	0	ug/L	NA
OV	M+P-XYLENES	TTNUS054	10000	10000	12000	20	0	10000	ug/L	Federal MCL
OV	METHACRYLONITRILE	126-98-7	0	0	1	5	0	1	ug/L	Tap Water RBC
OV	Methane	74-82-8	0	0	0	0	0	0	ug/L	NA
OV	METHYL METHACRYLATE	80-62-6	0	0	1400	25	0	1400	ug/L	Tap Water RBC
OV	METHYL TERT-BUTYL ETHER	1634-04-4	0	0	2.6	50	0	2.6	ug/L	Tap Water RBC
OV	Methylene chloride	75-09-2	5	5	4.1	5	0	5	ug/L	Federal MCL
OV	M-XYLENE	108-38-3	0	0	12000	20	0	12000	ug/L	Tap Water RBC
OV	O+P-Xylenes	xxxx	0	0	12000	20	0	12000	ug/L	Tap Water RBC
OV	O-XYLENE	95-47-6	10000	10000	12000	20	0	10000	ug/L	Federal MCL
OV	PENTACHLOROETHANE	76-01-7	0	0	0	0	0	0	ug/L	NA
OV	Styrene	100-42-5	100	100	1600	100	0	100	ug/L	Federal MCL
OV	Tetrachloroethene	127-18-4	5	3	0.63	3	0	3	ug/L	FL MCL
OV	Toluene	108-88-3	1000	1000	750	40	0	1000	ug/L	Federal MCL
OV	trans-1,2-dichloroethene	156-60-5	100	100	120	100	0	100	ug/L	Federal MCL
OV	trans-1,3-dichloropropene	10061-02-6	0	0	0	0	0	0	ug/L	NA
OV	TRANS-1,4-DICHLORO-2-BUTENE	110-57-6	0	0	0	0	0	0	ug/L	NA
OV	Trichloroethene	79-01-6	5	3	0.026	3	0	3	ug/L	FL MCL
OV	TRICHLOROFLUOROMETHANE	75-69-4	0	0	1300	2100	0	1300	ug/L	Tap Water RBC
OV	VINYL ACETATE	108-05-4	0	0	410	88	0	410	ug/L	Tap Water RBC
OV	Vinyl chloride	75-01-4	2	1	0.015	1	0	1	ug/L	FL MCL
OV	Xylenes, total	1330-20-7	10000	10000	12000	20	0	10000	ug/L	Federal MCL
PCB	Aroclor-1016	12674-11-2	0.5	0.5	0.96	0.5	0	0.5	ug/L	Federal MCL
PCB	Aroclor-1221	11104-28-2	0.5	0.5	0.033	0.5	0	0.5	ug/L	Federal MCL
PCB	Aroclor-1232	11141-16-5	0.5	0.5	0.033	0.5	0	0.5	ug/L	Federal MCL
PCB	Aroclor-1242	53469-21-9	0.5	0.5	0.033	0.5	0	0.5	ug/L	Federal MCL
PCB	Aroclor-1248	12672-29-6	0.5	0.5	0.033	0.5	0	0.5	ug/L	Federal MCL
PCB	Aroclor-1254	11097-69-1	0.5	0.5	0.033	0.5	0	0.5	ug/L	Federal MCL
PCB	Aroclor-1260	11096-82-5	0.5	0.5	0.033	0.5	0	0.5	ug/L	Federal MCL
PEST	2,4,5-T	93-76-5	0	0	0	70	0	70	ug/L	FL GCTL
PEST	2,4,5-TP (silvex)	93-72-1	50	50	0	50	0	50	ug/L	Federal MCL
PEST	2,4-D	94-75-7	70	70	370	70	0	70	ug/L	Federal MCL
PEST	4,4'-DDD	72-54-8	0	0	0.28	0.1	0	0.28	ug/L	Tap Water RBC
PEST	4,4'-DDE	72-55-9	0	0	0.2	0.1	0	0.2	ug/L	Tap Water RBC
PEST	4,4'-DDT	50-29-3	0	0	0.2	0.1	0	0.2	ug/L	Tap Water RBC
PEST	Acrolein	107-02-8	0	0	0.042	14	0	0.042	ug/L	Tap Water RBC
PEST	Aldrin	309-00-2	0	0	0.0039	0.005	0	0.0039	ug/L	Tap Water RBC
PEST	alpha-BHC	319-84-6	0	0	0.011	0.006	0	0.011	ug/L	Tap Water RBC
PEST	alpha-chlordane	5103-71-9	0	0	0	0	0	0	ug/L	NA
PEST	beta-BHC	319-85-7	0	0	0.037	0.02	0	0.037	ug/L	Tap Water RBC
PEST	Chlordane	57-74-9	2	0	0.19	0	0	2	ug/L	Federal MCL

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Fraction	Parameter	CAS No.	MCL	FL MCL	Tap Water RBC	FL GCTL	BG	ACTION LEVEL	units	SOURCE
PEST	delta-BHC	319-86-8	0	0	0	2.1	0	2.1	ug/L	FL GCTL
PEST	Dieldrin	60-57-1	0	0	0.0042	0.005	0	0.0042	ug/L	Tap Water RBC
PEST	DINOSEB	88-85-7	7	7	37	7	0	7	ug/L	Federal MCL
PEST	Endosulfan I	959-98-8	0	0	220	0	0	220	ug/L	Tap Water RBC
PEST	Endosulfan II	33213-65-9	0	0	220	0	0	220	ug/L	Tap Water RBC
PEST	Endosulfan sulfate	1031-07-8	0	0	0	0	0	0	ug/L	NA
PEST	Endrin	72-20-8	2	2	11	2	0	2	ug/L	Federal MCL
PEST	Endrin aldehyde	7421-93-4	0	0	0	0	0	0	ug/L	NA
PEST	Endrin ketone	53494-70-5	0	0	0	0	0	0	ug/L	NA
PEST	gamma-BHC (lindane)	58-89-9	0.2	0.2	0.052	0.2	0	0.2	ug/L	Federal MCL
PEST	gamma-chlordane	5103-74-2	0	0	0	0	0	0	ug/L	NA
PEST	Heptachlor	76-44-8	0.4	0.4	0.015	0.4	0	0.4	ug/L	Federal MCL
PEST	Heptachlor epoxide	1024-57-3	0.2	0.2	0.0074	0.2	0	0.2	ug/L	Federal MCL
PEST	Methoxychlor	72-43-5	40	40	180	40	0	40	ug/L	Federal MCL
PEST	Parathion	56-38-2	0	0	220	42	0	220	ug/L	Tap Water RBC
PEST	Phorate	298-02-2	0	0	0	1.4	0	1.4	ug/L	FL GCTL
PEST	Toxaphene	8001-35-2	3	3	0.061	3	0	3	ug/L	Federal MCL
PET	Total Petroleum Hydrocarbons	TTNUS001	0	0	0	5000	0	5000	ug/L	FL GCTL

MCL - Safe Drinking Water Act Maximum Contaminant Levels, EPA-816-F-02-013, July 2002
FL MCL - Florida Maximum Contaminant Level, F.A.C. 62-550, last updated 8-1-2000
Tap Water RBC - EPA Region III Tap Water Risk-Based Concentrations (10/09/2002)
FL GCTL - Florida Groundwater Cleanup Target Level, F.A.C. 62-777, Table 1 (08/05/1999)
BG - Twice the average background concentration for inorganics, and the average background concentration for organics, based ona subset of data from Appendix F of the Supplemental RFI/RI for Eight Sites (B&RE, 1998a)

TABLE C-2

SEDIMENT ACTION LEVELS
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KEY WEST, FLORIDA

Fraction	Parameter	CAS No.	FDEP SQAG TEL	EPA REG IV	EPA SQC (FRESH)	ER-L	ER-M	USEPA SQB	REG III BTAG	OTHER	BACKGROUND	FDEP Soil Industrial	ACTION LEVEL	REG UNITS	SOURCE
M	Aluminum	7429-90-5	0	0	0	0	0	0	0	0	2663.78	1E+17	2663.78	mg/kg	BACKGROUND
M	Antimony	7440-36-0	0	12	0	0	0	0	150	0	0	240	12	mg/kg	EPA IV SEDIMENT SCREENING VALUE
M	Arsenic	7440-38-2	7.24	7.24	0	8.2	70	0	8.2	0	5.44	3.7	7.24	mg/kg	FDEP SQAG TEL
M	Barium	7440-39-3	0	0	0	0	0	0	0	40	19.06	87000	40	mg/kg	OTHER
M	Beryllium	7440-41-7	0	0	0	0	0	0	0	0	0.1	800	0.1	mg/kg	BACKGROUND
M	Cadmium	7440-43-9	0.676	1	0	1.2	9.6	0	1.2	0	0.34	1300	0.676	mg/kg	FDEP SQAG TEL
M	Calcium	7440-70-2	0	0	0	0	0	0	0	0	0	0	0	mg/kg	NA
M	Chromium	7440-47-3	52.3	52.3	0	81	370	0	81	0	9.22	420	52.3	mg/kg	FDEP SQAG TEL
M	Cobalt	7440-48-4	0	0	0	0	0	0	0	0	0.48	110000	0.48	mg/kg	BACKGROUND
M	Copper	7440-50-8	18.7	18.7	0	34	270	0	34	0	18.42	76000	18.7	mg/kg	FDEP SQAG TEL
M	CYANIDE	57-12-5	0	0	0	0	0	0	0	0	0	39000	39000	mg/kg	INDUSTRIAL SCTL
M	Iron	7439-89-6	0	0	0	0	0	0	0	0	2398	480000	2398	mg/kg	BACKGROUND
M	Lead	7439-92-1	30.2	30.2	0	46.7	218	0	46.7	0	34.18	920	34.18	mg/kg	BACKGROUND
M	Magnesium	7439-95-4	0	0	0	0	0	0	0	0	0	0	0	mg/kg	NA
M	Manganese	7439-96-5	0	0	0	0	0	0	0	460	30.78	22000000	460	mg/kg	OTHER
M	Mercury	7439-97-6	0.13	0.13	0	0.15	0.71	0	0.15	0	0.1	26	0.13	mg/kg	FDEP SQAG TEL
M	Nickel	7440-02-0	15.9	15.9	0	20.9	51.6	0	20.9	0	4.14	28000	15.9	mg/kg	FDEP SQAG TEL
M	Potassium	7440-09-7	0	0	0	0	0	0	0	0	0	0	0	mg/kg	NA
M	Selenium	7782-49-2	0	0	0	0	0	0	0	0	1.42	10000	1.42	mg/kg	BACKGROUND
M	Silver	7440-22-4	0.733	2	0	1	3.7	0	1	0	0.44	9100	0.733	mg/kg	FDEP SQAG TEL
M	Sodium	7440-23-5	0	0	0	0	0	0	0	0	0	0	0	mg/kg	NA
M	Thallium	7440-28-0	0	0	0	0	0	0	0	0	0	0	0	mg/kg	NA
M	Tin	7440-31-5	0	0	0	0	0	0	0	0	1.98	660000	1.98	mg/kg	BACKGROUND
M	Vanadium	7440-62-2	0	0	0	0	0	0	0	0	10.44	7400	10.44	mg/kg	BACKGROUND
M	Zinc	7440-66-6	124	124	0	150	410	0	150	0	46.66	560000	124	mg/kg	FDEP SQAG TEL
OS	1,2,4-trichlorobenzene	120-82-1	0	0	0	0	0	9200	0	0	0	7500000	9200	ug/kg	EPA SQB
OS	1,2-dichlorobenzene	95-50-1	0	0	0	0	0	340	35	0	0	4600000	35	ug/kg	EPA III BTAG
OS	1,2-DIPHENYLHYDRAZINE	122-66-7	0	0	0	0	0	0	0	0	0	3700	3700	ug/kg	INDUSTRIAL SCTL
OS	1,3,5-TRINITROBENZENE	99-35-4	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
OS	1,3-dichlorobenzene	541-73-1	0	0	0	0	0	1700	0	0	0	180000	1700	ug/kg	EPA SQB
OS	1,3-DINITROBENZENE	99-65-0	0	0	0	0	0	0	0	0	0	33000	33000	ug/kg	INDUSTRIAL SCTL
OS	1,4-dichlorobenzene	106-46-7	0	0	0	0	0	350	110	0	0	9000	110	ug/kg	EPA III BTAG
OS	1,4-NAPHTHOQUINONE	130-15-4	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
OS	1-methylnapthalene	90-12-0	0	0	0	0	0	0	0	0	0	470000	470000	ug/kg	INDUSTRIAL SCTL
OS	1-NAPHTHYLAMINE	134-32-7	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
OS	1-PICOLINE	1333-41-1	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
OS	2,3,4,6-TETRACHLOROPHENOL	58-90-2	0	0	0	0	0	0	0	0	0	17000000	17000000	ug/kg	INDUSTRIAL SCTL
OS	2,4,5-trichlorophenol	95-95-4	0	0	0	0	0	0	0	0	0	82000000	82000000	ug/kg	INDUSTRIAL SCTL
OS	2,4,6-trichlorophenol	88-06-2	0	0	0	0	0	0	0	0	0	180000	180000	ug/kg	INDUSTRIAL SCTL
OS	2,4-dichlorophenol	120-83-2	0	0	0	0	0	0	0	0	0	1300000	1300000	ug/kg	INDUSTRIAL SCTL
OS	2,4-dimethylphenol	105-67-9	0	0	0	0	0	0	29	0	0	9800000	29	ug/kg	EPA III BTAG
OS	2,4-dinitrophenol	51-28-5	0	0	0	0	0	0	0	0	0	620000	620000	ug/kg	INDUSTRIAL SCTL
OS	2,4-dinitrotoluene	121-14-2	0	0	0	0	0	0	0	0	0	3700	3700	ug/kg	INDUSTRIAL SCTL
OS	2,6-DICHLOROPHENOL	87-65-0	0	0	0	0	0	0	0	0	0	2200000	2200000	ug/kg	INDUSTRIAL SCTL
OS	2,6-dinitrotoluene	606-20-2	0	0	0	0	0	0	0	0	0	2100	2100	ug/kg	INDUSTRIAL SCTL
OS	2-ACETYLAMINOFLUORENE	53-96-3	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
OS	2-chloronaphthalene	91-58-7	0	0	0	0	0	0	0	0	0	49000000	49000000	ug/kg	INDUSTRIAL SCTL
OS	2-chlorophenol	95-57-8	0	0	0	0	0	0	0	0	0	640000	640000	ug/kg	INDUSTRIAL SCTL
OS	2-methyl-4,6-dinitrophenol	534-52-1	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
OS	2-methylnaphthalene	91-57-6	20.2	330	0	70	670	0	70	0	0	560000	20.2	ug/kg	FDEP SQAG TEL
OS	2-methylphenol	95-48-7	0	0	0	0	0	0	63	0	0	28000000	63	ug/kg	EPA III BTAG
OS	2-NAPHTHYLAMINE	91-59-8	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
OS	2-nitroaniline	88-74-4	0	0	0	0	0	0	0	0	0	66000	66000	ug/kg	INDUSTRIAL SCTL
OS	2-nitrophenol	88-75-5	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
OS	2-PICOLINE	109-06-8	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
OS	3&4-METHYLPHENOL	TTNUS042	0	0	0	0	0	0	0	0	0	3000000	3000000	ug/kg	INDUSTRIAL SCTL
OS	3,3'-dichlorobenzidine	91-94-1	0	0	0	0	0	0	0	0	0	6300	6300	ug/kg	INDUSTRIAL SCTL
OS	3,3'-DIMETHYLBENZIDINE	119-93-7	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
OS	3-METHYLCHOLANTHRENE	56-49-5	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
OS	3-methylphenol	108-39-4	0	0	0	0	0	0	0	0	0	29000000	29000000	ug/kg	INDUSTRIAL SCTL
OS	3-nitroaniline	99-09-2	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA

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Fraction	Parameter	CAS No.	FDEP SQAG TEL	EPA REG IV	EPA SQC (FRESH)	ER-L	ER-M	USEPA SQB	REG III BTAG	OTHER	BACKGROUND	FDEP Soil Industrial	ACTION LEVEL	REG UNITS	SOURCE
OS	4-AMINOBIPHENYL	92-67-1	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
OS	4-bromophenyl phenyl ether	101-55-3	0	0	0	0	0	1300	0	0	0	0	1300	ug/kg	EPA SQB
OS	4-chloro-3-methylphenol	59-50-7	0	0	0	0	0	0	0	0	0	4400000	4400000	ug/kg	INDUSTRIAL SCTL
OS	4-chloroaniline	106-47-8	0	0	0	0	0	0	0	0	0	2000000	2000000	ug/kg	INDUSTRIAL SCTL
OS	4-chlorophenyl phenyl ether	7005-72-3	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
OS	4-methylphenol	106-44-5	0	0	0	0	0	0	0	0	0	3000000	3000000	ug/kg	INDUSTRIAL SCTL
OS	4-nitroaniline	100-01-6	0	0	0	0	0	0	0	0	0	56000	56000	ug/kg	INDUSTRIAL SCTL
OS	4-nitrophenol	100-02-7	0	0	0	0	0	0	0	0	0	4400000	4400000	ug/kg	INDUSTRIAL SCTL
OS	4-NITROQUINOLINE-1-OXIDE	56-57-5	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
OS	5-NITRO-O-TOLUIDINE	99-55-8	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
OS	7,12-DIMETHYLBENZ(A)ANTHRACENE	57-97-6	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
OS	A,A-DIMETHYLPHENETHYLAMINE	122-09-8	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
OS	Acenaphthene	83-32-9	6.71	330	620	16	500	0	16	0	0	18000000	6.71	ug/kg	FDEP SQAG TEL
OS	Acenaphthylene	208-96-8	5.87	330	0	44	640	0	44	0	0	11000000	5.87	ug/kg	FDEP SQAG TEL
OS	ACETOPHENONE	98-86-2	0	0	0	0	0	0	0	0	0	24000000	24000000	ug/kg	INDUSTRIAL SCTL
OS	ANILINE	62-53-3	0	0	0	0	0	0	0	0	0	100000	100000	ug/kg	INDUSTRIAL SCTL
OS	Anthracene	120-12-7	46.9	330	0	85.3	1100	0	85.3	0	0	260000000	46.9	ug/kg	FDEP SQAG TEL
OS	ARAMITE	140-57-8	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
OS	AZOBENZENE	103-33-3	0	0	0	0	0	0	0	0	0	24000	24000	ug/kg	INDUSTRIAL SCTL
OS	BENZIDINE	92-87-5	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
OS	Benzo(a)anthracene	56-55-3	74.8	330	0	261	1600	0	261	0	0	5000	74.8	ug/kg	FDEP SQAG TEL
OS	Benzo(a)pyrene	50-32-8	88.8	330	0	430	1600	0	430	0	0	500	88.8	ug/kg	FDEP SQAG TEL
OS	Benzo(b)fluoranthene	205-99-2	0	0	0	0	0	0	3200	0	0	4800	3200	ug/kg	EPA III BTAG
OS	Benzo(g,h,i)perylene	191-24-2	0	0	0	0	0	0	670	0	0	41000000	670	ug/kg	EPA III BTAG
OS	Benzo(k)fluoranthene	207-08-9	0	0	0	0	0	0	0	0	0	52000	52000	ug/kg	INDUSTRIAL SCTL
OS	BENZOIC ACID	65-85-0	0	0	0	0	0	0	650	0	0	1E+17	650	ug/kg	EPA III BTAG
OS	BENZYL ALCOHOL	100-51-6	0	0	0	0	0	0	57	0	0	610000000	57	ug/kg	EPA III BTAG
OS	Bis(2-chloroethoxy)methane	111-91-1	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
OS	Bis(2-chloroethyl)ether	111-44-4	0	0	0	0	0	0	0	0	0	400	400	ug/kg	INDUSTRIAL SCTL
OS	Bis(2-ethylhexyl)phthalate	117-81-7	182	182	0	0	0	0	1300	890000000	0	280000	182	ug/kg	FDEP SQAG TEL
OS	Butyl benzyl phthalate	85-68-7	0	0	0	0	0	11000	63	0	0	320000000	63	ug/kg	EPA III BTAG
OS	Carbazole	86-74-8	0	0	0	0	0	0	0	0	0	190000	190000	ug/kg	INDUSTRIAL SCTL
OS	CHLOROBENZILATE	510-15-6	0	0	0	0	0	0	0	0	0	14000	14000	ug/kg	INDUSTRIAL SCTL
OS	Chrysene	218-01-9	108	330	0	384	2800	0	384	0	0	450000	108	ug/kg	FDEP SQAG TEL
OS	DIALLATE	2303-16-4	0	0	0	0	0	0	0	0	0	56000	56000	ug/kg	INDUSTRIAL SCTL
OS	Dibenzo(a,h)anthracene	53-70-3	6.22	330	0	63.4	260	0	63.4	0	0	500	6.22	ug/kg	FDEP SQAG TEL
OS	Dibenzofuran	132-64-9	0	0	0	0	0	2000	540	0	0	5000000	540	ug/kg	EPA III BTAG
OS	Diethyl phthalate	84-66-2	0	0	0	0	0	630	200	0	0	920000000	200	ug/kg	EPA III BTAG
OS	DIMETHOATE	60-51-5	0	0	0	0	0	0	0	0	0	86000	86000	ug/kg	INDUSTRIAL SCTL
OS	Dimethyl phthalate	131-11-3	0	0	0	0	0	0	71	0	0	1E+17	71	ug/kg	EPA III BTAG
OS	Di-n-butyl phthalate	84-74-2	0	0	0	0	0	11000	1400	0	0	140000000	1400	ug/kg	EPA III BTAG
OS	Di-n-octyl phthalate	117-84-0	0	0	0	0	0	0	6200	0	0	27000000	6200	ug/kg	EPA III BTAG
OS	DIPHENYLAMINE	122-39-4	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
OS	DISULFOTON	298-04-4	0	0	0	0	0	0	0	0	0	56000	56000	ug/kg	INDUSTRIAL SCTL
OS	ETHYL METHANE SULFONATE	62-50-0	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
OS	FAMPHUR	52-85-7	0	0	0	0	0	0	0	0	0			ug/kg	NA
OS	Fluoranthene	206-44-0	113	330	2900	600	5100	0	600	0	0	48000000	113	ug/kg	FDEP SQAG TEL
OS	Fluorene	86-73-7	21.2	330	0	19	540	540	19	0	0	28000000	19	ug/kg	EFFECTS RANGE-LOW
OS	Hexachlorobenzene	118-74-1	0	0	0	0	0	0	22	0	0	1100	22	ug/kg	EPA III BTAG
OS	Hexachlorobutadiene	87-68-3	0	0	0	0	0	0	11	0	0	12000	11	ug/kg	EPA III BTAG
OS	Hexachlorocyclopentadiene	77-47-4	0	0	0	0	0	0	0	0	0	16000	16000	ug/kg	INDUSTRIAL SCTL
OS	Hexachloroethane	67-72-1	0	0	0	0	0	1000	0	0	0	78000	1000	ug/kg	EPA SQB
OS	HEXACHLOROPHENE	70-30-4	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
OS	HEXACHLOROPROPENE	1888-71-7	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
OS	Indeno(1,2,3-cd)pyrene	193-39-5	0	0	0	0	0	0	600	0	0	5300	600	ug/kg	EPA III BTAG
OS	ISODRIN	465-73-6	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
OS	Isophorone	78-59-1	0	0	0	0	0	0	0	0	0	580000	580000	ug/kg	INDUSTRIAL SCTL
OS	ISOSAFROLE	120-58-1	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
OS	KEPONE	143-50-0	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
OS	METHAPYRILENE	91-80-5	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
OS	METHYL METHANE SULFONATE	66-27-3	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA

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Fraction	Parameter	CAS No.	FDEP SQAG TEL	EPA REG IV	EPA SQC (FRESH)	ER-L	ER-M	USEPA SQB	REG III BTAG	OTHER	BACKGROUND	FDEP Soil Industrial	ACTION LEVEL	REG UNITS	SOURCE
OS	METHYL PARATHION	298-00-0	0	0	0	0	0	0	31	0	0	310000	31	ug/kg	EPA III BTAG
OS	Naphthalene	91-20-3	34.6	330	0	160	2100	480	160	0	0	270000	34.6	ug/kg	FDEP SQAG TEL
OS	Nitrobenzene	98-95-3	0	0	0	0	0	0	0	0	0	120000	120000	ug/kg	INDUSTRIAL SCTL
OS	N-NITROSODIETHYLAMINE	55-18-5	0	0	0	0	0	0	0	0	0	5	5	ug/kg	INDUSTRIAL SCTL
OS	N-NITROSODIMETHYLAMINE	62-75-9	0	0	0	0	0	0	0	0	0	20	20	ug/kg	INDUSTRIAL SCTL
OS	N-NITROSO-DI-N-BUTYLAMINE	924-16-3	0	0	0	0	0	0	0	0	0	70	70	ug/kg	INDUSTRIAL SCTL
OS	N-NITROSO-DI-N-PROPYLAMINE	621-64-7	0	0	0	0	0	0	0	0	0	200	200	ug/kg	INDUSTRIAL SCTL
OS	n-nitrosodiphenylamine	86-30-6	0	0	0	0	0	0	28	0	0	440000	28	ug/kg	EPA III BTAG
OS	N-NITROSOMETHYLETHYLAMINE	10595-95-6	0	0	0	0	0	0	0	0	0	20	20	ug/kg	INDUSTRIAL SCTL
OS	N-NITROSOMORPHOLINE	59-89-2	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
OS	N-NITROSOPIPERIDINE	100-75-4	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
OS	N-NITROSOPYRROLIDINE	930-55-2	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
OS	O,O,O-TRIETHYL PHOSPHOROTHIOATE	126-68-1	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
OS	O,O-DIETHYL-O-2-PYRAZINYLPHOSPHOROTHIOATE	297-97-2	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
OS	O-TOLUIDINE	95-53-4	0	0	0	0	0	0	0	0	0	3300	3300	ug/kg	INDUSTRIAL SCTL
OS	P-DIMETHYLAMINOAZOBENZENE	60-11-7	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
OS	PENTACHLOROBENZENE	608-93-5	0	0	690	0	0	0	0	0	0	250000	690	ug/kg	EPA SQC (FRESH)
OS	PENTACHLORONITROBENZENE	82-68-8	0	0	0	0	0	0	0	0	0	7700	7700	ug/kg	INDUSTRIAL SCTL
OS	Pentachlorophenol	87-86-5	0	0	0	0	0	0	360	0	0	23000	360	ug/kg	EPA III BTAG
OS	PHENACETIN	62-44-2	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
OS	Phenanthrene	85-01-8	86.7	330	850	240	1500	0	240	0	0	30000000	86.7	ug/kg	FDEP SQAG TEL
OS	Phenol	108-95-2	0	0	0	0	0	0	420	0	0	390000000	420	ug/kg	EPA III BTAG
OS	PHORATE	298-02-2	0	0	0	0	0	0	0	0	0	280000	280000	ug/kg	INDUSTRIAL SCTL
OS	P-PHENYLENEDIAMINE	106-50-3	0	0	0	0	0	0	0	0	0	83000000	83000000	ug/kg	INDUSTRIAL SCTL
OS	PRONAMIDE	23950-58-5	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
OS	Pyrene	129-00-0	153	330	0	665	2600	0	665	0	0	37000000	153	ug/kg	FDEP SQAG TEL
OS	PYRIDINE	110-86-1	0	0	0	0	0	0	0	0	0	95000	95000	ug/kg	INDUSTRIAL SCTL
OS	SAFROLE	94-59-7	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
OS	SULFOTEP	3689-24-5	0	0	0	0	0	0	0	0	0	420000	420000	ug/kg	INDUSTRIAL SCTL
OV	1,1,1,2-TETRACHLOROETHANE	630-20-6	0	0	0	0	0	0	0	0	0	5700	5700	ug/kg	INDUSTRIAL SCTL
OV	1,1,1-trichloroethane	71-55-6	0	0	0	0	0	170	31	0	0	3300000	31	ug/kg	EPA III BTAG
OV	1,1,2,2-tetrachloroethane	79-34-5	0	0	0	0	0	940	0	0	0	1100	940	ug/kg	EPA SQB
OV	1,1,2-trichloroethane	79-00-5	0	0	0	0	0	0	31	0	0	1800	31	ug/kg	EPA III BTAG
OV	1,1-dichloroethane	75-34-3	0	0	0	0	0	0	0	0	0	2000000	2000000	ug/kg	INDUSTRIAL SCTL
OV	1,1-dichloroethene	75-35-4	0	0	0	0	0	0	0	0	0	100	100	ug/kg	INDUSTRIAL SCTL
OV	1,2,3-TRICHLOROPROPANE	96-18-4	0	0	0	0	0	0	0	0	0	20	20	ug/kg	INDUSTRIAL SCTL
OV	1,2,4,5-TETRACHLOROBENZENE	95-94-3	0	0	0	0	0	0	0	0	0	51000	51000	ug/kg	INDUSTRIAL SCTL
OV	1,2-dibromomethane	74-95-3	0	0	0	0	0	0	0	0	0	400000	400000	ug/kg	INDUSTRIAL SCTL
OV	1,2-dichloroethane	107-06-2	0	0	0	0	0	0	0	0	0	700	700	ug/kg	INDUSTRIAL SCTL
OV	1,2-dichloroethene	540-59-0	0	0	0	0	0	0	0	0	0	130000	130000	ug/kg	INDUSTRIAL SCTL
OV	1,2-dichloropropane	78-87-5	0	0	0	0	0	0	0	0	0	800	800	ug/kg	INDUSTRIAL SCTL
OV	1,4-DIOXANE	123-91-1	0	0	0	0	0	0	0	0	0	18000	18000	ug/kg	INDUSTRIAL SCTL
OV	1-chlorohexane	544-10-5	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
OV	2-butanone	78-93-3	0	0	0	0	0	0	0	0	0	21000000	21000000	ug/kg	INDUSTRIAL SCTL
OV	2-CHLORO-1,3-BUTADIENE	126-99-8	0	0	0	0	0	0	0	0	0	17000	17000	ug/kg	INDUSTRIAL SCTL
OV	2-CHLOROETHYL VINYL ETHER	110-75-8	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
OV	2-hexanone	591-78-6	0	0	0	0	0	0	0	0	0	34000	34000	ug/kg	INDUSTRIAL SCTL
OV	3-CHLOROPROPENE	107-05-1	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
OV	4-methyl-2-pentanone	108-10-1	0	0	0	0	0	0	0	0	0	1500000	1500000	ug/kg	INDUSTRIAL SCTL
OV	Acetone	67-64-1	0	0	0	0	0	0	0	64	0	5500000	64	ug/kg	OTHER
OV	ACETONITRILE	75-05-8	0	0	0	0	0	0	0	0	0	960000	960000	ug/kg	INDUSTRIAL SCTL
OV	ACROLEIN	107-02-8	0	0	0	0	0	0	0	0	0	300	300	ug/kg	INDUSTRIAL SCTL
OV	ACRYLONITRILE	107-13-1	0	0	0	0	0	0	0	0	0	500	500	ug/kg	INDUSTRIAL SCTL
OV	Benzene	71-43-2	0	0	0	0	0	57	0	0	0	1600	57	ug/kg	EPA SQB
OV	Bis(2-chloroisopropyl)ether	108-60-1	0	0	0	0	0	0	0	0	0	7300	7300	ug/kg	INDUSTRIAL SCTL
OV	BROMOBENZENE	108-86-1	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
OV	Bromodichloromethane	75-27-4	0	0	0	0	0	0	0	0	0	2000	2000	ug/kg	INDUSTRIAL SCTL
OV	Bromoform	75-25-2	0	0	0	0	0	0	0	0	0	84000	84000	ug/kg	INDUSTRIAL SCTL
OV	Bromomethane	74-83-9	0	0	0	0	0	0	0	0	0	15000	15000	ug/kg	INDUSTRIAL SCTL
OV	Carbon disulfide	75-15-0	0	0	0	0	0	0	0	13	0	1400000	13	ug/kg	OTHER
OV	Carbon tetrachloride	56-23-5	0	0	0	0	0	0	0	0	0	600	600	ug/kg	INDUSTRIAL SCTL

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Fraction	Parameter	CAS No.	FDEP SQAG TEL	EPA REG IV	EPA SQC (FRESH)	ER-L	ER-M	USEPA SQB	REG III BTAG	OTHER	BACKGROUND	FDEP Soil Industrial	ACTION LEVEL	REG UNITS	SOURCE
OV	Chlorobenzene	108-90-7	0	0	0	0	0	820	0	0	0	200000	820	ug/kg	EPA SQB
OV	Chloroethane	75-00-3	0	0	0	0	0	0	0	0	0	4000	4000	ug/kg	INDUSTRIAL SCTL
OV	Chloroform	67-66-3	0	0	0	0	0	0	0	0	0	500	500	ug/kg	INDUSTRIAL SCTL
OV	Chloromethane	74-87-3	0	0	0	0	0	0	0	0	0	2300	2300	ug/kg	INDUSTRIAL SCTL
OV	CHLOROPRENE	557-98-2	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
OV	Chlorotoluene	25168-05-2	0	0	0	0	0	0	0	0	0	730000	730000	ug/kg	INDUSTRIAL SCTL
OV	cis-1,2-dichloroethene	156-59-2	0	0	0	0	0	0	0	23	0	130000	23	ug/kg	OTHER
OV	cis-1,3-dichloropropene	10061-01-5	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
OV	Dibromochloromethane	124-48-1	0	0	0	0	0	0	0	0	0	2100	2100	ug/kg	INDUSTRIAL SCTL
OV	DICHLORODIFLUOROMETHANE	75-71-8	0	0	0	0	0	0	0	0	0	370000	370000	ug/kg	INDUSTRIAL SCTL
OV	ETHYL METHACRYLATE	97-63-2	0	0	0	0	0	0	0	0	0	2600000	2600000	ug/kg	INDUSTRIAL SCTL
OV	Ethylbenzene	100-41-4	0	0	0	0	0	3600	10	0	0	8400000	10	ug/kg	EPA III BTAG
OV	IODOMETHANE	74-88-4	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
OV	Isobutanol	78-83-1	0	0	0	0	0	0	0	0	0	31000000	31000000	ug/kg	INDUSTRIAL SCTL
OV	METHACRYLONITRILE	126-98-7	0	0	0	0	0	0	0	0	0	5400	5400	ug/kg	INDUSTRIAL SCTL
OV	METHYL METHACRYLATE	80-62-6	0	0	0	0	0	0	0	0	0	9400000	9400000	ug/kg	INDUSTRIAL SCTL
OV	Methylene chloride	75-09-2	0	0	0	0	0	0	0	427	0	23000	427	ug/kg	OTHER
OV	PENTACHLOROETHANE	76-01-7	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
OV	PROPIONITRILE	107-12-0	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
OV	Styrene	100-42-5	0	0	0	0	0	0	0	0	0	21000000	21000000	ug/kg	INDUSTRIAL SCTL
OV	Tetrachloroethene	127-18-4	0	0	0	0	0	530	57	0	0	17000	57	ug/kg	EPA III BTAG
OV	Toluene	108-88-3	0	0	0	0	0	670	0	0	0	2600000	670	ug/kg	EPA SQB
OV	trans-1,2-dichloroethene	156-60-5	0	0	0	0	0	0	0	0	0	210000	210000	ug/kg	INDUSTRIAL SCTL
OV	trans-1,3-dichloropropene	10061-02-6	0	0	0	0	0	0	0	0	0	200	200	ug/kg	INDUSTRIAL SCTL
OV	TRANS-1,4-DICHLORO-2-BUTENE	110-57-6	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
OV	Trichloroethene	79-01-6	0	0	0	0	0	1600	0	0	0	8500	1600	ug/kg	EPA SQB
OV	TRICHLOROFLUOROMETHANE	75-69-4	0	0	0	0	0	0	0	0	0	1300000	1300000	ug/kg	INDUSTRIAL SCTL
OV	VINYL ACETATE	108-05-4	0	0	0	0	0	0	0	0	0	550000	550000	ug/kg	INDUSTRIAL SCTL
OV	Vinyl chloride	75-01-4	0	0	0	0	0	0	0	0	0	40	40	ug/kg	INDUSTRIAL SCTL
OV	Xylenes, total	1330-20-7	0	0	0	0	0	25	40	0	0	40000000	25	ug/kg	EPA SQB
PCB	Aroclor-1016	12674-11-2	21.6	33	0	22.7	180	0	22.7	0	0	2100	21.6	ug/kg	FDEP SQAG TEL
PCB	Aroclor-1221	11104-28-2	21.6	67	0	22.7	180	0	22.7	0	0	2100	21.6	ug/kg	FDEP SQAG TEL
PCB	Aroclor-1232	11141-16-5	21.6	33	0	22.7	180	0	22.7	0	0	2100	21.6	ug/kg	FDEP SQAG TEL
PCB	Aroclor-1242	53469-21-9	21.6	33	0	22.7	180	0	22.7	0	0	2100	21.6	ug/kg	FDEP SQAG TEL
PCB	Aroclor-1248	12672-29-6	21.6	33	0	22.7	180	0	22.7	0	0	2100	21.6	ug/kg	FDEP SQAG TEL
PCB	Aroclor-1254	11097-69-1	21.6	33	0	22.7	180	0	22.7	0	0	2100	21.6	ug/kg	FDEP SQAG TEL
PCB	Aroclor-1260	11096-82-5	21.6	33	0	22.7	180	0	22.7	0	0	2100	21.6	ug/kg	FDEP SQAG TEL
PEST	2,4,5-T	93-76-5	0	0	0	0	0	0	0	0	0	8300000	8300000	ug/kg	INDUSTRIAL SCTL
PEST	2,4,5-TP (SILVEX)	93-72-1	0	0	0	0	0	0	0	0	0	12000000	12000000	ug/kg	INDUSTRIAL SCTL
PEST	2,4-D	94-75-7	0	0	0	0	0	0	0	0	0	11000000	11000000	ug/kg	INDUSTRIAL SCTL
PEST	4,4'-DDD	72-54-8	1.22	3.3	0	2	20	0	16	0	1.78	18000	1.78	ug/kg	BACKGROUND
PEST	4,4'-DDE	72-55-9	2.07	3.3	0	2.2	27	0	2.2	0	1.87	13000	2.07	ug/kg	FDEP SQAG TEL
PEST	4,4'-DDT	50-29-3	1.19	3.3	0	1	7	0	1.58	0	1.76	13000	1.76	ug/kg	BACKGROUND
PEST	Aldrin	309-00-2	0	0	0	0	0	0	0	0	0	300	300	ug/kg	INDUSTRIAL SCTL
PEST	alpha-BHC	319-84-6	0	0	0	0	0	0	0	0	1.05	500	1.05	ug/kg	BACKGROUND
PEST	alpha-chlordane	5103-71-9	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
PEST	beta-BHC	319-85-7	0	0	0	0	0	0	0	5	0	2100	5	ug/kg	OTHER
PEST	Biphenyl	92-52-4	0	0	0	0	0	1100	0	0	0	26000000	1100	ug/kg	EPA SQB
PEST	Chlordane	57-74-9	2.26	1.7	0	0.5	6	0	0	0	0	12000	0.5	ug/kg	EFFECTS RANGE-LOW
PEST	DBCP (NEMAGON)	96-12-8	0	0	0	0	0	0	0	0	0	2700	2700	ug/kg	INDUSTRIAL SCTL
PEST	delta-BHC	319-86-8	0	0	0	0	0	0	0	3	0.99	420000	3	ug/kg	OTHER
PEST	Dieldrin	60-57-1	0.715	3.3	52	0.02	0.8	0	0	0	0	300	0.02	ug/kg	EFFECTS RANGE-LOW
PEST	DINOSEB	88-85-7	0	0	0	0	0	0	0	0	0	740000	740000	ug/kg	INDUSTRIAL SCTL
PEST	Endosulfan I	959-98-8	0	0	0	0	0	2.9	0	0	1.2	6700000	2.9	ug/kg	EPA SQB
PEST	Endosulfan II	33213-65-9	0	0	0	0	0	14	0	0	0	6700000	14	ug/kg	EPA SQB
PEST	Endosulfan sulfate	1031-07-8	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
PEST	Endrin	72-20-8	0	3.3	20	0	0	0	0	0	1.56	340000	3.3	ug/kg	EPA IV SEDIMENT SCREENING VALUE
PEST	Endrin aldehyde	7421-93-4	0	0	0	0	0	0	0	0	0	480000	480000	ug/kg	INDUSTRIAL SCTL
PEST	Endrin ketone	53494-70-5	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA
PEST	gamma-BHC (lindane)	58-89-9	0.32	3.3	0	0	0	3.7	0	0	1.22	2200	1.22	ug/kg	BACKGROUND
PEST	gamma-chlordane	5103-74-2	0	0	0	0	0	0	0	0	0	0	0	ug/kg	NA

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Fraction	Parameter	CAS No.	FDEP SQAG TEL	EPA REG IV	EPA SQC (FRESH)	ER-L	ER-M	USEPA SQB	REG III BTAG	OTHER	BACKGROUND	FDEP Soil Industrial	ACTION LEVEL	REG UNITS	SOURCE
PEST	Heptachlor	76-44-8	0	0	0	0	0	0	0	4.9	0.92	900	4.9	ug/kg	OTHER
PEST	Heptachlor epoxide	1024-57-3	0	0	0	0	0	0	0	0	0	400	400	ug/kg	INDUSTRIAL SCTL
PEST	malathion	121-75-5	0	0	0	0	0	0.67	0	0	0	20000000	0.67	ug/kg	EPA SQB
PEST	Methoxychlor	72-43-5	0	0	0	0	0	19	0	0	11.7	7500000	19	ug/kg	EPA SQB
PEST	PARATHION	56-38-2	0	0	0	0	0	0	31	0	0	9100000	31	ug/kg	EPA III BTAG
PEST	Toxaphene	8001-35-2	0	0	0	0	0	28	0	0	0	3700	28	ug/kg	EPA SQB

FDEP SQAG TEL - FDEP Sediment Quality Assessment Guidelines for Florida Coast Waters Toxic Effects Level (1994)
EPA REG IV - EPA Region IV's Sediment Quality Screening Values for Hazardous Waste Sites (1995)
EPA SQC (FRESH) - EPA Sediment Quality Criteria (freshwater) (1993)
ER-L - Effects Range - Low (Long et al., 1995)
ER-M - Effects Range - Median (Long et al., 1995)
USEPA SQB - EPA Sediment Quality Benchmarks (1995)
REG III BTAG - EPA Region III Biotechnical Assistance Group Screening Levels for Sediment (1995)
OTHER - Baudo et al. 1990; Hull and Suter, 1994; OME, 1992
BG - Twice the average background concentration for inorganics, and the average background concentration for organics, based ona subset of data from Appendix F of the Supplemental RFI/RI for Eight Sites (B&RE, 1998a)

TABLE C-3

SURFACE WATER ACTION LEVELS
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Fraction	Parameter	CAS No.	FDEP Criteria	EPA Reg IV (Marine)	EPA Reg IV (Fresh)	National (Marine)	National (Fresh)	Reg III Marine	Reg III Fresh	FDEP SW CTL (Marine)	BG	FL GCTL	ACTION LEVEL	REG UNITS	SOURCE
HERB	2,4,5-T	93-76-5	0	0	0	0	0	0	0	145	0	70	145	ug/L	FDEP SCTL MARINE
HERB	2,4,5-TP (SILVEX)	93-72-1	0	0	0	0	0	0	0	0	0	50	50	ug/L	FDEP GCTL
HERB	2,4-D	94-75-7	0	0	0	0	0	0	0	80	0	70	80	ug/L	FDEP SCTL MARINE
HERB	DIMETHOATE	60-51-5	0	0	0	0	0	0	0	0.1	0	0.1	0.1	ug/L	FDEP SCTL MARINE
HERB	DINOSEB	88-85-7	0	0	0	0	0	0	0	5.9	0	7	5.9	ug/L	FDEP SCTL MARINE
HERB	DISULFOTON	298-04-4	0	0	0	0	0	0	0	0.3	0	0.3	0.3	ug/L	FDEP SCTL MARINE
HERB	ETHYL PARATHION	56-38-2	0.04	0	0	0	0	0	0	0.04	0	42	0.04	ug/L	FDEP CLASS III MARINE
HERB	METHYL PARATHION	298-00-0	0	0	0	0	0	0	0	0.01	0	0	0.01	ug/L	FDEP SCTL MARINE
HERB	PHORATE	298-02-2	0	0	0	0	0	0	0	0.0055	0	1.4	0.0055	ug/L	FDEP SCTL MARINE
HERB	SULFOTEP	3689-24-5	0	0	0	0	0	0	0	0.0115	0	3.5	0.0115	ug/L	FDEP SCTL MARINE
HERB	THIONAZIN	297-97-2	0	0	0	0	0	0	0	0	0	0	0	ug/L	NA
M	Aluminum	7429-90-5	1500	0	87	0	87	0	25	13	51.94	200	1500	ug/L	FDEP CLASS III MARINE
M	Antimony	7440-36-0	4300	0	160	500	30	500	30	4300	4.9	6	4300	ug/L	FDEP CLASS III MARINE
M	Arsenic	7440-38-2	50	36	190	36	150	0	874	50	5.08	50	50	ug/L	FDEP CLASS III MARINE
M	Barium	7440-39-3	0	0	0	0	0	10000	10000	0	12.86	0	10000	ug/L	EPA REG III (MARINE)
M	Beryllium	7440-41-7	0.13	0	0.53	0	0	1500	5.3	0.013	0.28	4	0.28	ug/L	BACKGROUND
M	Cadmium	7440-43-9	9.3	9.3	0.66	8.8	0.25	9.3	0.53	9.3	0	5	9.3	ug/L	FDEP CLASS III MARINE
M	Calcium	7440-70-2	0	0	0	0	0	0	0	0	0	0	0	ug/L	NA
M	Chromium	7440-47-3	50	50	11	50	11	50	2	50	0	100	50	ug/L	FDEP CLASS III MARINE
M	Cobalt	7440-48-4	0	0	0	0	0	0	35000	0	0	420	35000	ug/L	EPA REG III (FRESH)
M	Copper	7440-50-8	3.7	2.9	6.54	3.1	9	2.9	6.5	3.7	2.88	1000	3.7	ug/L	FDEP CLASS III MARINE
M	CYANIDE	57-12-5	1	1	5.2	1	5.2	1	5.2	1	0	0	1	ug/L	FDEP CLASS III MARINE
M	Iron	7439-89-6	300	0	1000	0	1000	0	320	300	51.6	300	300	ug/L	FDEP CLASS III MARINE
M	Lead	7439-92-1	8.5	8.5	1.32	8.1	2.5	5.6	3.2	8.5	0	15	8.5	ug/L	FDEP CLASS III MARINE
M	Magnesium	7439-95-4	0	0	0	0	0	0	0	0	0	0	0	ug/L	NA
M	Manganese	7439-96-5	0	0	0	0	0	10	14500	0	4.4	50	10	ug/L	EPA REG III (MARINE)
M	Mercury	7439-97-6	0.025	0.025	0.012	0.94	0.77	0.025	0.012	0.025	1.26	2	1.26	ug/L	BACKGROUND
M	Nickel	7440-02-0	8.3	8.3	87.71	8.2	52	8.3	160	8.3	0	100	8.3	ug/L	FDEP CLASS III MARINE
M	Potassium	7440-09-7	0	0	0	0	0	0	0	0	0	0	0	ug/L	NA
M	Selenium	7782-49-2	71	71	5	71	5	35	5	71	0	50	71	ug/L	FDEP CLASS III MARINE
M	Silver	7440-22-4	2.3	0.23	0.012	0	0	0.0001	0.0001	0.35	0	100	2.3	ug/L	FDEP CLASS III MARINE
M	Sodium	7440-23-5	0	0	0	0	0	0	0	0	0	160000	160000	ug/L	FDEP GCTL
M	Thallium	7440-28-0	6.3	21.3	4	0	0	2130	40	6.3	7.3	2	7.3	ug/L	BACKGROUND
M	Tin	7440-31-5	0	0	0	0	0	0.01	0.026	0	0	4200	0.01	ug/L	EPA REG III (MARINE)
M	Vanadium	7440-62-2	0	0	0	0	0	10000	10000	0	2.18	49	10000	ug/L	EPA REG III (MARINE)
M	Zinc	7440-66-6	86	86	58.91	81	120	19	30	86	4.54	5000	86	ug/L	FDEP CLASS III MARINE
MISC	SULFIDE	18496-25-8	0	2	2	2	2	0	0	0	0	0	0	ug/L	NA
OS	1,2,4,5-TETRACHLOROBENZENE	95-94-3	0	129	50	0	0	129	50	2.3	0	2.1	129	ug/L	EPA REG IV (MARINE)
OS	1,2,4-trichlorobenzene	120-82-1	0	4.5	44.9	0	0	129	50	22.5	0	70	129	ug/L	EPA REG III (MARINE)
OS	1,2-dichlorobenzene	95-50-1	0	19.7	15.8	0	0	129	763	99	0	600	129	ug/L	EPA REG III (MARINE)
OS	1,2-DIPHENYLHYDRAZINE	122-66-7	0	0	0	0	0	0	270	0.38	0	10	0.38	ug/L	FDEP SCTL MARINE
OS	1,3 DINITROBENZENE	99-65-0	0	0	0	0	0	0	1200	72	0	8	72	ug/L	FDEP SCTL MARINE
OS	1,3,5-TRINITROBENZENE	99-35-4	0	0	0	0	0	0	0	19	0	210	19	ug/L	FDEP SCTL MARINE
OS	1,3-dichlorobenzene	541-73-1	0	28.5	50.2	0	0	0	763	85	0	10	85	ug/L	FDEP SCTL MARINE
OS	1,4-BENZENEDIAMINE	106-50-3	0	0	0	0	0	0	0	0	0	1330	1330	ug/L	FDEP GCTL
OS	1,4-dichlorobenzene	106-46-7	0	19.9	11.2	0	0	129	763	100	0	75	129	ug/L	EPA REG III (MARINE)
OS	1,4-dioxane	123-91-1	0	0	0	0	0	0	0	245	0	5	245	ug/L	FDEP SCTL MARINE
OS	1,4-NAPHTHOQUINONE	130-15-4	0	0	0	0	0	0	0	0	0	0	0	ug/L	NA
OS	1-NAPHTHYLAMINE	134-32-7	0	0	0	0	0	0	0	0	0	0	0	ug/L	NA
OS	2,3,4,6-TETRACHLOROPHENOL	58-90-2	0	0	0	0	0	0	0	4.5	0	210	4.5	ug/L	FDEP SCTL MARINE
OS	2,4,5-trichlorophenol	95-95-4	0	0	0	0	0	11	63	22.5	0	4	11	ug/L	EPA REG III (MARINE)
OS	2,4,6-trichlorophenol	88-06-2	6.5	0	3.2	0	0	0	970	6.5	0	3.2	6.5	ug/L	FDEP CLASS III MARINE
OS	2,4-dichlorophenol	120-83-2	790	0	36.5	0	0	0	365	13	0	0.5	790	ug/L	FDEP CLASS III MARINE
OS	2,4-dimethylphenol	105-67-9	0	0	21.2	0	0	0	2120	261	0	140	261	ug/L	FDEP SCTL MARINE
OS	2,4-dinitrophenol	51-28-5	14260	48.5	6.2	0	0	4850	150	3	0	14	14260	ug/L	FDEP CLASS III MARINE
OS	2,4-dinitrotoluene	121-14-2	9.1	0	310	0	0	370	230	9.1	0	0.1	9.1	ug/L	FDEP CLASS III MARINE
OS	2,6-DICHLOROPHENOL	87-65-0	0	0	0	0	0	0	0	73	0	4	73	ug/L	FDEP SCTL MARINE
OS	2,6-dinitrotoluene	606-20-2	0	0	0	0	0	0	0	4	0	0.1	4	ug/L	FDEP SCTL MARINE

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Fraction	Parameter	CAS No.	FDEP Criteria	EPA Reg IV (Marine)	EPA Reg IV (Fresh)	National (Marine)	National (Fresh)	Reg III Marine	Reg III Fresh	FDEP SW CTL (Marine)	BG	FL GCTL	ACTION LEVEL	REG UNITS	SOURCE
OS	2-ACETYLAMINOFLUORENE	53-96-3	0	0	0	0	0	0	0	0	0	0	0	ug/L	NA
OS	2-chloronaphthalene	91-58-7	0	0	0	0	0	7.5	620	0	0	560	7.5	ug/L	EPA REG III (MARINE)
OS	2-chlorophenol	95-57-8	400	0	43.8	0	0	0	970	130	0	35	400	ug/L	FDEP CLASS III MARINE
OS	2-methyl-4,6-dinitrophenol	534-52-1	0	0	2.3	0	0	0	0	0	0	0	3.7	ug/L	NA
OS	2-methylnaphthalene	91-57-6	0	0	0	0	0	300	0	30	0	20	300	ug/L	EPA REG III (MARINE)
OS	2-methylphenol	95-48-7	0	0	0	0	0	0	0	250	0	35	250	ug/L	FDEP SCTL MARINE
OS	2-NAPHTHYLAMINE	91-59-8	0	0	0	0	0	0	0	0	0	10	10	ug/L	FDEP GCTL
OS	2-nitroaniline	88-74-4	0	0	0	0	0	0	0	0	0	50	50	ug/L	FDEP GCTL
OS	2-nitrophenol	88-75-5	0	0	3500	0	0	0	0	0	0	0	0	ug/L	NA
OS	2-PICOLINE	109-06-8	0	0	0	0	0	0	0	0	0	0	0	ug/L	NA
OS	3 -methylphenol	108-39-4	0	0	0	0	0	0	0	445	0	35	445	ug/L	FDEP SCTL MARINE
OS	3&4-METHYLPHENOL	TTNUS042	0	0	0	0	0	0	0	70	0	3.8	70	ug/L	FDEP SCTL MARINE
OS	3,3'-dichlorobenzidine	91-94-1	0	0	0	0	0	0	0	0.06	0	12	0.06	ug/L	FDEP SCTL MARINE
OS	3,3'-DIMETHYLBENZIDINE	119-93-7	0	0	0	0	0	0	0	0	0	160	0.0073	ug/L	NA
OS	3-METHYLCHOLANTHRENE	56-49-5	0	0	0	0	0	0	0	0	0	0	0	ug/L	NA
OS	3-nitroaniline	99-09-2	0	0	0	0	0	0	0	0	0	50	3.3	ug/L	NA
OS	4-AMINOBIPHENYL	92-67-1	0	0	0	0	0	0	0	0	0	0	0	ug/L	NA
OS	4-bromophenyl phenyl ether	101-55-3	0	0	12.2	0	0	0	0	0	0	406	406	ug/L	FDEP GCTL
OS	4-chloro-3-methylphenol	59-50-7	0	0	0.3	0	0	0	0	100	0	63	100	ug/L	FDEP SCTL MARINE
OS	4-chloroaniline	106-47-8	0	0	0	0	0	29700	0	2.5	0	28	29700	ug/L	EPA REG III (MARINE)
OS	4-chlorophenyl phenyl ether	7005-72-3	0	0	0	0	0	0	0	0	0	0	0	ug/L	NA
OS	4-methylphenol	106-44-5	0	0	0	0	0	0	0	70	0	4	70	ug/L	FDEP SCTL MARINE
OS	4-nitroaniline	100-01-6	0	0	0	0	0	0	0	1200	0	21	1200	ug/L	FDEP SCTL MARINE
OS	4-nitrophenol	100-02-7	0	71.7	82.8	0	0	4850	150	55	0	56	4850	ug/L	EPA REG III (MARINE)
OS	4-NITROQUINOLINE-1-OXIDE	56-57-5	0	0	0	0	0	0	0	0	0	0	0	ug/L	NA
OS	5-NITRO-O-TOLUIDINE	99-55-8	0	0	0	0	0	0	0	0	0	10	10	ug/L	FDEP GCTL
OS	7,12-DIMETHYLBENZ(A)ANTHRACENE	57-97-6	0	0	0	0	0	0	0	0	0	0	0	ug/L	NA
OS	A,A-DIMETHYLPHENETHYLAMINE	122-09-8	0	0	0	0	0	0	0	0	0	0	0	ug/L	NA
OS	Acenaphthene	83-32-9	2700	9.7	17	0	0	710	520	3	0	20	2700	ug/L	FDEP CLASS III MARINE
OS	Acenaphthylene	208-96-8	0.031	0	0	0	0	300	0	0.031	0	210	0.031	ug/L	FDEP CLASS III MARINE
OS	ACETOPHENONE	98-86-2	0	0	0	0	0	0	0	7750	0	700	7750	ug/L	FDEP SCTL MARINE
OS	ANILINE	62-53-3	0	0	0	0	0	0	0	4	0	6.1	4	ug/L	FDEP SCTL MARINE
OS	Anthracene	120-12-7	110000	0	0	0	0	300	0.1	0.3	0	2100	110000	ug/L	FDEP CLASS III MARINE
OS	ARAMITE	140-57-8	0	0	0	0	0	0	0	3	0	10	3	ug/L	FDEP SCTL MARINE
OS	BENZIDINE	92-87-5	0	0	25	0	0	0	2500	0	0	400	2500	ug/L	EPA REG III (FRESH)
OS	Benzo(a)anthracene	56-55-3	0.031	0	0	0	0	8.13	6.3	0.031	0	0.2	0.031	ug/L	FDEP CLASS III MARINE
OS	Benzo(a)pyrene	50-32-8	0.031	0	0	0	0	0.21	0	0.031	0	0.2	0.031	ug/L	FDEP CLASS III MARINE
OS	Benzo(b)fluoranthene	205-99-2	0.031	0	0	0	0	300	0	0.031	0	0.2	0.031	ug/L	FDEP CLASS III MARINE
OS	Benzo(g,h,i)perylene	191-24-2	0.031	0	0	0	0	300	0	0.031	0	210	0.031	ug/L	FDEP CLASS III MARINE
OS	Benzo(k)fluoranthene	207-08-9	0.031	0	0	0	0	300	0	0.031	0	0.5	0.031	ug/L	FDEP CLASS III MARINE
OS	BENZOIC ACID	65-85-0	0	0	0	0	0	0	0	9000	0	28000	9000	ug/L	FDEP SCTL MARINE
OS	BENZYL ALCOHOL	100-51-6	0	0	0	0	0	0	460000	500	0	2100	500	ug/L	FDEP SCTL MARINE
OS	Bis(2-chloroethoxy)methane	111-91-1	0	0	0	0	0	6400	11000	0	0	0	6400	ug/L	EPA REG III (MARINE)
OS	Bis(2-chloroethyl)ether	111-44-4	0	0	2380	0	0	0	0	9.99	0	4	9.99	ug/L	FDEP SCTL MARINE
OS	Bis(2-ethylhexyl)phthalate	117-81-7	0	0	0.3	0	0	360	30	0.02	0	6	360	ug/L	EPA REG III (MARINE)
OS	Butyl benzyl phthalate	85-68-7	0	29.4	22	0	0	3.4	3	25.5	0	140	3.4	ug/L	EPA REG III (MARINE)
OS	Carbazole	86-74-8	0	0	0	0	0	0	0	46.5	0	4	46.5	ug/L	FDEP SCTL MARINE
OS	CHLOROBENZILATE	510-15-6	0	0	0	0	0	0	0	0.09	0	0.1	0.09	ug/L	FDEP SCTL MARINE
OS	Chrysene	218-01-9	0.031	0	0	0	0	300	0	0.031	0	4.8	0.031	ug/L	FDEP CLASS III MARINE
OS	DBCP (NEMAGON)	96-12-8	0	0	0	0	0	0	0	0	0	0	0.2	ug/L	NA
OS	DIALLATE	2303-16-4	0	0	0	0	0	0	0	0	0	0.6	0.6	ug/L	FDEP GCTL
OS	Dibenzo(a,h)anthracene	53-70-3	0.031	0	0	0	0	300	0	0.031	0	0.2	0.031	ug/L	FDEP CLASS III MARINE
OS	Dibenzofuran	132-64-9	0	0	0	0	0	0	0	67	0	28	67	ug/L	FDEP SCTL MARINE
OS	Diethyl phthalate	84-66-2	0	75.9	521	0	0	3.4	3	380	0	5600	3.4	ug/L	EPA REG III (MARINE)
OS	Dimethyl phthalate	131-11-3	0	580	330	0	0	3.4	3	1450	0	70000	3.4	ug/L	EPA REG III (MARINE)
OS	Di-n-butyl phthalate	84-74-2	0	3.4	9.4	0	0	3.4	3	23	0	700	3.4	ug/L	EPA REG IV (MARINE)
OS	Di-n-octyl phthalate	117-84-0	0	0	0	0	0	3.4	3	0	0	140	3.4	ug/L	EPA REG III (MARINE)
OS	DIPHENYLAMINE	122-39-4	0	0	0	0	0	0	0	0	0	175	910	ug/L	NA

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Fraction	Parameter	CAS No.	FDEP Criteria	EPA Reg IV (Marine)	EPA Reg IV (Fresh)	National (Marine)	National (Fresh)	Reg III Marine	Reg III Fresh	FDEP SW CTL (Marine)	BG	FL GCTL	ACTION LEVEL	REG UNITS	SOURCE
OS	ETHYL METHACRYLATE	97-63-2	0	0	0	0	0	0	0	0	0	630	550	ug/L	NA
OS	ETHYL METHANE SULFONATE	62-50-0	0	0	0	0	0	0	0	0	0	0	0	ug/L	NA
OS	FAMPHUR	52-85-7	0	0	0	0	0	0	0	0	0	3.5	3.5	ug/L	FDEP GCTL
OS	Fluoranthene	206-44-0	370	1.6	39.8	0	0	16	3980	0.3	0	280	370	ug/L	FDEP CLASS III MARINE
OS	Fluorene	86-73-7	14000	0	0	0	0	300	430	30	0	280	14000	ug/L	FDEP CLASS III MARINE
OS	Hexachlorobenzene	118-74-1	0	0	0	0	0	129	3.68	0.00036	0	1	129	ug/L	EPA REG III (MARINE)
OS	Hexachlorobutadiene	87-68-3	49.7	0.32	0.93	0	0	32	9.3	0	0	0.5	49.7	ug/L	FDEP CLASS III MARINE
OS	Hexachlorocyclopentadiene	77-47-4	0	0.07	0.07	0	0	7	5.2	2.95	0	50	7	ug/L	EPA REG III (MARINE)
OS	Hexachloroethane	67-72-1	0	9.4	9.8	0	0	940	540	1.1	0	2.5	940	ug/L	EPA REG III (MARINE)
OS	HEXACHLOROPHENE	70-30-4	0	0	0	0	0	0	0	1.05	0	6	1.05	ug/L	FDEP SCTL MARINE
OS	HEXACHLOROPROPENE	1888-71-7	0	0	0	0	0	0	0	0	0	0	0	ug/L	NA
OS	Indeno(1,2,3-cd)pyrene	193-39-5	0.031	0	0	0	0	300	0	0.031	0	0.2	0.031	ug/L	FDEP CLASS III MARINE
OS	ISODRIN	465-73-6	0	0	0	0	0	0	0	0	0	0	0	ug/L	NA
OS	Isophorone	78-59-1	0	129	1170	0	0	12900	117000	645	0	37	12900	ug/L	EPA REG III (MARINE)
OS	ISOSAFROLE	120-58-1	0	0	0	0	0	0	0	0	0	0	0	ug/L	NA
OS	KEPONE	143-50-0	0	0	0	0	0	7	7	0	0	20	7	ug/L	EPA REG III (MARINE)
OS	METHAPYRILENE	91-80-5	0	0	0	0	0	0	0	0	0	0	0	ug/L	NA
OS	METHYL METHANE SULFONATE	66-27-3	0	0	0	0	0	0	0	0	0	0	0	ug/L	NA
OS	Naphthalene	91-20-3	0	23.5	62	0	0	2300	100	26	0	20	2300	ug/L	EPA REG III (MARINE)
OS	Nitrobenzene	98-95-3	0	66.8	270	0	0	6680	27000	90	0	4	6680	ug/L	EPA REG III (MARINE)
OS	N-NITROSODIETHYLAMINE	55-18-5	0	0	0	0	0	0	0	0.18	0	4	0.18	ug/L	FDEP SCTL MARINE
OS	N-NITROSODIMETHYLAMINE	62-75-9	0	0	0	0	0	0	0	0.53	0	2	0.53	ug/L	FDEP SCTL MARINE
OS	N-NITROSO-DI-N-BUTYLAMINE	924-16-3	0	0	0	0	0	0	0	0.16	0	4	0.16	ug/L	FDEP SCTL MARINE
OS	N-NITROSO-DI-N-PROPYLAMINE	621-64-7	0	0	0	0	0	0	0	0.83	0	4	0.83	ug/L	FDEP SCTL MARINE
OS	n-nitrosodiphenylamine	86-30-6	0	33000	58.5	0	0	3300000	5850	44	0	7.1	3300000	ug/L	EPA REG III (MARINE)
OS	N-NITROSOMETHYLETHYLAMINE	10595-95-6	0	0	0	0	0	0	0	1.22	0	8	1.22	ug/L	FDEP SCTL MARINE
OS	N-NITROSOMORPHOLINE	59-89-2	0	0	0	0	0	0	0	0	0	0	0	ug/L	NA
OS	N-NITROSOPIPERIDINE	100-75-4	0	0	0	0	0	0	0	0	0	0	0	ug/L	NA
OS	N-NITROSOPYRROLIDINE	930-55-2	0	0	0	0	0	0	0	0	0	8	0.032	ug/L	NA
OS	O,O,O-TRIETHYL PHOSPHOROTHIOATE	126-68-1	0	0	0	0	0	0	0	0	0	0	0	ug/L	NA
OS	O-TOLUIDINE	95-53-4	0	0	0	0	0	0	0	26	0	50	26	ug/L	FDEP SCTL MARINE
OS	P-(DIMETHYLAMINO)AZOBENZENE	60-11-7	0	0	0	0	0	0	0	0	0	0	0	ug/L	NA
OS	PENTACHLOROBENZENE	608-93-5	0	0	0	0	0	129	50	1.7	0	5.6	129	ug/L	EPA REG III (MARINE)
OS	Pentachloroethane	76-01-7	0	0	0	0	0	281	1100	0	0	0	281	ug/L	EPA REG III (MARINE)
OS	PENTACHLORONITROBENZENE	82-68-8	0	0	0	0	0	0	0	0.04	0	0.5	0.04	ug/L	FDEP SCTL MARINE
OS	Pentachlorophenol	87-86-5	7.9	7.9	13	7.9	15	7.9	13	7.9	0	1	7.9	ug/L	FDEP CLASS III MARINE
OS	PHENACETIN	62-44-2	0	0	0	0	0	0	0	0	0	0	0	ug/L	NA
OS	Phenanthrene	85-01-8	0.031	0	0	0	0	4.6	6.3	0.031	0	210	0.031	ug/L	FDEP CLASS III MARINE
OS	Phenol	108-95-2	300	58	256	0	0	5800	79	6.5	0	10	300	ug/L	FDEP CLASS III MARINE
OS	PRONAMIDE	23950-58-5	0	0	0	0	0	0	0	0	0	53	53	ug/L	FDEP GCTL
OS	Pyrene	129-00-0	11000	0	0	0	0	300	0	0.3	0	210	11000	ug/L	FDEP CLASS III MARINE
OS	PYRIDINE	110-86-1	0	0	0	0	0	0	0	1300	0	7	1300	ug/L	FDEP SCTL MARINE
OS	SAFROLE	94-59-7	0	0	0	0	0	0	0	0	0	0	0	ug/L	NA
OV	1,1,1,2-TETRACHLOROETHANE	630-20-6	0	0	0	0	0	0	0	0	0	1.3	0.41	ug/L	NA
OV	1,1,1-trichloroethane	71-55-6	0	312	528	0	0	31200	9400	270	0	200	31200	ug/L	EPA REG III (MARINE)
OV	1,1,2,2-tetrachloroethane	79-34-5	10.8	90.2	240	0	0	6230	2400	10.8	0	0.2	10.8	ug/L	FDEP CLASS III MARINE
OV	1,1,2-trichloroethane	79-00-5	0	0	940	0	0	31200	9400	28.5	0	5	31200	ug/L	EPA REG III (MARINE)
OV	1,1-dichloroethane	75-34-3	0	0	0	0	0	320000	160000	0	0	70	320000	ug/L	EPA REG III (MARINE)
OV	1,1-dichloroethene	75-35-4	3.2	2240	303	0	0	224000	11600	3.2	0	7	3.2	ug/L	FDEP CLASS III MARINE
OV	1,2,3-TRICHLOROPROPANE	96-18-4	0	0	0	0	0	0	0	0.26	0	0.2	0.26	ug/L	FDEP SCTL MARINE
OV	1,2-DIBROMOETHANE	106-93-4	0	0	0	0	0	0	18000	13	0	0.02	13	ug/L	FDEP SCTL MARINE
OV	1,2-dichloroethane	107-06-2	0	1130	2000	0	0	113000	20000	5	0	3	113000	ug/L	EPA REG III (MARINE)
OV	1,2-dichloroethene	540-59-0	0	0	0	0	0	224000	11600	7000	0	70	224000	ug/L	EPA REG III (MARINE)
OV	1,2-dichloropropane	78-87-5	0	2400	525	0	0	3040	5700	2600	0	5	3040	ug/L	EPA REG III (MARINE)
OV	1-chlorohexane	544-10-5	0	0	0	0	0	0	0	0	0	0	0	ug/L	NA
OV	2-butanone	78-93-3	0	0	0	0	0	0	3220000	120000	0	4200	120000	ug/L	FDEP SCTL MARINE
OV	2-CHLORO-1,3-BUTADIENE	126-99-8	0	0	0	0	0	0	0	0	0	140	140	ug/L	FDEP GCTL
OV	2-CHLOROETHYL VINYL ETHER	110-75-8	0	0	3540	0	0	0	0	0	0	175	175	ug/L	FDEP GCTL

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Fraction	Parameter	CAS No.	FDEP Criteria	EPA Reg IV (Marine)	EPA Reg IV (Fresh)	National (Marine)	National (Fresh)	Reg III Marine	Reg III Fresh	FDEP SW CTL (Marine)	BG	FL GCTL	ACTION LEVEL	REG UNITS	SOURCE
OV	2-CHLOROTOLUENE	95-49-8	0	0	0	0	0	0	0	390	0	140	390	ug/L	FDEP SCTL MARINE
OV	2-hexanone	591-78-6	0	0	0	0	0	0	428000	0	0	280	428000	ug/L	EPA REG III (FRESH)
OV	3-CHLOROPROPENE	107-05-1	0	0	0	0	0	0	0	0	0	35	35	ug/L	FDEP GCTL
OV	4-methyl-2-pentanone	108-10-1	0	0	0	0	0	0	460000	23000	0	560	23000	ug/L	FDEP SCTL MARINE
OV	Acetone	67-64-1	0	0	0	0	0	0	90000000	1692	0	700	1692	ug/L	FDEP SCTL MARINE
OV	ACETONITRILE	75-05-8	0	0	0	0	0	0	0	19983	0	500	19983	ug/L	FDEP SCTL MARINE
OV	ACROLEIN	107-02-8	0	0.55	2.1	0	0	55	21	0.4	0	14	55	ug/L	EPA REG III (MARINE)
OV	ACRYLONITRILE	107-13-1	0	0	75.5	0	0	0	2600	49.9	0	1	49.9	ug/L	FDEP SCTL MARINE
OV	AZOBENZENE	103-33-3	0	0	0	0	0	0	0	0.559	0	4	0.559	ug/L	FDEP SCTL MARINE
OV	Benzene	71-43-2	71.28	109	53	0	0	700	5300	71.28	0	1	71.28	ug/L	FDEP CLASS III MARINE
OV	Bis(2-chloroisopropyl)ether	108-60-1	0	0	0	0	0	0	0	0.5	0	10	0.5	ug/L	FDEP SCTL MARINE
OV	BROMOBENZENE	108-86-1	0	0	0	0	0	0	0	0	0	0	0	ug/L	NA
OV	Bromodichloromethane	75-27-4	22	0	0	0	0	6400	11000	22	0	0.6	22	ug/L	FDEP CLASS III MARINE
OV	Bromoform	75-25-2	360	640	293	0	0	1000	11000	360	0	4.4	360	ug/L	FDEP CLASS III MARINE
OV	Bromomethane	74-83-9	0	120	110	0	0	0	0	35	0	9.8	35	ug/L	FDEP SCTL MARINE
OV	Carbon disulfide	75-15-0	0	0	0	0	0	2	2	105	0	700	2	ug/L	EPA REG III (MARINE)
OV	Carbon tetrachloride	56-23-5	4.42	1500	352	0	0	50000	35200	4.42	0	3	4.42	ug/L	FDEP CLASS III MARINE
OV	Chlorobenzene	108-90-7	0	105	195	0	0	129	50	17	0	100	129	ug/L	EPA REG III (MARINE)
OV	Chloroethane	75-00-3	0	0	0	0	0	0	0	0	0	12	3.6	ug/L	NA
OV	Chloroform	67-66-3	470.8	815	289	0	0	0	1240	470.8	0	5.7	470.8	ug/L	FDEP CLASS III MARINE
OV	Chloromethane	74-87-3	470.8	2700	5500	0	0	0	0	470.8	0	2.7	470.8	ug/L	FDEP CLASS III MARINE
OV	Chlorotoluene	25168-05-2	0	0	0	0	0	0	0	390	0	140	390	ug/L	FDEP SCTL MARINE
OV	cis-1,2-dichloroethene	156-59-2	0	0	0	0	0	224000	11600	0	0	70	224000	ug/L	EPA REG III (MARINE)
OV	cis-1,3-dichloropropene	10061-01-5	0	7.9	24.4	0	0	0	0	0	0	0	0	ug/L	NA
OV	Dibromochloromethane	124-48-1	34	0	0	0	0	6400	11000	34	0	0.4	34	ug/L	FDEP CLASS III MARINE
OV	DIBROMOMETHANE	74-95-3	0	0	0	0	0	6400	11000	0	0	70	6400	ug/L	EPA REG III (MARINE)
OV	DICHLORODIFLUOROMETHANE	75-71-8	0	0	0	0	0	6400	11000	0	0	1400	6400	ug/L	EPA REG III (MARINE)
OV	ETHYL CYANIDE	107-12-0	0	0	0	0	0	0	0	0	0	0	0	ug/L	NA
OV	Ethylbenzene	100-41-4	0	4.3	453	0	0	430	32000	605	0	30	430	ug/L	EPA REG III (MARINE)
OV	IODOMETHANE	74-88-4	0	0	0	0	0	0	0	0	0	0	0	ug/L	NA
OV	Isobutanol	78-83-1	0	0	0	0	0	0	0	47450	0	2100	47450	ug/L	FDEP SCTL MARINE
OV	METHACRYLONITRILE	126-98-7	0	0	0	0	0	0	0	0	0	5	1	ug/L	NA
OV	METHYL METHACRYLATE	80-62-6	0	0	0	0	0	0	0	6500	0	25	6500	ug/L	FDEP SCTL MARINE
OV	Methylene chloride	75-09-2	1580	2560	1930	0	0	6400	11000	1580	0	5	1580	ug/L	FDEP CLASS III MARINE
OV	Styrene	100-42-5	0	0	0	0	0	0	0	455	0	100	455	ug/L	FDEP SCTL MARINE
OV	Tetrachloroethene	127-18-4	8.85	45	84	0	0	450	840	8.85	0	3	8.85	ug/L	FDEP CLASS III MARINE
OV	Toluene	108-88-3	0	37	175	0	0	1050	17000	475	0	40	1050	ug/L	EPA REG III (MARINE)
OV	trans-1,2-dichloroethene	156-60-5	0	0	1350	0	0	224000	11600	11000	0	100	224000	ug/L	EPA REG III (MARINE)
OV	trans-1,3-dichloropropene	10061-02-6	0	7.9	24.4	0	0	0	0	0	0	0	0	ug/L	NA
OV	TRANS-1,4-DICHLORO-2-BUTENE	110-57-6	0	0	0	0	0	0	0	0	0	0	0	ug/L	NA
OV	Trichloroethene	79-01-6	80.7	0	0	0	0	2000	21900	80.7	0	3	80.7	ug/L	FDEP CLASS III MARINE
OV	TRICHLOROFLUOROMETHANE	75-69-4	0	0	0	0	0	6400	11000	0	0	2100	6400	ug/L	EPA REG III (MARINE)
OV	VINYL ACETATE	108-05-4	0	0	0	0	0	0	0	700	0	88	700	ug/L	FDEP SCTL MARINE
OV	Vinyl chloride	75-01-4	0	0	0	0	0	224000	11600	0	0	1	224000	ug/L	EPA REG III (MARINE)
OV	Xylenes, total	1330-20-7	0	0	0	0	0	6000	6000	370	0	20	6000	ug/L	EPA REG III (MARINE)
PCB	Aroclor-1016	12674-11-2	0.000045	0.03	0.014	0.03	0.014	0.03	0.014	0.00045	0	0.5	0.000045	ug/L	FDEP CLASS III MARINE
PCB	Aroclor-1221	11104-28-2	0.000045	0.03	0.014	0.03	0.014	0.03	0.014	0.00045	0	0.5	0.000045	ug/L	FDEP CLASS III MARINE
PCB	Aroclor-1232	11141-16-5	0.000045	0.03	0.014	0.03	0.014	0.03	0.014	0.00045	0	0.5	0.000045	ug/L	FDEP CLASS III MARINE
PCB	Aroclor-1242	53469-21-9	0.000045	0.03	0.014	0.03	0.014	0.03	0.014	0.00045	0	0.5	0.000045	ug/L	FDEP CLASS III MARINE
PCB	Aroclor-1248	12672-29-6	0.000045	0.03	0.014	0.03	0.014	0.03	0.014	0.00045	0	0.5	0.000045	ug/L	FDEP CLASS III MARINE
PCB	Aroclor-1254	11097-69-1	0.000045	0.03	0.014	0.03	0.014	0.03	0.014	0.00045	0	0.5	0.000045	ug/L	FDEP CLASS III MARINE
PCB	Aroclor-1260	11096-82-5	0.000045	0.03	0.014	0.03	0.014	0.03	0.014	0.00045	0	0.5	0.000045	ug/L	FDEP CLASS III MARINE
PEST	4,4'-DDD	72-54-8	0	0.025	0.0064	0	0	0.68	0.6	0.003	0	0.1	0.68	ug/L	EPA REG III (MARINE)
PEST	4,4'-DDE	72-55-9	0	0.14	10.5	0	0	14	1050	0.0006	0	0.1	14	ug/L	EPA REG III (MARINE)
PEST	4,4'-DDT	50-29-3	0.00059	0.001	0.001	0.001	0.001	0.001	0.001	0.00059	0	0.1	0.00059	ug/L	FDEP CLASS III MARINE
PEST	Aldrin	309-00-2	0.00014	0.13	0.3	1.3	3	1.3	3	0.00014	0	0.005	0.00014	ug/L	FDEP CLASS III MARINE
PEST	alpha-BHC	319-84-6	0	1400	500	0	0	0.34	100	0.0116	0	0.006	0.34	ug/L	EPA REG III (MARINE)
PEST	alpha-chlordane	5103-71-9	0	0	0	0	0	0	0	0	0	0	0	ug/L	NA

TABLE C-3

SURFACE WATER ACTION LEVELS
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Fraction	Parameter	CAS No.	FDEP Criteria	EPA Reg IV (Marine)	EPA Reg IV (Fresh)	National (Marine)	National (Fresh)	Reg III Marine	Reg III Fresh	FDEP SW CTL (Marine)	BG	FL GCTL	ACTION LEVEL	REG UNITS	SOURCE
PEST	beta-BHC	319-85-7	0.046	0	5000	0	0	0.34	100	0.013	0	0.02	0.046	ug/L	FDEP CLASS III MARINE
PEST	Chlordane	57-74-9	0.00059	0.004	0.0043	0.004	0.0043	0.004	0.0043	0.00059	0	0	0.00059	ug/L	FDEP CLASS III MARINE
PEST	delta-BHC	319-86-8	0	0	0	0	0	0.34	100	0	0	2.1	0.34	ug/L	EPA REG III (MARINE)
PEST	Dieldrin	60-57-1	0.00014	0.0019	0.0019	0.0019	0.056	0.0019	0.0019	0.00014	0	0.005	0.00014	ug/L	FDEP CLASS III MARINE
PEST	Endosulfan I	959-98-8	0.0087	0.0087	0.056	0.0087	0.056	0.0087	0.056	0	0	0	0.0087	ug/L	FDEP CLASS III MARINE
PEST	Endosulfan II	33213-65-9	0.0087	0.0087	0.056	0.0087	0.056	0.0087	0.056	0	0	0	0.0087	ug/L	FDEP CLASS III MARINE
PEST	Endosulfan sulfate	1031-07-8	0	0	0	0	0	0	0	0	0	0	0	ug/L	NA
PEST	Endrin	72-20-8	0.0023	0.0023	0.0023	0.0023	0.036	0.0023	0.0023	0.0023	0	2	0.0023	ug/L	FDEP CLASS III MARINE
PEST	Endrin aldehyde	7421-93-4	0	0	0	0	0	0	0	0	0	0	0	ug/L	NA
PEST	Endrin ketone	53494-70-5	0	0	0	0	0	0	0	0	0	0	0	ug/L	NA
PEST	gamma-BHC (lindane)	58-89-9	0.063	0.016	0.08	0.16	0.95	0.16	0.08	0.063	0	0.2	0.063	ug/L	FDEP CLASS III MARINE
PEST	gamma-chlordane	5103-74-2	0	0.004	0	0	0	0	0	0	0	0	0	ug/L	NA
PEST	Heptachlor	76-44-8	0.00021	0.0036	0.0038	0.0036	0.0038	0.0036	0.0038	0.00021	0	0.4	0.00021	ug/L	FDEP CLASS III MARINE
PEST	Heptachlor epoxide	1024-57-3	0	0.0036	0.0038	0.0036	0.0038	0.0036	0.0038	0.002	0	0.2	0.0036	ug/L	EPA REG IV (MARINE)
PEST	Methoxychlor	72-43-5	0.03	0.03	0.03	0	0	0.03	0.03	0.03	0	40	0.03	ug/L	FDEP CLASS III MARINE
PEST	Toxaphene	8001-35-2	0.0002	0	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0	3	0.0002	ug/L	FDEP CLASS III MARINE

FDEP Criteria - FDEP Criteria for Surface Water Quality Classifications, F.A.C. 62-302.530 (Class III Marine)
EPA Reg IV (Marine) - EPA Region IV Saltwater Surface Water Screening Values (1995)
EPA Reg IV (Fresh) - EPA Region IV Freshwater Surface Water Screening Values (1995)
National (Marine) - EPA National Recommended Water Quality Criteria (2000)
National (Fresh) - EPA National Recommended Water Quality Criteria (2000)
Reg III Marine - EPA Region III Biotechnical Assistance Group Marine Surface Water Screening Levels (1995)
Reg III Fresh - EPA Region III Biotechnical Assistance Group Freshwater Surface Water Screening Levels (1995)
FDEP SW CTL (Marine) - FDEP Marine Surface Water Criteria Cleanup Target Level, FAC 62-777, Table I (08/05/1999)
BG - Twice the average background concentration for inorganics, and the average background concentration for organics, based ona subset of data from Appendix F of the Supplemental RFI/RI for Eight Sites (B&RE, 1998a)
FL GCTL - Florida Groundwater Cleanup Target Level, F.A.C. 62-777, Table 1 (08/05/1999)

TABLE C-4

INDUSTRIAL SOIL ACTION LEVELS
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KEY WEST, FLORIDA

Fraction	Parameter	CAS No.	FDEP IND SCTL	Res Soil RBCs	BG	IND AL	REG UNITS	IND SOURCE
DIOX	1,2,3,4,6,7,8,9-OCDD	3268-87-9	300000	43000	0	300000	ng/kg	IND SCTL
DIOX	1,2,3,4,6,7,8,9-OCDF	39001-02-0	300000	43000	0	300000	ng/kg	IND SCTL
DIOX	1,2,3,4,6,7,8-HPCDD	35822-46-9	3000	430	0	3000	ng/kg	IND SCTL
DIOX	1,2,3,4,6,7,8-HPCDF	67562-39-4	3000	430	0	3000	ng/kg	IND SCTL
DIOX	1,2,3,4,7,8,9-HPCDF	55673-89-7	3000	430	0	3000	ng/kg	IND SCTL
DIOX	1,2,3,4,7,8-HXCDD	39227-28-6	300	43	0	300	ng/kg	IND SCTL
DIOX	1,2,3,4,7,8-HXCDF	70648-26-9	300	43	0	300	ng/kg	IND SCTL
DIOX	1,2,3,6,7,8-HXCDD	57653-85-7	300	43	0	300	ng/kg	IND SCTL
DIOX	1,2,3,6,7,8-HXCDF	57117-44-9	300	43	0	300	ng/kg	IND SCTL
DIOX	1,2,3,7,8,9-HXCDD	19408-74-3	300	43	0	300	ng/kg	IND SCTL
DIOX	1,2,3,7,8,9-HXCDF	72918-21-9	300	43	0	300	ng/kg	IND SCTL
DIOX	1,2,3,7,8-PECDD	40321-76-4	30	4.3	0	30	ng/kg	IND SCTL
DIOX	1,2,3,7,8-PECDF	57117-41-6	600	86	0	600	ng/kg	IND SCTL
DIOX	2,3,4,6,7,8-HXCDF	60851-34-5	300	43	0	300	ng/kg	IND SCTL
DIOX	2,3,4,7,8-PECDF	57117-31-4	60	8.6	0	60	ng/kg	IND SCTL
DIOX	2,3,7,8-TCDD	1746-01-6	30	4.3	0	30	ng/kg	IND SCTL
DIOX	2,3,7,8-TCDF	51207-31-9	300	43	0	300	ng/kg	IND SCTL
DIOX	TOTAL HPCDD	37871-00-4	3000	430	0	3000	ng/kg	IND SCTL
DIOX	TOTAL HPCDF	38998-75-3	3000	430	0	3000	ng/kg	IND SCTL
DIOX	TOTAL HXCDD	34465-46-8	300	43	0	300	ng/kg	IND SCTL
DIOX	TOTAL HXCDF	55684-94-1	300	43	0	300	ng/kg	IND SCTL
DIOX	TOTAL ORGANIC HALIDES	TTNUS043	0	0	0	0	ng/kg	NA
DIOX	TOTAL PECDD	36088-22-9	30	4.3	0	30	ng/kg	IND SCTL
DIOX	TOTAL PECDF	30402-15-4	60	8.6	0	60	ng/kg	IND SCTL
DIOX	TOTAL TCDD	41903-57-5	30	4.3	0	30	ng/kg	IND SCTL
DIOX	TOTAL TCDF	55722-27-5	300	43	0	300	ng/kg	IND SCTL
M	Aluminum	7429-90-5	1E+17	78000	3774.57	1E+17	mg/kg	IND SCTL
M	Antimony	7440-36-0	240	31	0.58	240	mg/kg	IND SCTL
M	Arsenic	7440-38-2	3.7	0.43	2.66	3.7	mg/kg	IND SCTL
M	Barium	7440-39-3	87000	5500	21.9	87000	mg/kg	IND SCTL
M	Beryllium	7440-41-7	800	160	0.08	800	mg/kg	IND SCTL
M	Bismuth	7440-69-9	0	0	0	0	mg/kg	NA
M	Cadmium	7440-43-9	1300	39	0.28	1300	mg/kg	IND SCTL
M	Calcium	7440-70-2	0	0	0	0	mg/kg	NA
M	Chromium	7440-47-3	420	230	12.34	420	mg/kg	IND SCTL
M	Cobalt	7440-48-4	110000	1600	0.46	110000	mg/kg	IND SCTL
M	Copper	7440-50-8	76000	3100	11.54	76000	mg/kg	IND SCTL

TABLE C-4

INDUSTRIAL SOIL ACTION LEVELS
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Fraction	Parameter	CAS No.	FDEP IND SCTL	Res Soil RBCs	BG	IND AL	REG UNITS	IND SOURCE
M	CYANIDE	57-12-5	39000	1600	0	39000	mg/kg	IND SCTL
M	Iron	7439-89-6	480000	23000	2334.88	480000	mg/kg	IND SCTL
M	Lead	7439-92-1	920	0	33.32	920	mg/kg	IND SCTL
M	Magnesium	7439-95-4	0	0	0	0	mg/kg	NA
M	Manganese	7439-96-5	2200	1600	35.3	2200	mg/kg	IND SCTL
M	Mercury	7439-97-6	26	0	0.06	26	mg/kg	IND SCTL
M	Molybdenum	7439-98-7	9700	390	0	9700	mg/kg	IND SCTL
M	Nickel	7440-02-0	28000	1600	3.4	28000	mg/kg	IND SCTL
M	Potassium	7440-09-7	0	0	0	0	mg/kg	NA
M	Rubidium	7440-17-7	0	0	0	0	mg/kg	NA
M	Selenium	7782-49-2	10000	390	1.3	10000	mg/kg	IND SCTL
M	Silver	7440-22-4	9100	390	0	9100	mg/kg	IND SCTL
M	Sodium	7440-23-5	0	0	0	0	mg/kg	NA
M	Strontium	7440-24-6	10000000000	47000	0	10000000000	mg/kg	IND SCTL
M	Thallium	7440-28-0	0	5.5	0	5.5	mg/kg	RES SOIL RBC
M	Tin	7440-31-5	660000	47000	3.92	660000	mg/kg	IND SCTL
M	Titanium	7440-32-6	0	310000	0	310000	mg/kg	RES SOIL RBC
M	Vanadium	7440-62-2	7400	23	8.32	7400	mg/kg	IND SCTL
M	Zinc	7440-66-6	560000	23000	32.18	560000	mg/kg	IND SCTL
M	Zirconium	7440-67-7	0	0	0	0	mg/kg	NA
MISC	Fractional Organic Carbon	7440-44-0	0	0	0	0	ug/kg	NA
MISC	PH	TTNUS002	0	0	0	0	pH units	NA
MISC	SULFIDE	18496-25-8	0	0	0	0	ug/kg	NA
MISC	TOTAL SOLIDS	TTNUS046	0	0	0	0	%	NA
OS	1,2,4,5-TETRACHLOROBENZENE	95-94-3	51000	23000	0	51000	ug/kg	IND SCTL
OS	1,2,4-trichlorobenzene	120-82-1	750000	780000	0	750000	ug/kg	IND SCTL
OS	1,2-dichlorobenzene	95-50-1	4600000	7000000	0	4600000	ug/kg	IND SCTL
OS	1,2-DIPHENYLHYDRAZINE	122-66-7	3700	800	0	3700	ug/kg	IND SCTL
OS	1,3,5-Trinitrobenzene	99-35-4	0	0	0	0	ug/kg	NA
OS	1,3-dichlorobenzene	541-73-1	180000	2300000	0	180000	ug/kg	IND SCTL
OS	1,3-DINITROBENZENE	99-65-0	33000	7800	0	33000	ug/kg	IND SCTL
OS	1,4-dichlorobenzene	106-46-7	9000	27000	0	9000	ug/kg	IND SCTL
OS	1,4-NAPHTHOQUINONE	130-15-4	0	0	0	0	ug/kg	NA
OS	1,4-PHENYLENEDIAMINE	106-50-3	83000000	15000	0	83000000	ug/kg	IND SCTL
OS	1-METHYLNAPHTHALENE	90-12-0	470000	0	0	470000	ug/kg	IND SCTL
OS	1-NAPHTHYLAMINE	134-32-7	0	0	0	0	ug/kg	NA
OS	1-PICOLINE	109-06-8	0	0	0	0	ug/kg	NA

TABLE C-4

INDUSTRIAL SOIL ACTION LEVELS
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Fraction	Parameter	CAS No.	FDEP IND SCTL	Res Soil RBCs	BG	IND AL	REG UNITS	IND SOURCE
OS	2,3,4,6-TETRACHLOROPHENOL	58-90-2	17000000	2300000	0	17000000	ug/kg	IND SCTL
OS	2,4,5-trichlorophenol	95-95-4	82000000	7800000	0	82000000	ug/kg	IND SCTL
OS	2,4,6-trichlorophenol	88-06-2	180000	58000	0	180000	ug/kg	IND SCTL
OS	2,4-dichlorophenol	120-83-2	1300000	230000	0	1300000	ug/kg	IND SCTL
OS	2,4-dimethylphenol	105-67-9	9800000	1600000	0	9800000	ug/kg	IND SCTL
OS	2,4-dinitrophenol	51-28-5	620000	160000	0	620000	ug/kg	IND SCTL
OS	2,4-dinitrotoluene	121-14-2	3700	160000	0	3700	ug/kg	IND SCTL
OS	2,6-DICHLOROPHENOL	87-65-0	2200000	0	0	2200000	ug/kg	IND SCTL
OS	2,6-dinitrotoluene	606-20-2	2100	78000	0	2100	ug/kg	IND SCTL
OS	2-ACETYLAMINOFLUORENE	53-96-3	0	0	0	0	ug/kg	NA
OS	2-chloronaphthalene	91-58-7	49000000	6300000	0	49000000	ug/kg	IND SCTL
OS	2-chlorophenol	95-57-8	340000	390000	0	340000	ug/kg	IND SCTL
OS	2-methyl-4,6-dinitrophenol	534-52-1	0	7800	0	7800	ug/kg	RES SOIL RBC
OS	2-methylnaphthalene	91-57-6	560000	1600000	0	560000	ug/kg	IND SCTL
OS	2-methylphenol	95-48-7	28000000	3900000	0	28000000	ug/kg	IND SCTL
OS	2-NAPHTHYLAMINE	91-59-8	0	0	0	0	ug/kg	NA
OS	2-nitroaniline	88-74-4	66000	230000	0	66000	ug/kg	IND SCTL
OS	2-nitrophenol	88-75-5	0	0	0	0	ug/kg	NA
OS	3&4-METHYLPHENOL	TTNUS042	3000000	390000	0	3000000	ug/kg	IND SCTL
OS	3,3'-dichlorobenzidine	91-94-1	6300	1400	0	6300	ug/kg	IND SCTL
OS	3,3'-DIMETHYLBENZIDINE	119-93-7	0	280	0	280	ug/kg	RES SOIL RBC
OS	3-METHYLCHOLANTHRENE	56-49-5	0	0	0	0	ug/kg	NA
OS	3-methylphenol	108-39-4	29000000	3900000	0	29000000	ug/kg	IND SCTL
OS	3-nitroaniline	99-09-2	0	23000	0	23000	ug/kg	RES SOIL RBC
OS	4-AMINOBIPHENYL	92-67-1	0	0	0	0	ug/kg	NA
OS	4-bromophenyl phenyl ether	101-55-3	0	0	0	0	ug/kg	NA
OS	4-chloro-3-methylphenol	59-50-7	4400000	0	0	4400000	ug/kg	IND SCTL
OS	4-chloroaniline	106-47-8	2000000	310000	0	2000000	ug/kg	IND SCTL
OS	4-chlorophenyl phenyl ether	7005-72-3	0	0	0	0	ug/kg	NA
OS	4-methylphenol	106-44-5	3000000	390000	0	3000000	ug/kg	IND SCTL
OS	4-nitroaniline	100-01-6	26000	32000	0	26000	ug/kg	IND SCTL
OS	4-nitrophenol	100-02-7	4400000	0	0	4400000	ug/kg	IND SCTL
OS	4-NITROQUINOLINE-1-OXIDE	56-57-5	0	0	0	0	ug/kg	NA
OS	5-NITRO-O-TOLUIDINE	99-55-8	0	19000	0	19000	ug/kg	RES SOIL RBC
OS	7,12-DIMETHYLBENZ(A)ANTHRACENE	57-97-6	0	0	0	0	ug/kg	NA
OS	A,A-DIMETHYLPHENETHYLAMINE	122-09-8	0	0	0	0	ug/kg	NA
OS	Acenaphthene	83-32-9	18000000	4700000	0	18000000	ug/kg	IND SCTL

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Fraction	Parameter	CAS No.	FDEP IND SCTL	Res Soil RBCs	BG	IND AL	REG UNITS	IND SOURCE
OS	Acenaphthylene	208-96-8	11000000	0	0	11000000	ug/kg	IND SCTL
OS	ACETOPHENONE	98-86-2	24000000	7800000	0	24000000	ug/kg	IND SCTL
OS	ANILINE	62-53-3	100000	110000	0	100000	ug/kg	IND SCTL
OS	Anthracene	120-12-7	260000000	23000000	0	260000000	ug/kg	IND SCTL
OS	ARAMITE	140-57-8	0	0	0	0	ug/kg	NA
OS	AZOBENZENE	103-33-3	24000	5800	0	24000	ug/kg	IND SCTL
OS	BENZIDINE	92-87-5	0	2.8	0	2.8	ug/kg	RES SOIL RBC
OS	Benzo(a)anthracene	56-55-3	5000	87	0	5000	ug/kg	IND SCTL
OS	Benzo(a)pyrene	50-32-8	500	870	0	500	ug/kg	IND SCTL
OS	Benzo(b)fluoranthene	205-99-2	4800	880	0	4800	ug/kg	IND SCTL
OS	Benzo(g,h,i)perylene	191-24-2	41000000	0	0	41000000	ug/kg	IND SCTL
OS	Benzo(k)fluoranthene	207-08-9	52000	8700	0	52000	ug/kg	IND SCTL
OS	BENZOIC ACID	65-85-0	1E+17	310000000	0	1E+17	ug/kg	IND SCTL
OS	BENZYL ALCOHOL	100-51-6	610000000	23000000	0	610000000	ug/kg	IND SCTL
OS	Bis(2-chloroethoxy)methane	111-91-1	0	0	0	0	ug/kg	NA
OS	Bis(2-chloroethyl)ether	111-44-4	400	580	0	400	ug/kg	IND SCTL
OS	Bis(2-ethylhexyl)phthalate	117-81-7	280000	46000	0	280000	ug/kg	IND SCTL
OS	Butyl benzyl phthalate	85-68-7	320000000	16000000	0	320000000	ug/kg	IND SCTL
OS	Carbazole	86-74-8	190000	32000	0	190000	ug/kg	IND SCTL
OS	CHLOROBENZILATE	510-15-6	14000	2400	0	14000	ug/kg	IND SCTL
OS	Chrysene	218-01-9	450000	87000	0	450000	ug/kg	IND SCTL
OS	DIALLATE	2303-16-4	56000	0	0	56000	ug/kg	IND SCTL
OS	Dibenzo(a,h)anthracene	53-70-3	500	87	0	500	ug/kg	IND SCTL
OS	Dibenzofuran	132-64-9	5000000	160000	0	5000000	ug/kg	IND SCTL
OS	Diethyl phthalate	84-66-2	920000000	63000000	0	920000000	ug/kg	IND SCTL
OS	DIMETHOATE	60-51-5	86000	0	0	86000	ug/kg	IND SCTL
OS	Dimethyl phthalate	131-11-3	1E+17	780000000	0	1E+17	ug/kg	IND SCTL
OS	Di-n-butyl phthalate	84-74-2	140000000	7800000	0	140000000	ug/kg	IND SCTL
OS	Di-n-octyl phthalate	117-84-0	27000000	3100000	0	27000000	ug/kg	IND SCTL
OS	DIPHENYLAMINE	122-39-4	0	2000000	0	2000000	ug/kg	RES SOIL RBC
OS	ETHYL METHANE SULFONATE	62-50-0	0	0	0	0	ug/kg	NA
OS	FAMPHUR	52-85-7	0	0	0	0	ug/kg	NA
OS	Fluoranthene	206-44-0	48000000	3100000	0	48000000	ug/kg	IND SCTL
OS	Fluorene	86-73-7	28000000	3100000	0	28000000	ug/kg	IND SCTL
OS	Hexachlorobenzene	118-74-1	1100	400	0	1100	ug/kg	IND SCTL
OS	Hexachlorobutadiene	87-68-3	12000	8200	0	12000	ug/kg	IND SCTL
OS	Hexachlorocyclopentadiene	77-47-4	16000	470000	0	16000	ug/kg	IND SCTL

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Fraction	Parameter	CAS No.	FDEP IND SCTL	Res Soil RBCs	BG	IND AL	REG UNITS	IND SOURCE
OS	Hexachloroethane	67-72-1	78000	46000	0	78000	ug/kg	IND SCTL
OS	HEXACHLOROPHENE	70-30-4	0	23000	0	23000	ug/kg	RES SOIL RBC
OS	HEXACHLOROPROPENE	1888-71-7	0	0	0	0	ug/kg	NA
OS	Indeno(1,2,3-cd)pyrene	193-39-5	5300	870	0	5300	ug/kg	IND SCTL
OS	ISODRIN	465-73-6	0	0	0	0	ug/kg	NA
OS	Isophorone	78-59-1	580000	670000	0	580000	ug/kg	IND SCTL
OS	ISOSAFROLE	120-58-1	0	0	0	0	ug/kg	NA
OS	KEPONE	143-50-0	0	80	0	80	ug/kg	RES SOIL RBC
OS	METHAPYRILENE	91-80-5	0	0	0	0	ug/kg	NA
OS	METHYL METHANE SULFONATE	66-27-3	0	0	0	0	ug/kg	NA
OS	METHYL PARATHION	298-00-0	310000	20000	0	310000	ug/kg	IND SCTL
OS	Naphthalene	91-20-3	270000	1600000	0	270000	ug/kg	IND SCTL
OS	Nitrobenzene	98-95-3	120000	39000	0	120000	ug/kg	IND SCTL
OS	N-NITROSODIETHYLAMINE	55-18-5	5	4.3	0	5	ug/kg	IND SCTL
OS	N-NITROSODIMETHYLAMINE	62-75-9	20	13	0	20	ug/kg	IND SCTL
OS	N-NITROSO-DI-N-BUTYLAMINE	924-16-3	70	120	0	70	ug/kg	IND SCTL
OS	N-NITROSO-DI-N-PROPYLAMINE	621-64-7	200	91	0	200	ug/kg	IND SCTL
OS	n-nitrosodiphenylamine	86-30-6	440000	130000	0	440000	ug/kg	IND SCTL
OS	N-NITROSOMETHYLETHYLAMINE	10595-95-6	20	29	0	20	ug/kg	IND SCTL
OS	N-NITROSOMORPHOLINE	59-89-2	0	0	0	0	ug/kg	NA
OS	N-NITROSOPIPERIDINE	100-75-4	0	0	0	0	ug/kg	NA
OS	N-NITROSOPYRROLIDINE	930-55-2	0	300	0	300	ug/kg	RES SOIL RBC
OS	O,O,O-TRIETHYL PHOSPHOROTHIOATE	126-68-1	0	0	0	0	ug/kg	NA
OS	O-TOLUIDINE	95-53-4	3300	2700	0	3300	ug/kg	IND SCTL
OS	P-(DIMETHYLAMINO)AZOBENZENE	60-11-7	0	0	0	0	ug/kg	NA
OS	PENTACHLOROBENZENE	608-93-5	250000	63000	0	250000	ug/kg	IND SCTL
OS	PENTACHLORONITROBENZENE	82-68-8	7700	2500	0	7700	ug/kg	IND SCTL
OS	Pentachlorophenol	87-86-5	23000	5300	0	23000	ug/kg	IND SCTL
OS	PHENACETIN	62-44-2	0	0	0	0	ug/kg	NA
OS	Phenanthrene	85-01-8	30000000	0	0	30000000	ug/kg	IND SCTL
OS	Phenol	108-95-2	390000000	23000000	0	390000000	ug/kg	IND SCTL
OS	PHORATE	298-02-2	280000	0	0	280000	ug/kg	IND SCTL
OS	PRONAMIDE	23950-58-5	0	0	0	0	ug/kg	NA
OS	Pyrene	129-00-0	37000000	2300000	0	37000000	ug/kg	IND SCTL
OS	PYRIDINE	110-86-1	95000	78000	0	95000	ug/kg	IND SCTL
OS	SAFROLE	94-59-7	0	0	0	0	ug/kg	NA
OS	SULFOTEP	3689-24-5	420000	0	0	420000	ug/kg	IND SCTL

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Fraction	Parameter	CAS No.	FDEP IND SCTL	Res Soil RBCs	BG	IND AL	REG UNITS	IND SOURCE
OS	THIONAZIN	297-97-2	0	0	0	0	ug/kg	NA
OV	1,1,1,2-TETRACHLOROETHANE	630-20-6	5700	25000	0	5700	ug/kg	IND SCTL
OV	1,1,1-trichloroethane	71-55-6	3300000	22000000	0	3300000	ug/kg	IND SCTL
OV	1,1,2,2-tetrachloroethane	79-34-5	1100	32000	0	1100	ug/kg	IND SCTL
OV	1,1,2-trichloroethane	79-00-5	1800	11000	0	1800	ug/kg	IND SCTL
OV	1,1-dichloroethane	75-34-3	2000000	7800000	0	2000000	ug/kg	IND SCTL
OV	1,1-dichloroethene	75-35-4	100	3900000	0	100	ug/kg	IND SCTL
OV	1,2,3-TRICHLOROPROPANE	96-18-4	20	320	0	20	ug/kg	IND SCTL
OV	1,2-DIBROMO-3-CHLOROPROPANE	96-12-8	2700	460	0	2700	ug/kg	IND SCTL
OV	1,2-DIBROMOETHANE	106-93-4	40	7.5	0	40	ug/kg	IND SCTL
OV	1,2-DIBROMOMETHANE	74-95-3	400000	780000	0	400000	ug/kg	IND SCTL
OV	1,2-dichloroethane	107-06-2	700	7000	0	700	ug/kg	IND SCTL
OV	1,2-dichloroethene	540-59-0	130000	700000	0	130000	ug/kg	IND SCTL
OV	1,2-dichloropropane	78-87-5	800	9400	0	800	ug/kg	IND SCTL
OV	1,3-DICHLOROPROPENE	542-75-6	200	6400	0	200	ug/kg	IND SCTL
OV	1,4-DIOXANE	123-91-1	18000	58000	0	18000	ug/kg	IND SCTL
OV	1-chlorohexane	544-10-5	0	0	0	0	ug/kg	NA
OV	2-butanone	78-93-3	21000000	47000000	0	21000000	ug/kg	IND SCTL
OV	2-CHLORO-1,3-BUTADIENE	126-99-8	17000	1600000	0	17000	ug/kg	IND SCTL
OV	2-CHLOROETHYL VINYL ETHER	110-75-8	0	0	0	0	ug/kg	NA
OV	2-CHLOROTOLUENE	95-49-8	850000	1600000	0	850000	ug/kg	IND SCTL
OV	2-hexanone	591-78-6	34000	0	0	34000	ug/kg	IND SCTL
OV	3-CHLOROPROPENE	107-05-1	0	0	0	0	ug/kg	NA
OV	4-methyl-2-pentanone	108-10-1	1500000	0	0	1500000	ug/kg	IND SCTL
OV	Acetone	67-64-1	5500000	7000000	0	5500000	ug/kg	IND SCTL
OV	ACETONITRILE	75-05-8	960000	0	0	960000	ug/kg	IND SCTL
OV	ACROLEIN	107-02-8	300	39000	0	300	ug/kg	IND SCTL
OV	ACRYLONITRILE	107-13-1	500	1200	0	500	ug/kg	IND SCTL
OV	Benzene	71-43-2	1600	12000	0	1600	ug/kg	IND SCTL
OV	Bis(2-chloroisopropyl)ether	108-60-1	7300	9100	0	7300	ug/kg	IND SCTL
OV	BROMOBENZENE	108-86-1	0	0	0	0	ug/kg	NA
OV	Bromodichloromethane	75-27-4	2000	10000	0	2000	ug/kg	IND SCTL
OV	Bromoform	75-25-2	84000	81000	0	84000	ug/kg	IND SCTL
OV	Bromomethane	74-83-9	15000	110000	0	15000	ug/kg	IND SCTL
OV	Carbon disulfide	75-15-0	1400000	7800000	0	1400000	ug/kg	IND SCTL
OV	Carbon tetrachloride	56-23-5	600	4900	0	600	ug/kg	IND SCTL
OV	Chlorobenzene	108-90-7	200000	1600000	0	200000	ug/kg	IND SCTL

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Fraction	Parameter	CAS No.	FDEP IND SCTL	Res Soil RBCs	BG	IND AL	REG UNITS	IND SOURCE
OV	Chloroethane	75-00-3	4000	220000	0	4000	ug/kg	IND SCTL
OV	Chloroform	67-66-3	500	780000	0	500	ug/kg	IND SCTL
OV	Chloromethane	74-87-3	2300	0	0	2300	ug/kg	IND SCTL
OV	Chlorotoluene	25168-05-2	730000	0	0	730000	ug/kg	IND SCTL
OV	cis-1,2-dichloroethene	156-59-2	130000	780000	0	130000	ug/kg	IND SCTL
OV	cis-1,3-dichloropropene	10061-01-5	0	0	0	0	ug/kg	NA
OV	Dibromochloromethane	124-48-1	2100	7600	0	2100	ug/kg	IND SCTL
OV	DICHLORODIFLUOROMETHANE	75-71-8	370000	16000000	0	370000	ug/kg	IND SCTL
OV	ETHYL CYANIDE	107-12-0	0	0	0	0	ug/kg	NA
OV	ETHYL METHACRYLATE	97-63-2	2600000	7000000	0	2600000	ug/kg	IND SCTL
OV	Ethylbenzene	100-41-4	8400000	7800000	0	8400000	ug/kg	IND SCTL
OV	IODOMETHANE	74-88-4	0	0	0	0	ug/kg	NA
OV	ISOBUTANOL	78-83-1	31000000	23000000	0	31000000	ug/kg	IND SCTL
OV	M+P-XYLENES	TTNUS054	40000000	16000000	0	40000000	ug/kg	IND SCTL
OV	METHACRYLONITRILE	126-98-7	5400	7800	0	5400	ug/kg	IND SCTL
OV	METHYL METHACRYLATE	80-62-6	9400000	110000000	0	9400000	ug/kg	IND SCTL
OV	METHYL TERT-BUTYL ETHER	1634-04-4	22000000	160000	0	22000000	ug/kg	IND SCTL
OV	Methylene chloride	75-09-2	23000	85000	5.6	23000	ug/kg	IND SCTL
OV	O-XYLENE	95-47-6	40000000	16000000	0	40000000	ug/kg	IND SCTL
OV	PENTACHLOROETHANE	76-01-7	0	0	0	0	ug/kg	NA
OV	Styrene	100-42-5	21000000	16000000	0	21000000	ug/kg	IND SCTL
OV	Tetrachloroethene	127-18-4	17000	1200	0	17000	ug/kg	IND SCTL
OV	Toluene	108-88-3	2600000	16000000	0	2600000	ug/kg	IND SCTL
OV	trans-1,2-dichloroethene	156-60-5	210000	1600000	0	210000	ug/kg	IND SCTL
OV	trans-1,3-dichloropropene	10061-02-6	200	0	0	200	ug/kg	IND SCTL
OV	TRANS-1,4-DICHLORO-2-BUTENE	110-57-6	0	0	0	0	ug/kg	NA
OV	Trichloroethene	79-01-6	8500	1600	0	8500	ug/kg	IND SCTL
OV	TRICHLOROFLUOROMETHANE	75-69-4	1300000	23000000	0	1300000	ug/kg	IND SCTL
OV	VINYL ACETATE	108-05-4	550000	78000000	0	550000	ug/kg	IND SCTL
OV	Vinyl chloride	75-01-4	40	90	0	40	ug/kg	IND SCTL
OV	Xylenes, total	1330-20-7	40000000	16000000	0	40000000	ug/kg	IND SCTL
PCB	Aroclor-1016	12674-11-2	2100	5500	0	2100	ug/kg	IND SCTL
PCB	Aroclor-1221	11104-28-2	2100	320	0	2100	ug/kg	IND SCTL
PCB	Aroclor-1232	11141-16-5	2100	320	0	2100	ug/kg	IND SCTL
PCB	Aroclor-1242	53469-21-9	2100	320	0	2100	ug/kg	IND SCTL
PCB	Aroclor-1248	12672-29-6	2100	320	0	2100	ug/kg	IND SCTL
PCB	Aroclor-1254	11097-69-1	2100	320	0	2100	ug/kg	IND SCTL

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Fraction	Parameter	CAS No.	FDEP IND SCTL	Res Soil RBCs	BG	IND AL	REG UNITS	IND SOURCE
PCB	Aroclor-1260	11096-82-5	2100	320	0	2100	ug/kg	IND SCTL
PEST	2,4,5-T	93-76-5	8300000	780000	0	8300000	ug/kg	IND SCTL
PEST	2,4,5-TP (SILVEX)	93-72-1	12000000	630000	0	12000000	ug/kg	IND SCTL
PEST	2,4-D	94-75-7	11000000	780000	0	11000000	ug/kg	IND SCTL
PEST	4,4'-DDD	72-54-8	18000	2700	27.2	18000	ug/kg	IND SCTL
PEST	4,4'-DDE	72-55-9	13000	1900	83.33	13000	ug/kg	IND SCTL
PEST	4,4'-DDT	50-29-3	13000	1900	61.24	13000	ug/kg	IND SCTL
PEST	Aldrin	309-00-2	300	38	0	300	ug/kg	IND SCTL
PEST	alpha-BHC	319-84-6	500	100	0	500	ug/kg	IND SCTL
PEST	alpha-chlordane	5103-71-9	0	0	0	0	ug/kg	NA
PEST	beta-BHC	319-85-7	2100	350	0	2100	ug/kg	IND SCTL
PEST	CHLORDANE	57-74-9	12000	1800	0	12000	ug/kg	IND SCTL
PEST	delta-BHC	319-86-8	420000	0	0	420000	ug/kg	IND SCTL
PEST	Dieldrin	60-57-1	300	40	0	300	ug/kg	IND SCTL
PEST	DINOSEB	88-85-7	740000	78000	0	740000	ug/kg	IND SCTL
PEST	DISULFOTON	298-04-4	56000	3100	0	56000	ug/kg	IND SCTL
PEST	Endosulfan I	959-98-8	6700000	470000	6.26	6700000	ug/kg	IND SCTL
PEST	Endosulfan II	33213-65-9	6700000	470000	0	6700000	ug/kg	IND SCTL
PEST	Endosulfan sulfate	1031-07-8	0	0	0	0	ug/kg	NA
PEST	Endrin	72-20-8	340000	23000	11.8	340000	ug/kg	IND SCTL
PEST	Endrin aldehyde	7421-93-4	480000	0	0	480000	ug/kg	IND SCTL
PEST	Endrin ketone	53494-70-5	0	0	0	0	ug/kg	NA
PEST	gamma-BHC (lindane)	58-89-9	2200	490	0	2200	ug/kg	IND SCTL
PEST	gamma-chlordane	5103-74-2	0	0	0	0	ug/kg	NA
PEST	Heptachlor	76-44-8	900	140	0	900	ug/kg	IND SCTL
PEST	Heptachlor epoxide	1024-57-3	400	70	0	400	ug/kg	IND SCTL
PEST	Methoxychlor	72-43-5	7500000	390000	59.86	7500000	ug/kg	IND SCTL
PEST	PARATHION	56-38-2	9100000	470000	0	9100000	ug/kg	IND SCTL
PEST	Toxaphene	8001-35-2	3700	580	0	3700	ug/kg	IND SCTL
PET	TOTAL PETROLEUM HYDROCARBONS	TTNUS001	2500	0	0	2500	mg/kg	IND SCTL
TOX	TOTAL COMBUSTABLE ORGANICS	TTNUS045	0	0	0	0	ug/kg	NA

FDEP IND SCTL - FDEP Soil Cleanup Target Level for Commercial/Industrial Direct Exposure, FAC 62-777 Table II (08/05/1999)
Res Soil RBCs - EPA Region III Risk-Based Concentrations (10/15/2003)
BG - Twice the average background concentration for inorganics, and the average background concentration for organics, based ona subset of data from Appendix F of the Supplemental RFI/RI for Eight Sites (B&RE, 1998a)