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CORRECTIVE MEASURES STUDY REPORT FOR SOLID WASTE MANAGEMENT UNIT 5
REVISION 2 WITH TRANSMITTAL LETTER NAS KEY WEST FL
3/9/1999
TETRA TECH NUS

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Rev. 2
3/9/99

0014

Corrective Measures Study Report
for
Solid Waste Management Unit 5
(SWMU 5)

Naval Air Station Key West
Boca Chica Key, Florida

Southern Division
Naval Facilities Engineering Command
Contract Number N62467-94-D-0888
Contract Task Order 0007

March 1999

TETRA TECH NUS, INC.
900 Trail Ridge Road ▪ Aiken, South Carolina 29803
(803) 649-7963 ▪ FAX (803) 641-0375 ▪ www.tetratech.com

AIK-99-0042

March 9, 1999

Project Number HK 7046 *via U.S. Mail*

Mr. Dudley Patrick - Code 1858
Southern Division
NAVFACENGCOM
P.O. Box 190010
North Charleston, South Carolina 29419-9010

Reference: CLEAN Contract No. N62467-94-D-0888
Contract Task Order No. 007

Subject: Corrective Measures Study Reports for Solid Waste Management Units 5 and 7, Rev. 2
Naval Air Station Key West, Florida

Dear Mr. Patrick:

Tetra Tech NUS, Inc. (TtNUS) is pleased to submit the enclosed Corrective Measures Study (CMS) Reports for Solid Waste Management Units (SWMUs) 5 and 7, Rev. 2, Naval Air Station (NAS) Key West. These documents incorporate all comments on previous versions of the documents as resolved by the NAS Key West Partnering Team and they are considered the final versions, pending regulatory acceptance. I have enclosed only those pages that have changed from the Rev. 1 version of the documents to save paper. For your convenience, I have also enclosed pages 2-15 and 2-16 from the SWMU 7 CMS report because it was not copied correctly when the Rev. 1 version of the report was submitted in December 1998.

As you requested, copies of the two enclosed documents are being sent to members of the NAS Key West Partnering Team and Restoration Advisory Board. Please call me at (803) 649-7963, extension 345 with any questions you may have regarding the enclosed documents.

Sincerely,

Dean Fleiger for...

C. M. Bryan
Project Manager

CMB:spd

Enclosures

cc: Ms. M. Berry, EPA (2 copies)
Mr. J. Caspary, FDEP (2 copies)
Mr. R. Demes, NAS Key West
Mr. P. Williams, NAS Key West (2 copies)
Mr. R. Cohose, Bechtel Environmental, Inc.
Mr. M. Perry, TtNUS Technical Coordinator
Ms. R. Orlandi, RAB Community Member
Ms. M. Stafford, RAB Community Member
Mr. M. Ingram, RAB Community Member
Ms. R. Haag, South Florida Water Management District
Files: 7046-7.13.3, 7.14.3

TETRA TECH NUS, INC.
661 Andersen Drive ▪ Pittsburgh, Pennsylvania 15220-2745
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PITT-12-8-065

December 11, 1998

Project Number HK 7046

Mr. Dudley Patrick - Code 1858
Southern Division
NAVFACENGCOM
P.O. Box 190010
North Charleston, South Carolina 29419-9010

Reference: CLEAN Contract No. N62467-94-D-0888
Contract Task Order No. 0007

Subject: Corrective Measures Study Report for Solid Waste Management Unit 5, Rev. 1
Naval Air Station Key West, Florida

Dear Mr. Patrick:

Tetra Tech NUS, Inc. (TtNUS) is pleased to submit the enclosed Rev. 1 Corrective Measures Study (CMS) Report for Solid Waste Management Unit (SWMU) 5, at Naval Air Station (NAS) Key West, Florida. This revision addresses the comments provided to TtNUS on the Rev. 0 CMS Report for SWMU 5. In accordance with the NAS Key West Corrective Action Management Plan, this document will become final if no more comments are received from the regulatory agencies.

In an effort to conserve natural resources, only those sections of the report that contain changes are being submitted in Rev. 1. Please replace the spine, cover, and all sections of the Rev. 0 copy with the enclosed Rev. 1 updates.

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

Sincerely,

for C. M. Bryan
Project Manager

CMB:spd

Enclosure

c: Ms. D. Evans-Ripley, SouthDiv (w/o encl.)
Ms. M. Berry, EPA (2 copies)
Mr. J. Caspary, FDEP (2 copies)
Mr. R. Demes, NAS Key West
Mr. P. Williams, NAS Key West (2 copies)
Mr. R. Hoekstra, Bechtel Environmental, Inc.
Mr. M. Perry, TtNUS Technical Coordinator
Ms. R. Orlandi, RAB Community Member
Ms. M. Stafford, RAB Community Member
Mr. M. Ingram, RAB Community Member
Ms. R. Haag, South Florida Water Management District
File: 7046-7.13.2

bcc:

Jason Brown, TetraTech NUS, Pittsburgh (2 copies)
Greg Maynard, TetraTech NUS, King of Prussia
Mark Sparanza, TetraTech NUS, Pittsburgh

Rev. 2
3/9/99

CORRECTIVE MEASURES STUDY REPORT FOR SOLID WASTE MANAGEMENT UNIT 5 (SWMU 5)

NAVAL AIR STATION KEY WEST
BOCA CHICA KEY, FLORIDA

COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Southern Division
Naval Facilities Engineering Command
2155 Eagle Drive
North Charleston, South Carolina 29406

Submitted by:
Tetra Tech NUS, Inc.
661 Andersen Drive
Foster Plaza 7
Pittsburgh, Pennsylvania 15220

CONTRACT NUMBER N62467-94-D-0888
CONTRACT TASK ORDER 0007

MARCH 1999

PREPARED BY:

for...

CHARLES BRYAN
TASK ORDER MANAGER
TETRA TECH NUS, INC.
AIKEN, SOUTH CAROLINA

APPROVED FOR SUBMITTAL BY:

DEBBIE WROBLEWSKI
PROGRAM MANAGER
TETRA TECH NUS, INC.
PITTSBURGH, PENNSYLVANIA

Rev. 2
3/9/99

CERTIFICATION OF TECHNICAL CONFORMITY

Name: Mark P. Speranza

Signature: Mark P. Speranza

Professional Engineer
Certificate Number: PE0050304

Date: March 9, 1999

This Professional Engineer Certificate indicates that this document complies with the State of Florida's regulatory requirements for an engineering document. The Professional Engineering Certificate does not indicate that this report can be used for construction.

Mark P. Speranza

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

SECTION **PAGE**

APPENDICES

TABLES

FIGURES

ACRONYMS

ARARs	Applicable or Relevant and Appropriate Requirements
AWQC	Ambient Water Quality Criteria
B&R Environmental	Brown & Root Environmental
BDAT	Best Demonstrated Available Technology
bgs	Below Ground Surface
BTAG	Biological Technical Assistance Group
CAA	Clean Air Act
CAMP	Corrective Action Management Plan
CAO	Corrective Action Objective
CAP	Corrective Action Program
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-Term Environmental Action Navy
CLP	Contract Laboratory Program
cm/sec	centimeters per second
CMS	Corrective Measure Study
COC	Chemical of Concern
COPC	Chemicals of Potential Concern
CWA	Clean Water Act
cy	cubic yard
DDD	Dichlorodiphenyl Dichloroethane
DDE	Dichlorodiphenyl Dichloroethylene
DDT	Dichlorodiphenyl Trichloroethane
dl	deciliter
DOD	Department of Defense
DOT	Department of Transportation
ECC	Ecological Chemicals of Concern
EPA	United States Environmental Protection Agency
ERA	Ecological Risk Assessment
ER-L	Effects Range Low
ER-M	Effects Range Median
FAC	Florida Administrative Code
FDEP	Florida Department of Environmental Protection

ft	feet
ft^2	square feet
g	gram
gpd	gallons per day
HHRA	Human Health Risk Assessment
HI	Hazard Index
HQ	Hazard Quotient
HSWA	Hazardous and Solid Waste Amendments
ICR	Incremental Cancer Risk
IEUBK	Integrated Exposure and Uptake Biokinetic
IRA	Interim Remedial Action
IRP	Installation Restoration Program
kg	kilogram
L	Liter
LDR	Land Disposal Restriction
MCL	Maximum Contaminant Levels
MCLG	Maximum Contaminant Level Goal
meq	milliequivalent
MOA	Memorandum of Agreement
µg	microgram
mg	milligram
msl	mean sea level
NAAQS	National Ambient Air Quality Standards
NACIP	Naval Assessment and Control of Installation Pollutants Program
NAS	Naval Air Station
NAVFACENGCOM	Naval Facilities Engineering Command
NCP	National Contingency Plan
NESHAP	National Emission Standards for Hazardous Air Pollutants
NFA	No Further Action
NPDES	National Pollution Discharge Elimination System
NSPS	New Source Performance Standards
O&M	Operation and Maintenance
OSHA	Occupational Safety and Health Administration
PAH	Polynuclear Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyls
ppb	parts per billion

PPE	Personal Protective Equipment
ppm	parts per million
QA	Quality Assurance
QC	Quality Control
RAB	Restoration Advisory Board
RBC	Risk-Based Concentration
RCRA	Resource Conservation and Recovery Act
RfD	Reference Dose
RFI	RCRA Facility Investigation
RGO	Remedial Goal Options
RI	Remedial Investigation
SAL	Screening Action Level
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act
SCG	Soil Clean-up Goals
SDWA	Safe Drinking Water Act
SIP	State Implementation Plan
SPT	Standard Penetration Test
SVOC	Semi-Volatile Organic Compound
SWMU	Solid Waste Management Unit
TBC	To Be Considered
TOC	Total Organic Compound
TSDF	Treatment, Storage, and Disposal Facility
yd	yard
yd^3	cubic yards
VOC	Volatile Organic Compound

EXECUTIVE SUMMARY

Tetra Tech NUS, Inc. (TtNUS), formerly Brown & Root Environmental (B&R Environmental) conducted a Corrective Measure Study (CMS) of Solid Waste Management Unit (SWMU) 5, Aircraft Intermediate Maintenance Department (AIMD) Building A-990 - Sandblasting Area, Naval Air Station (NAS) Key West under Contract Number N62467-94-D-0888, Contract Task Order (CTO) 0007, for the U.S. Navy, Naval Facilities Engineering Command, Southern Division (NAVFACENGCOM-Southern Division). This CMS was based on the results of previous investigations as listed below.

Investigation	Date	Regulatory Driver
Resource Conservation and Recovery Act (RCRA) Facility Investigation and Remedial Investigation (RFI/RI) conducted by IT Corporation	1994	RCRA/Comprehensive Environmental Response Compensation and Liability Act (CERCLA)
Supplemental RFI/RI conducted by B&R Environmental	1997	RCRA/CERCLA

SITE DESCRIPTION

SWMU 5 (Boca Chica AIMD Sandblasting Area-Building A-990) is located at the western end of the airfield on Boca Chica Key. The Sandblasting Area was used from the early 1970s until 1995 to remove paint from surfaces of ground handling and ground support vehicles and equipment, aircraft parts, and other metal objects and pieces of equipment. The Sandblasting Area is located adjacent to Building A-990 and measures approximately 65 feet by 90 feet. Sandblasting residue was normally left on the ground or stockpiled for disposal. The former sandblasting area consists of bare rock and concrete and an extensive paved area located north of the site. A concrete access road is located to the south, and six AIMD buildings are situated along this road. A variety of aircraft maintenance operations are conducted in the buildings and in the area to the north. Immediately south of the concrete access road is a concrete ditch that collects stormwater runoff from the AIMD area and transports it westward. The concrete drainage ditch ends in a small grassy area approximately 300 feet west of the site. Surface-water flow beyond this point is nonexistent except after heavy rainfall events, when surface water flows overland to a shallow pond. The pond is connected by a culvert under a paved road to an extensive area of large lagoons south of the road. A large dirt berm is located immediately south of the concrete ditch. With the exception of the berm, the topography of the site and surrounding area is flat.

PURPOSE

The purpose of this CMS is to identify corrective action objectives (CAOs), identify and screen corrective measure technologies, develop corrective measure alternatives, evaluate corrective measure alternatives, and justify and recommend a final corrective action for groundwater, soil, sediment, and surface-water contamination within SWMU 5.

CORRECTIVE ACTION OBJECTIVES

CAOs specify chemicals of concern (COCs), media of interest, exposure pathways, and cleanup goals or acceptable contaminant concentrations. CAOs may be developed to permit consideration of a range of treatment and containment alternatives. This CMS addresses soil and sediment contamination within SWMU 5. To protect the public from potential current and future health, the following CAOs have been developed for SWMU 5 soil and sediment to address the primary exposure pathways:

- Prevent human receptors from contacting contaminants in the soil and sediment at concentrations which would result in adverse effects.

- Compliance at SWMU 5 with contaminant-specific, location-specific, and action-specific Federal and state applicable or relevant and appropriate requirements (ARARs).

CORRECTIVE MEASURE ALTERNATIVE DEVELOPMENT

Alternatives were developed which evaluate corrective measures in each of the media that address the COCs and exposure pathways in order to achieve the CAOs. For SWMU 5, the projected future land use is anticipated to be non-residential; therefore, only COCs determined under non-residential land use scenarios are considered in this CMS. Alternatives were developed that range from no action to those that address all contaminants that could potentially affect industrial use human receptors. The alternatives that were assembled are briefly described below.

SWMU 5 Alternatives

Alternative 1 - No Action: The No Action alternative is a general response action wherein the status quo is maintained at the site. This alternative is retained to provide a baseline for comparison to other alternatives and therefore, does not address the remaining contamination of the soil, sediment, surface water, and groundwater.

Alternative 2 - Institutional Controls with Monitoring: This alternative consists of one major component, institutional controls (i.e. land-use controls, monitoring, and educational programs). Land-use controls would be imposed to eliminate or reduce the pathways of human exposure to contaminants at the site. In addition, surface-water, sediment, and groundwater sampling would be conducted. Per the NAS Key West memorandum of agreement (MOA) with the U.S. EPA and FDEP (NASKW, 1998), the facility will perform quarterly inspections and make an annual report to U.S. EPA and FDEP verifying the integrity of institutional controls at the site. The reviews would include recommendations for further action at the site (i.e. continued monitoring, additional remedial action, no further action, etc.).

Alternative 3 - Remove, Treat, and Dispose of Soil Contaminated at Concentrations Greater than Modified Industrial Remedial Goal Options (RGOs): Under this alternative, approximately 100 cubic yards (yd^3) of soil contaminated in excess of Modified Industrial RGOs would be excavated from one hot-spot on the berm south of the former sandblasting area. Stockpiled soils will be transported to an off-site RCRA permitted treatment, storage, and disposal facility (TSDF) for treatment, if required, and disposal. This alternative would also include the implementation of land-use controls to eliminate or reduce pathways of exposure from residual contaminants at the site and monitoring to verify that unacceptable risk did not exist. Per the NAS Key West MOA with the U.S. EPA and FDEP (NASKW, 1998), the facility will perform quarterly inspections and make an annual report to U.S. EPA and FDEP verifying the integrity of institutional controls at the site. The reviews would include recommendations for further action at the site (i.e. continued monitoring, additional remedial action, no further action, etc.).

EVALUATION OF CORRECTIVE MEASURE ALTERNATIVES

Each alternative was evaluated using the nine criteria specified in the Guidance for RCRA Corrective Action Plan (OSWER Directive 9902.3-2A, U.S. EPA May, 1994). These criteria include Protection of Human Health and the Environment; Media Clean-up Standards; Source Control; Waste Management Standards; Long-Term Reliability and Effectiveness; Reduction in Toxicity, Mobility, or Volume; Short-Term Effectiveness; Implementability; and Cost. Section 5.0 of this report presents the results of this evaluation process.

A comparative analysis of each alternative was completed. This comparative analysis was performed with respect to specific factors for each of the nine above-mentioned criteria and differences among the alternatives were identified. The results of this analysis are presented in Section 5.0. The estimated costs for each alternative are as follows:

Alternative	Capital ($)	Operating ($/year)	Present Worth ($)
1	0	0	0
2	4,500	9,800-39,200	125,000
3	112,000	9,800-39,200	233,000

The costs are itemized in the detailed cost sheets presented in Appendix C.

It should be also noted that, to date, the Navy has spent approximately 7.9 million dollars on IRAs at nine sites/SWMUs/Areas of Concern.

The recommended alternative for this site is Alternative 2 – Institutional Controls with Monitoring. Under this alternative, groundwater, sediment, and surface water would be sampled and analyzed at a frequency yet-to-be determined by the NAS Key West Partnering Team. Further, exposure to soil in the adjacent berm would be managed by implementing appropriate access restrictions to affected soil in said berm. The institutional control alternative is further described below.

By separate MOA with the U.S. EPA and the FDEP, NAS Key West, on behalf of the Department of the Navy, agreed to implement periodic site inspection, condition certification, and agency notification procedures designed to ensure the maintenance by Station personnel of any site-specific land-use controls (LUC) deemed necessary for future protection of human health and the environment. A fundamental premise underlying execution of that agreement was that through the Navy's substantial good-faith compliance with the procedures called for therein, reasonable assurances would be provided to the U.S. EPA and FDEP as to the permanency of those remedies, which included the use of specific LUCs.

Although the terms and conditions of the Memorandum of Agreement (MOA) are not specifically incorporated herein by reference, it is understood and agreed by the Navy, U.S. EPA, and FDEP that the contemplated permanence of the remedy reflected herein shall be dependent on the Station's substantial good-faith compliance with the specific LUC maintenance commitments reflected therein. Should such compliance not occur or should the MOA be terminated, it is understood that the protectiveness of the remedy concurred in may be reconsidered and that additional measures may need to be taken to adequately ensure necessary future protection of human health and the environment.

The proposed alternative, Institutional Controls with Monitoring, is protective of human health and the environment under current industrial land use, complies with State and Federal ARARs, and is cost effective.

1.0 INTRODUCTION

Tetra Tech NUS, Inc. (TtNUS), formerly, Brown & Root Environmental (B&R Environmental), is preparing this CMS for SWMU 5, Aircraft Intermediate Maintenance Department (AIMD) Building A-990 - Sandblasting Area, NAS Key West under Contract Number N62467-94-D-0888, Contract Task Order 0007, for the U.S. Navy, NAVFACENGCOM - Southern Division. This CMS was based on the results of previous investigations as listed below.

Investigation	Date	Regulatory Driver
RFI/RI conducted by IT Corporation	1994	RCRA/CERCLA
Supplemental RFI/RI conducted by B&R Environmental	1998	RCRA/CERCLA

All samples of soil, sediment, groundwater, and surface water obtained during the Supplemental RFI/RI in 1997 were used in the human health and ecological risk assessments. The risk assessments verified the necessity for the CMS. This CMS addresses the additional corrective measures that are necessary and appropriate.

1.1 PURPOSE

The purpose of this CMS is to identify Corrective Action Objectives (CAOs), identify and screen corrective measure technologies, develop corrective measure alternatives, evaluate the corrective measure alternatives, and recommend and justify a final corrective action for groundwater, soil, sediment, and surfacewater contamination within SWMU 5.

1.2 REPORT ORGANIZATION

Section 1.0 of this report is this introduction that provides a brief description of the background and purpose of the CMS for SWMU 5, AIMD Building A-990 - Sandblasting Area, NAS Key West. Section 2.0 presents the description of current conditions, including a discussion on the nature and extent of contamination and site conditions. The CAOs for SWMU 5 are described in Section 3.0, as is the volume of contaminated media. Section 4.0 describes the identification, screening, and development of corrective measure alternatives. Section 5.0 presents the detailed evaluation of the corrective measure alternatives. Section 6.0 provides a comparative analysis of the corrective action alternatives and provides the recommendation for the final corrective measure.

1.3 BACKGROUND

A RCRA corrective action, as mandated by the Hazardous and Solid Waste Amendments (HSWA), is a process by which a hazardous waste treatment, storage, and disposal facility (TSDF)/solid waste disposal unit is investigated and remediated, when necessary. RCRA corrective action is generally required for a TSDF/SWMU as part of Part B Permit activities conducted by authorized states or by United States Environmental Protection Agency (U.S. EPA), or through enforcement actions by U.S. EPA. The Corrective Action Program (CAP) is a program that was setup to assist U.S. EPA in developing CAOs and Corrective Action requirements in permit applications and permits. At a TSDF/SWMU the CAP evaluates the nature and extent of the release of hazardous waste or constituents; evaluates facility characteristics; and identifies, develops, and implements the appropriate corrective measure or measures adequate to protect human health and the environment.

The CAP involves three distinct steps: the RFI, the CMS, and Corrective Measures Implementation. The objective of an RFI is to thoroughly evaluate the nature and extent of the release of hazardous waste and hazardous constituents and to gather necessary data to support the CMS. The objective of a CMS is to develop and evaluate a corrective measure alternative or alternatives and to recommend the final corrective measure or measures. The objective of the Corrective Measures Implementation is to design, construct, operate, maintain, and monitor the performance of the corrective measure or measures selected during the CMS.

In addition to RCRA/HSWA sites at NAS Key West, there are several Installation Restoration Program (IRP) sites. Clean-up activities for the IRP are implemented in accordance with the National Contingency Plan (NCP) and CERCLA, as amended by the Superfund Amendments and Reauthorization Act (SARA). CERCLA establishes the approach to address and clean up hazardous waste sites at both private and federal facilities.

IT Corporation conducted a Phase I RCRA Facility Investigation/Remedial Investigation (RFI/RI) at NAS Key West from 1992 through 1994 (IT Corporation, 1994). This investigation confirmed the presence of contamination at certain NAS Key West sites. A Supplemental RFI/RI was conducted in accordance with HSWA Permit No. FL6-170-022-952, issued by U.S. EPA. A Corrective Action Management Plan (CAMP) was prepared to describe the strategy for implementing the RCRA CAP at NAS Key West (ABB, 1995a).

In August 1996, B&R Environmental began the sampling phase of the Supplemental RFI/RI Sampling and Analysis Plan (SAP) in accordance with the regulatory-approved planning documents (ABB, 1995a) at

SWMU 5. B&R Environmental used the RFI/RI sample results to determine risks to human health and ecological receptors. A limited validation effort was performed for the analytical data collected by B&R Environmental. B&R Environmental also used the data provided in the RFI/RI prepared by IT Corporation (IT Corporation, 1994) to assess site risks. In the Supplemental RFI/RI, one of B&R Environmental recommendations was that a CMS be conducted for SWMU 5, Building A-990 - Sandblasting Area.

The data obtained from the August to October 1996 field sampling at SWMU 5 were partially validated using the industry-accepted process described in Section 2.0 of Appendix C of the RFI/RI (B&R Environmental 1998). In general, this data assessment process followed Contract Laboratory Program (CLP) protocol and Naval Facilities Engineering Service Center data quality assessment guidance. In 1996, the data received a limited validation review; approximately 10 percent of 1996 the data were fully validated. Historical data were not subjected to any data quality assessment. They were assumed to have been assessed during their investigation activities and were accepted at face value since records of validation were not available.

1.4 INSTALLATION DESCRIPTION

NAS Key West is in southern Monroe County, Florida, on Boca Chica Key, which is located approximately 5 miles east of Key West. Key West and Boca Chica Key, the two westernmost major islands of the Florida Keys, are approximately 150 miles southwest of Miami. Key West and Boca Chica Key are connected to the mainland by the Overseas Highway (U.S. Highway No. 1). Figure 1-1 presents a regional map showing the location of Boca Chica Key and Key West within the Florida Keys. Figure 1-2 presents the location of SWMU 5 at the facility. 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. Other parts of the complex include Trumbo Point, Sigsbee Key (formerly Dredgers Key), Fleming Key, Demolition Key, Truman Annex on Key West, and Big Coppitt Key. The entire complex encompasses an area of approximately 5,000 acres. Boca Chica Key is approximately 3 miles wide and 3 miles long, and the air station encompasses an area of 3,250 acres. With the exception of filled areas that underlie the Overseas Highway, the elevations of Boca Chica Key are less than 5 feet above mean sea level (msl) (IT Corporation, 1994).

NAS Key West currently maintains aviation operations, a research laboratory, communications intelligence, counter-narcotics air surveillance operations, a weather service, and several other related activities. In addition to the Naval activities and units, other Department of Defense (DOD) and federal agencies at NAS Key West include US Air Force squadrons, a US Army Special Forces Division, the US Coast Guard, and a Defense Property Disposal Office.

Boca Chica Key is approximately 3 miles long and 3 miles wide. The City of Key West, which is the county seat of Monroe County, has a residential population of 24,832 (USCBS, 1990). The principal industry is tourism, with about 1,500,000 tourists visiting annually. The major sources of employment in Key West are tourism, fishing, wholesale and retail trade, services, construction, finance, insurance, real estate, Federal, state, and local government, and transportation industries.

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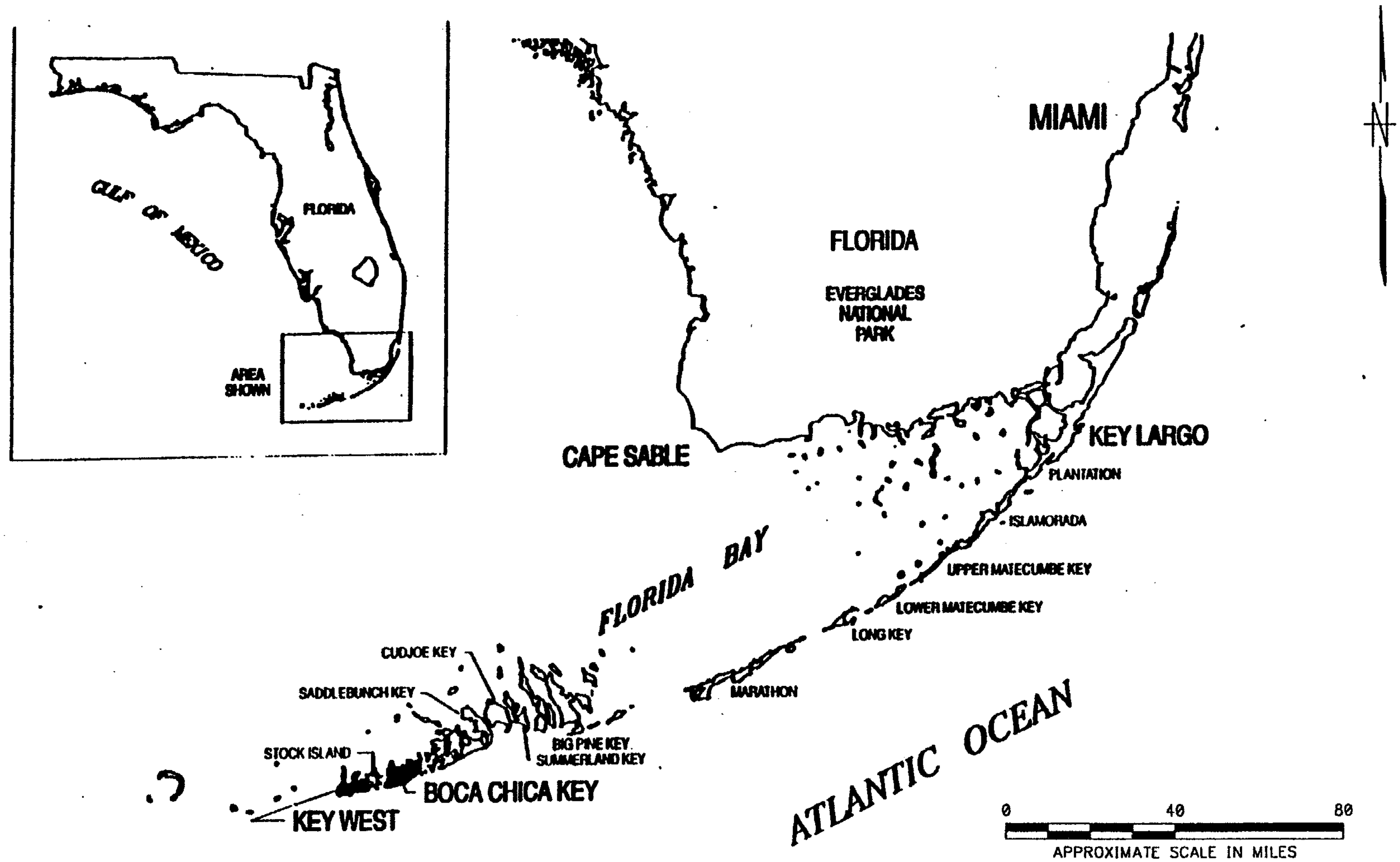

DRAWN BY HJP DATE 2/10/98	FACILITY LOCATION MAP NAVAL AIR STATION KEY WEST BOCA CHICA KEY, FLORIDA	CONTRACT NO. 7046
CHECKED BY DATE		APPROVED BY DATE
COST/SCHED-AREA		APPROVED BY DATE
SCALE AS NOTED		DRAWING NO. FIGURE 1-1 REV. 0

FORM CADD NO. SDV_AH12.DWG - REV 0 - 1/20/98

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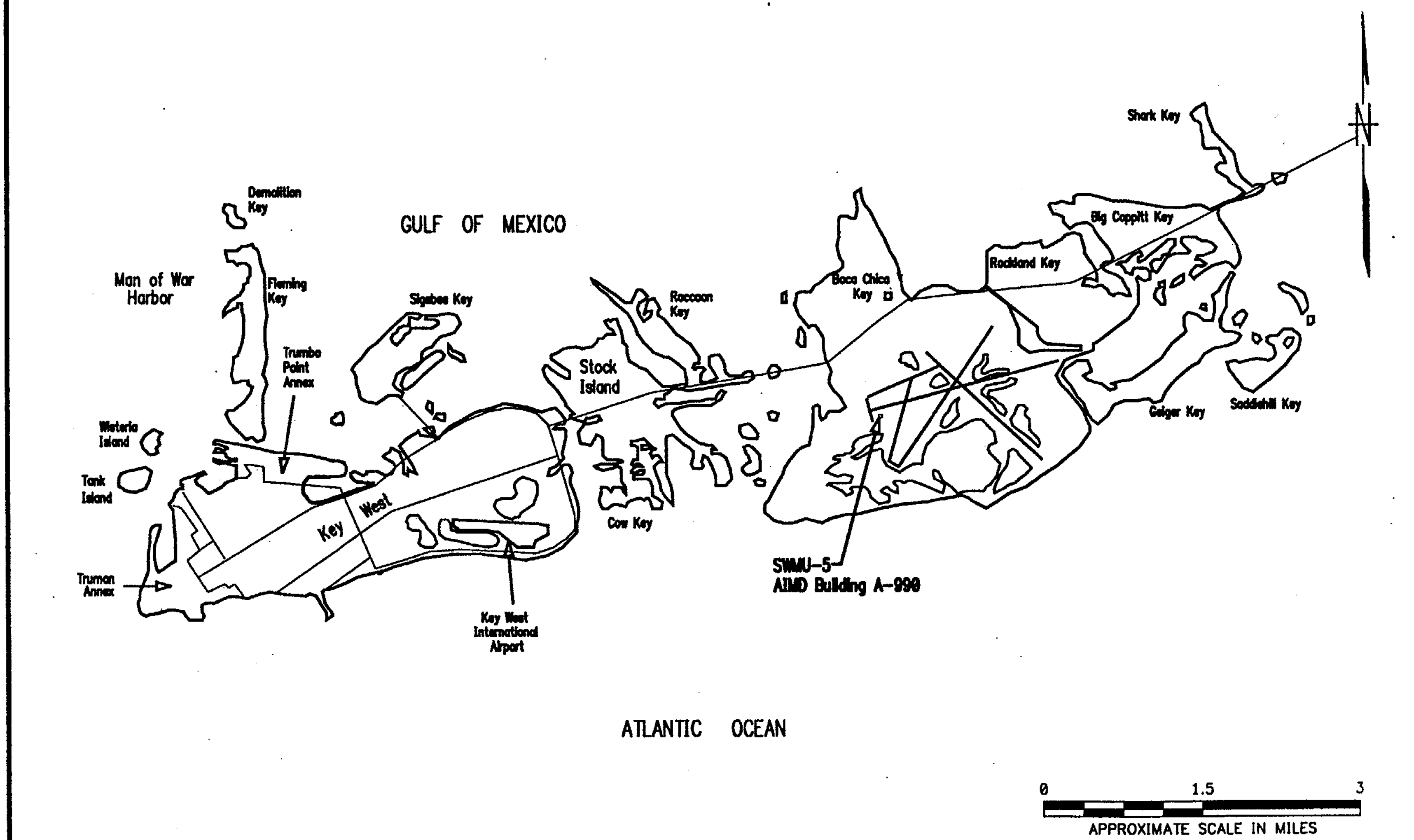

DRAWN BY HJP DATE 2/10/98		SWMU 5 LOCATION BOCA CHICA KEY, FLORIDA	CONTRACT NO. 7046
CHECKED BY DATE			APPROVED BY DATE
COST/SCHED-AREA			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 1-2 REV. 0

FORM CADD NO. SDV_AH12.DWG - REV 0 - 1/20/98

049805/P

CTO 0007

Rev. 1
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2.0 DESCRIPTION OF CURRENT CONDITIONS

2.1 SITE DESCRIPTION

SWMU 5 (Boca Chica Building A-990 - Sandblasting Area) is located at the western end of the airfield. The Sandblasting Area was used from the early 1970s until 1995 to remove paint from surfaces of ground handling and ground support vehicles and equipment, aircraft parts, and other metal objects and pieces of equipment. The Sandblasting Area is located adjacent to Building A-990 and measures approximately 65 feet by 90 feet, as shown on Figure 2-1. Sandblasting residue was normally left on the ground or stockpiled for disposal. The area consists of bare rock and concrete and an extensive paved area located north of the site. AIMD buildings are located east and west of the site. A concrete access road is located to the south, and six AIMD buildings are situated along this road. A variety of aircraft maintenance operations are conducted in the buildings and in the area to the north. Immediately south of the concrete access road is a concrete ditch that collects stormwater runoff from the AIMD area and transports it westward. The concrete drainage ditch ends in a small grassy area approximately 300 feet west of the site. Surface water flow beyond this point is nonexistent except after heavy rainfalls, when surface water flows overland to a shallow pond. The pond is connected by a culvert under a paved road to an extensive area of large lagoons south of the road. A large dirt berm is located immediately south of the concrete ditch. The berm is vegetated with grass, weeds, Brazilian pepper, and Australian pines. With the exception of the berm, the topography of the site and surrounding area is flat.

2.2 SITE GEOLOGY AND HYDROGEOLOGY

The site-specific geology and hydrogeology of the unit were determined from soil borings and monitoring wells installed during the RFI/RI (IT Corporation, 1994) and the Supplemental RFI/RI (B&R Environmental, 1998). The lithologic description of soil samples was recorded during the installation of soil borings and monitoring wells in 1993 [Appendix E of the Final RFI/RI Report (IT Corporation, 1994)]. The lithologic descriptions reveal the presence of two distinguishable units in the subsurface of the site. The uppermost unit is a light brown, poorly sorted mixture of sand and limestone fill material varying in thickness from 4 to 5 feet. The fill material particles vary in size from a pebble to a fine-grained material. Natural oolitic limestone was encountered below the fill material and was found to continue to the depths at which monitoring wells were terminated.

The primary hydrogeologic unit underlying the site is a surficial oolite limestone aquifer. During the Supplemental RFI/RI, B&R Environmental installed two additional monitoring wells (S5MW-4 and S5MW-5) and also sampled the existing wells. The depths to groundwater during this sampling event ranged from 2.79 feet to 2.98 feet below ground surface. Groundwater elevations varied from 0.98 feet to 1.06 feet above msl. Groundwater flow at the site is generally toward the west. Recharge of the aquifer is primarily through direct infiltration of precipitation. Tidal influences would appear to be greatest adjacent to the lagoon south and west of the facility. Monitoring well construction logs for the wells installed in 1996 are represented in Appendix E of the Supplemental RFI/RI (B&R Environmental, 1998).

2.3 SUMMARY OF THE NATURE AND EXTENT OF CONTAMINATION

Sandblasting was performed at SWMU 5 to remove paint from surfaces of ground handling and ground support vehicles and equipment, aircraft parts, and other metal objects and pieces of equipment. Paints and other materials resulting from the sandblasting of equipment, parts, and vehicles are potential sources of contamination. Consistent with these activities, inorganics were the most common contaminants detected at SWMU 5. Inorganic contamination appeared to be most widespread in soil and sediment, with the occurrence and distribution of the same parameters in groundwater and surface water being generally more limited and localized.

The following discussions summarize the nature and extent of contamination. All the chemicals detected were compared to applicable or relevant and appropriate requirements (ARARs) and Screening Action Levels (SALs) for each medium. These ARARs/SALs are discussed in Section 2.3.1 of the Supplemental RFI/RI (B&R Environmental, 1998).

Soil

Chemicals that were detected in soil in excess of the ARAR/SAL criteria, as reported in the Supplemental RFI/RI report are depicted in Figure 2-2. The figure includes analytical results from the IT Corporation RFI/RI and the Supplemental RFI/RI. Metals were the only compounds that exceeded ARAR/SAL criteria in subsurface and surface soils at SWMU 5. Antimony exceeded its 0.79 mg/kg screening criterion at sampling location S5SB-4 in subsurface and surface soil within the immediate Sandblasting Area sampled by IT Corporation in 1993. Several other inorganics were also detected in excess of their screening values in surface soil within the Sandblasting Area by IT Corporation in 1993: beryllium, tin, and zinc, at S5SB-4 and lead and sulfide at S5SB-2 (sulfide was not tested in any other surface soil sample). Beryllium and tin were not detected in soil elsewhere at the site. Lead also exceeded its 31 mg/kg screening value at the two sampling locations outside the immediate Sandblasting Area (S5SB-3 and S5SB-1). The maximum concentration of lead (52.1 mg/kg) was located at S5SB-1 on the berm south of the Sandblasting Area. Zinc exceeded its screening value (30 mg/kg) at S5SB-3 (86 mg/kg) and, although it was detected in other surface soil samples (S5SB-1 and S5SB-2), its concentration at these other locations was less than the 30 mg/kg screening value. Arsenic, cadmium, and nickel were detected in several surface soil samples but they exceeded screening values (2.5 mg/kg, 2.5 mg/kg, and 3.4 mg/kg) at only one location each: arsenic (13 mg/kg) and nickel (7.6 mg/kg) at S5SB-1 and cadmium (12.6 mg/kg) at S5SB-3.

Sediment

Metals were detected in sediment at SWMU 5, although no inorganics were detected in the sediment sample collected at the entrance to the lagoons located southwest of the site. Maximum concentrations were generally detected in samples collected from the concrete ditch immediately south of the Sandblasting Area and immediately west of the berm. Maximum concentrations that were detected at S5SS-1 (just west of the berm) and that exceeded screening criteria included arsenic (8.6 mg/kg), barium (250 mg/kg), beryllium (1.8 mg/kg), cadmium (120 mg/kg), chromium (428 mg/kg), copper (38.9 mg/kg), lead (966 mg/kg), mercury (0.13 mg/kg), and nickel (26.6 mg/kg). S5SS-2, collected immediately south of the Sandblasting Area, contained the maximum concentration in excess of screening criteria for beryllium (2.6 mg/kg). Both of these samples were collected during the RFI/RI. After completion of the RFI/RI sampling conducted by IT Corporation, the Navy removed the sediment from the concrete ditch. During field work for the Supplemental RFI/RI there was no sediment in the concrete ditch. Maximum concentrations of silver (1.3 mg/kg) and zinc (1,260 mg/kg) were detected near the pond at S5SS-5. The most frequently detected chemicals in sediment at SWMU 5 included arsenic, barium, chromium, copper, lead, nickel, vanadium, and zinc. Each of these inorganics were detected at all six sample locations. Figure 2-3 lists the analytical results from the IT Corporation RFI/RI and the Supplemental RFI/RI that exceeded the most restrictive ARAR/SAL levels.

A single VOC, acetone - which is a common laboratory contaminant, was detected in excess of the 68.6 μg/L sediment screening criterion at two sample locations: in the pond (S5SS-3, 79.4 μg/kg) and in the nearest lagoon, which is southwest of the pond (S5SS-6, 147 μg/kg). Acetone was also detected below its screening criterion in the ditch immediately south of the Sandblasting Area (S5SS-2, 24 μg/kg). Two SVOCs were also detected in the sediment at SWMU 5, and both were in excess of the screening criteria. Bis(2-ethylhexyl)phthalate exceeded its 182 μg/kg screening value in the ditch near the Sandblasting Area (S5SS-2, 570 μg/kg) and near the pond (S5SS-5, 467.5 μg/kg). Butyl benzyl phthalate was detected in excess of its 63 μg/kg screening value at a single location near the pond (S5SS-5, 495 μg/kg).

Surface Water

Inorganics were detected in only two surface water samples from SWMU 5 and the majority of the detected compounds occurred only at S5SS-2, sampled by IT Corporation in 1993. One chemical, lead, was detected at two locations in excess of its 1.32 µg/L screening criterion. Lead was detected at S5SS-2 (68.9 µg/L) and in the pond at S5SW-3 (5.1 µg/L). Lead was the only compound detected at S5SW-3, sampled by B&R Environmental in 1996. All other metal detections occurred only at S5SS-2. Cadmium, chromium, copper, and zinc were detected there at levels in excess of the screening criteria. Figure 2-4 shows analytical results from the IT Corporation RFI/RI and the Supplemental RFI/RI that exceed the most restrictive ARAR/SAL levels. The ARAR/SAL criteria are also illustrated in the figure.

Groundwater

Data from the RFI/RI and the Supplemental RFI/RI were considered in the analysis of groundwater contamination at SWMU 5. Samples were collected from the same two monitoring well locations during both investigations. Figures 2-5 and 2-6 show the occurrence of analytes that exceeded the screening values and indicated possible groundwater contamination during the RFI/RI and the Supplemental RFI/RI, respectively. The ARAR/SAL criteria are also illustrated in the figures.

Antimony, beryllium, cyanide, lead, and mercury were detected at levels greater than the screening criteria in groundwater at SWMU 5. Beryllium, cyanide, and lead exceeded the screening values only in 1993 samples. Antimony was detected at S5MW-2 in excess of its 6 µg/L screening value in both investigations, although the 1996 concentration (26.2 µg/L) was somewhat reduced from that observed in 1993 (31.8 µg/L). Mercury was the only chemical detected in excess of its screening criterion (2 µg/L) in 1996 (S5MW-2, 4.7 µg/L) and was not detected in 1993. At S5MW-3, mercury slightly increased in concentration between 1993 and 1996, although neither detection approached the screening value. A single SVOC, bis(2-ethyhexyl) phthalate, was also detected in excess of its 3 µg/L screening criterion at a single location (S5MW-2, 4 µg/L) during the 1993 sampling.

2.4 HUMAN HEALTH RISK ASSESSMENT SUMMARY

This section summarizes the results of the Human Health Risk Assessment (HHRA) conducted at SWMU 5 (Section 2.4.1) and describes the process of selecting chemicals of concern (COCs) (Section 2.4.2) for use in this CMS.

2.4.1 Human Health Risk Assessment (HHRA) Summary

The baseline HHRA in the Supplemental RFI/RI is a qualitative and quantitative assessment of actual or potential risks for SWMU 5. A list of chemicals of potential concern (COPCs) was developed for each medium covered by this CMS report. Only those chemicals found to be of potential concern were considered for evaluation in the quantitative risk assessment.

The COPCs were selected for each environmental medium sampled at SWMU 5 except groundwater, which was determined not to be a potential concern to human receptors. The potential receptors that apply to media sampled at SWMU 5 include current adolescent and adult trespassers, current occupational workers, current site maintenance workers, future excavation workers, and future residents. All potential receptors and exposure pathways were evaluated quantitatively except for the excavation worker, because no COPCs were selected in subsurface soils.

The estimated cumulative carcinogenic and noncarcinogenic risks for hypothetical future residents, trespasser adults and adolescents, maintenance workers, and occupational workers at SWMU 5 are listed in Table 2-1. The total risk for each exposure route and the cumulative risk across pathways are also included. The HHRA was prepared in four parts: carcinogenic risks, noncarcinogenic risks, a comparison of groundwater results to the screening criteria, and a special note concerning fish.

2.4.1.1 Carcinogenic Risks

The estimated carcinogenic risk calculated in the Supplemental RFI/RI for the future resident (2E-04), is greater than the U.S. EPA target risk range of 1E-04 to 1E-06. Four soil/sediment exposure routes contributed significantly to the incremental cancer risk (ICR) for the future resident. Estimated cancer risks attributed to exposure to surface soil were 3E-05 (ingestion) and 1E-04 (dermal contact). Estimated cancer risks attributed to exposure to sediment were 1E-05 (ingestion) and 2E-05 (dermal contact). The principal COPC contributing to these cancer risks was arsenic in surface soil and sediment. However, arsenic was detected at levels in surface soil (site = 0.34 to 13.1 mg/kg; Background = 0.63 to 2.7 mg/kg) and sediment (site = 4.3 to 8.6 mg/kg; Background = 1.5 to 7 mg/kg) that only slightly exceeded background levels in these media.

The estimated carcinogenic risks for the trespasser adult (9E-06), trespasser adolescent (8E-06), maintenance worker (3E-06), and occupational worker (3E-05) are within the U.S. EPA target risk range. The excavation worker was not evaluated because no COPCs were selected in subsurface soils. In all media, the principal COPC contributing to these cancer risks was arsenic in surface soil and sediment.

2.4.1.2 Noncarcinogenic Risks

The estimated noncarcinogenic hazard index (HI) for the future resident (3.0) exceeds 1.0, the U.S. EPA benchmark below which adverse noncarcinogenic health effects are not anticipated under conditions established in the exposure assessment. Four soil/sediment exposure routes contributed a significant portion to the HI for the future resident. Estimated hazard quotients (HQs) attributed to exposure to surface soil were 0.9 (ingestion) and 0.9 (dermal contact). Estimated HQs attributed to exposure to sediment were 0.9 (ingestion) and 0.4 (dermal contact). The principal COPCs contributing to the noncarcinogenic risk are arsenic (1.4) in surface soil and arsenic (0.25), cadmium (0.65), and chromium (0.33) in sediment. The target organs for these chemicals are skin (arsenic and chromium) and kidney (cadmium and chromium). The HI does exceed 1.0 for skin as a target organ. However, arsenic was detected at levels in surface soil (site = 0.34 to 13.1 mg/kg; Background = 0.63 to 2.7 mg/kg) and sediment (site = 4.3 to 8.6 mg/kg; Background = 1.5 to 7 mg/kg) that only slightly exceeded background levels in these media. Chromium was detected in sediment at levels exceeding background (site = 16.5 to 428 mg/kg; Background = 2.1 to 11.7 mg/kg).

2.4.1.3 Quantitative and Qualitative Risk Assessment for Groundwater

Groundwater was not evaluated as part of the baseline HHRA because it is classified as Class G-III, nonpotable water by Florida Department of Environmental Protection (FDEP). As discussed in the Supplemental RFI/RI Report (B&R Environmental, 1998), groundwater obtained from the surficial aquifer at Key West has a high salinity and the public water supply obtained from the mainland is officially designated as the only potable source. No public registered domestic freshwater wells exist, although domestic wells are reportedly used for purposes such as flushing water. Although treatment could possibly be used to improve water quality, the local water authority has the authority to regulate all potable supplies in the keys. A preliminary comparison of unfiltered groundwater concentrations at SWMU 5 versus tap water risk-based concentrations (RBCs) (U.S. EPA, 1996) and maximum contaminant levels (MCLs) (U.S. EPA, October 1996) is presented in Tables 2-2 and 2-3 to provide a benchmark of the magnitude of contamination in groundwater.

2.4.1.4 Fish and the Quantitative Risk Assessment

Fish and shellfish at SWMU 5 were not considered a human health concern because intensive fish collection activities did not reveal any edible fish at the site. A more complete discussion of this subject is presented in Section 3 of the supplemental RFI/RI report (B&R Environmental, 1998).

2.4.2 Chemicals of Concern

Chemicals of Concern (COCs) for use in this CMS were selected based on two sets of criteria, U.S. EPA Region IV and FDEP soil clean-up goals. Other sources of risk-based criteria include RCRA Corrective Action Levels and ARARs.

2.4.2.1 Chemicals of Concern Based on U.S. EPA Region IV Criteria

From the COPCs chosen for each medium in the baseline HHRA, COCs were selected based on U.S. EPA Region IV criteria. The U.S. EPA Region IV criteria for selecting COCs are based on those chemicals that contribute a significant cancer risk (1E-06) or a non-cancer HQ above 0.1 in conjunction with a receptor scenario so that the total risk (combined across pathways) above the level of concern (1E-04 cancer risk or an HI of 1.0). The COCs selected based on U.S. EPA Region IV criteria at SWMU 5 are as follows.

When the risk assessment was prepared, beryllium was evaluated as a carcinogen. In April 1998, the EPA withdrew the cancer slope factor for beryllium from the IRIS database. Therefore, at this time, beryllium would only be evaluated as a noncarcinogen. However, because beryllium does not significantly affect risk to human health and for the sake of consistency with the RFI, beryllium is still identified as a carcinogen in this CMS.

Surface Soils

Based on Future Residential Exposure Scenario

- Arsenic [cancer and noncancer risk (skin)]
- Beryllium [cancer risk]

Sediment

Based on Future Resident (Recreational Use)

- Arsenic [cancer and noncancer risk (skin)]
- Beryllium [cancer risk]
- Chromium [noncancer risk (skin)]

2.4.2.2 Chemicals of Concern Based on FDEP Criteria

From the COPCs chosen for each medium in the baseline HHRA, COCs were selected based on FDEP's recommended approach. The FDEP approach for selecting COCs are those chemicals that contribute a significant cancer risk (1E-06) or a non-cancer HI above 1.0 (affected the same target organ). The COCs selected based on the FDEP approach at SWMU 5 are as follows.

Surface Soils

Based on Future Residential Exposure Scenario

- Arsenic [cancer and noncancer risk (skin)]
- Beryllium [cancer risk]

Based on Future Trespasser Adult & Adolescent, Maintenance Worker, and Occupational Worker

- Arsenic [cancer risk]

Sediment

Based on Future Resident (Recreational Use)

- Arsenic [cancer and noncancer risk (skin)]
- Beryllium [cancer risk]
- Chromium [noncancer risk (skin)]

Based on Future Trespasser Adult & Adolescent

- Arsenic [cancer risk]

2.5 ECOLOGICAL RISK ASSESSMENT SUMMARY

The maximum detected chemical concentrations in groundwater, surface water, sediment, and soil were used as representative exposure point concentrations for screening against threshold values. Potential exposure routes considered in the Supplemental RFI/RI for terrestrial and aquatic receptors are incidental ingestion of soil, sediments, and contaminated surface water, ingestion of contaminated food items, root translocation, drinking contaminated water, dermal contact, direct contact with sediments and surface water, and direct aerial deposition.

Ecological contaminants of potential concern (COPCs) were identified in the ecological risk assessment (ERA) at SWMU 5 for groundwater, surface water, sediment, and surface soil. Tables 2-4 through 2-8 identify these COPCs and include the range of detected values, ecological threshold values, HQs, and the reason the contaminant was retained or eliminated as a COPC.

The Supplemental RFI/RI ERA concluded that the potential risks to ecological receptors at SWMU 5 appear to be negligible. Soil, water, and sediment contaminants do not appear to have bioaccumulated in vegetation or fish to any significant extent. In addition, terrestrial habitat at the site is of minimal areal extent and quality, resulting in minimal use of the site and vicinity by terrestrial receptors. Potential risks to aquatic, terrestrial, and piscivorious receptors and to benthic organisms appear to be low. No ecological COPCs were retained as final COCs in the ecological risk assessment.

TABLE 2-1

CUMULATIVE RISKS
SWMU 5*
NAVAL AIR STATION KEY WEST
BOCA CHICA KEY, FLORIDA
PAGE 1 OF 2

Exposure Route	Resident	Trespasser Adult	Trespasser Adolescent	Maintenance Worker	Excavation Worker	Occupational Worker
INCREMENTAL CANCER RISK						
Surface Soil						
Dermal Contact	1E-4	5E-6	4E-6	3E-6	NA	3E-5
Incidental Ingestion	3E-5	5E-7	7E-7	4E-7	NA	4E-6
Inhalation of Fugitive Dust	3E-12	2E-14	1E-14	2E-14	NA	4E-3
Subtotal of Medium	1E-4	5E-6	5E-6	3E-6	NA	3E-5
Subsurface Soil						
Dermal Contact	NA	NA	NA	NA	NA	NA
Incidental Ingestion	NA	NA	NA	NA	NA	NA
Inhalation of Fugitive Dust	NA	NA	NA	NA	NA	NA
Subtotal of Medium	NA	NA	NA	NA	NA	NA
Sediment						
Dermal Contact	2E-5	3E-6	3E-6	NA	NA	NA
Incidental Ingestion	1E-5	6E-7	7E-7	NA	NA	NA
Subtotal of Medium	3E-5	3E-6	3E-6	NA	NA	NA
Surface Water						
Dermal Contact	**	**	**	NA	NA	NA
Incidental Ingestion	**	**	**	NA	NA	NA
Subtotal of Medium	**	**	**	NA	NA	NA
Shellfish						
Incidental Ingestion	NA	NA	NA	NA	NA	NA
Subtotal of Medium	NA	NA	NA	NA	NA	NA
TOTAL	2E-4	9E-6	8E-6	3E-6	**	3E-5

TABLE 2-1

CUMULATIVE RISKS
SWMU 5*
NAVAL AIR STATION KEY WEST
BOCA CHICA KEY, FLORIDA
PAGE 2 OF 2

Exposure Route	Resident	Trespasser Adult	Trespasser Adolescent	Maintenance Worker	Excavation Worker	Occupational Worker
HAZARD INDEX						
Surface Soil						
Dermal Contact	9E-1	4E-2	6E-2	2E-2	NA	2E-1
Incidental Ingestion	9E-1	6E-3	1E-2	4E-3	NA	3E-2
Inhalation of Fugitive Dust	1E-8	4E-11	5E-11	4E-11	NA	9E-10
Subtotal of Medium	2E+0	5E-2	8E-2	2E-2	NA	2E-1
Subsurface Soil						
Dermal Contact	NA	NA	NA	NA	NA	NA
Incidental Ingestion	NA	NA	NA	NA	NA	NA
Inhalation of Fugitive Dust	NA	NA	NA	NA	NA	NA
Subtotal of Medium	NA	NA	NA	NA	NA	NA
Sediment						
Dermal Contact	4E-1	6E-2	9E-2	NA	NA	NA
Incidental Ingestion	9E-1	2E-2	5E-2	NA	NA	NA
Subtotal of Medium	1E+0	8E-2	1E-1	NA	NA	NA
Surface Water						
Dermal Contact	2E-3	9E-5	1E-4	NA	NA	NA
Incidental Ingestion	3E-3	2E-4	4E-4	NA	NA	NA
Subtotal of Medium	5E-3	3E-4	5E-4	NA	NA	NA
Shellfish						
Incidental Ingestion	NA	NA	NA	NA	NA	NA
Subtotal of Medium	NA	NA	NA	NA	NA	NA
TOTAL	3E+0	1E-1	2E-1	2E-2	**	2E-1

* = Chemicals Specific Risks are presented in Appendix A
** = Either no COPCs were selected, or the COPCs selected for this pathway did not have applicable toxicity values.
NA = Not Applicable, pathway is not applicable for the respective media.

TABLE 2-2

OCCURRENCE, DISTRIBUTION, AND COMPARISON WITH MCLs AND RBCs
INORGANICS IN GROUNDWATER AT SWMU 5 (µg/L)
NAVAL AIR STATION KEY WEST
BOCA CHICA KEY, FLORIDA

Chemical	Background			Site				Maximum Contaminant Level	Maximum Exceeds MCL?	Tap Water Risk-Based Concentration	Maximum Exceeds RBC?
	Frequency of Detection	Range of Positive Detection	Average	Frequency of Detection	Range of Positive Detection	Average of Detected Values	Average of all Values				
Antimony	0/12	Not detected	–	2/4	26.2 - 31.8	29	18.75	6	Y	1.5	Y
Arsenic	3/13	4.1 - 11.9	4.54	2/4	2.3 - 3.4	2.9	3.45	50	N	0.045	Y
Barium	10/13	6.4 - 19.45	10.20	4/4	8.9 - 54.7	26.23	26.23	2,000	N	260	N
Beryllium	0/13	Not detected	–	1/4	1.3 - 1.3	1.3	0.50	4	N	0.016	Y
Cadmium	0/13	Not detected	–	1/4	4.8 - 4.8	4.8	1.93	5	N	1.8	Y
Chromium*	3/13	0.71 - 13	2.51	3/4	1.7 - 35.6	23.2	17.64	100	N	18	Y
Cyanide	2/8	2.4 - 5.525	1.47	2/3	1.5 - 230	115.7	77.38	200	Y	73	Y
Lead	1/12	2.5 - 2.5	1.39	2/4	9.8 - 24.7	17.2	9.36	15**	Y	15	Y
Manganese	7/10	2.2 - 10.3	3.78	2/2	2.3 - 3	2.63	2.63	–	NA	84	N
Mercury	4/13	0.13 - 0.24	0.10	3/4	0.19 - 4.7	1.7	1.32	2	Y	1.1	Y
Silver	1/13	3.3 - 3.3	1.37	1/4	1.9 - 1.9	1.9	1.96	–	NA	18	N
Sulfide	3/3	10,000 - 52,000	28,000	1/1	4,000 - 4,000	4,000	4,000	–	NA	–	NA
Vanadium	4/13	3.4 - 3.9	2.62	2/4	2.3 - 2.4	2.3	3.66	–	NA	26	N
Zinc	3/13	3.425 - 15.3	2.82	4/4	26.5 - 82.4	47.64	47.64	–	NA	1,100	N

Notes:
Maximum Contaminant Levels (MCLs) are from Drinking Water Regulations and Health Advisories (EPA, 1996a).
Risk-based screening levels (RBCs) represent concentrations associated with a 1E-06 cancer risk level or a non-cancer hazard index of 0.1.
Applicable RBCs originate from EPA Region 3 RBCs for residential exposure, tap water ingestion, with non-cancer risk adjusted to 0.1 hazard index.
An RBC for lead based on cancer risk or hazard index is not available. The 15 µg/L EPA MCL is used as an applicable RBC for tap water ingestion.
NA = Not Applicable.

*As Total chromium
**Lead Action Level

TABLE 2-3

OCCURRENCE, DISTRIBUTION, AND COMPARISON WITH MCLs AND RBCs
ORGANICS IN GROUNDWATER AT SWMU 5 (µg/L)
NAVAL AIR STATION KEY WEST
BOCA CHICA KEY, FLORIDA

Chemical	Background			Site				Maximum Contaminant Level	Maximum Exceeds MCL?	Tap Water Risk-Based Concentration	Maximum Exceeds RBC?
	Frequency of Detection	Range of Positive Detection	Average	Frequency of Detection	Range of Positive Detection	Average of Detected Values	Average of all Values				
SEMIVOLATILE ORGANIC COMPOUNDS											
Bis(2-ethylhexyl)phthalate	0/7	Not detected	–	1/3	4 - 4	4	7.17	6	N	4.8	N
VOLATILE ORGANIC COMPOUNDS											
Methylene chloride	2/4	1 - 1	1.75	1/2	2 - 2	2	4.75	5	N	4.1	N

Notes:

Maximum Contaminant Levels (MCLs) are from Drinking Water Regulations and Health Advisories (EPA, 1996a).

Risk-based screening levels (RBCs) represent concentrations associated with a 1E-06 cancer risk level or a non-cancer hazard index of 0.1.

Applicable RBCs originate from EPA Region 3 RBCs for residential exposure, tap water ingestion, with non-cancer risk adjusted to 0.1 hazard index.

NA = Not Applicable

TABLE 2-4

ECOLOGICAL CHEMICALS OF POTENTIAL CONCERN IN GROUNDWATER (µg/L) - SWMU 5
NAVAL AIR STATION KEY WEST
BOCA CHICA KEY, FLORIDA

Analytes	Frequency of Detection	Average Background Concentration	Range of Detected Values	Ecological Threshold	Hazard Quotient	Reason for Retention or Elimination as an Ecological Chemical of Potential Concern (COPC)
INORGANICS						
Antimony	1/2	ND	26.2	4,300	0.01	Eliminated - does not exceed threshold
Barium	2/2	10.2	8.9 - 12.2	10,000	0.00	Eliminated - does not exceed 2 X background
Chromium	1/2	2.51	1.7	50	0.03	Eliminated - does not exceed 2 X background
Cyanide	1/2	1.47	1.5	1	1.45	Eliminated - does not exceed 2 X background
Manganese	2/2	3.78	2.3 - 3	10	0.30	Eliminated - does not exceed 2 X background
Mercury	2/2	0.1	0.26 - 4.7	0.025	189.00	Retained - exceeds 2 X background and HQ > 1
Silver	1/2	1.37	1.9	0.05	37.0	Eliminated - does not exceed 2 X background
Vanadium	2/2	2.62	2.3 - 2.4	10,000	0.00	Eliminated - does not exceed 2 X background
Zinc	2/2	2.82	26.5 - 52.4	86	0.61	Eliminated - does not exceed threshold

ND = Not detected.

TABLE 2-5

ECOLOGICAL CHEMICALS OF POTENTIAL CONCERN IN SURFACE WATER (µg/L) - SWMU 5
NAVAL AIR STATION KEY WEST
BOCA CHICA KEY, FLORIDA

Analytes	Frequency of Detection	Average Background Concentration	Range of Detected Values	Ecological Threshold	Hazard Quotient	Reason for Retention or Elimination as an Ecological Chemical of Potential Concern (COPC)
INORGANICS						
Arsenic	1/5	3.97	3.5	50	0.07	Eliminated - does not exceed 2 X background
Barium	1/5	6.93	53.1	10,000	0.005	Eliminated - does not exceed threshold
Cadmium	1/5	ND	9.7	9.3	1.04	Retained - HQ > 1
Chromium	1/5	2.62	58.2	50	1.16	Retained - exceeds 2 X background and HQ > 1
Copper	1/5	2.26	13.6	2.4	5.7	Retained - exceeds 2 X background and HQ > 1
Lead	2/5	ND	5.1 - 68.9	5.6	12.3	Retained - HQ > 1
Zinc	1/5	7.19	147	86	1.7	Retained - exceeds 2 X background and HQ > 1
VOLATILE ORGANIC COMPOUNDS						
Acetone	1/5	4.33	12	9,000,000	1.3E-06	Eliminated - does not exceed threshold
Methylene chloride	1/5	1.50	1	2,560	0.0004	Eliminated - does not exceed threshold

ND = Not detected.

TABLE 2-6

ECOLOGICAL CHEMICALS OF POTENTIAL CONCERN IN SEDIMENT - SWMU 5
NAVAL AIR STATION KEY WEST
BOCA CHICA KEY, FLORIDA
PAGE 1 OF 2

Analytes	Frequency of Detection	Average Background Concentration	Range of Detected Values	Ecological Threshold	Hazard Quotient	Reason for Retention or Elimination as an Ecological Chemical of Potential Concern (COPC)
INORGANICS (mg/kg)						
Aluminum	4/4	1,331.89	1,340 - 3,040	NA	-	Retained - exceeds 2 X background and no suitable threshold available
Antimony	1/6	ND	4	12	0.3	Eliminated - does not exceed threshold
Arsenic	6/6	2.63	4.3 - 8.6	7.24/70	1.2/0.1	Retained - exceeds 2 X background and HQ > 1
Barium	6/6	9.27	10.6 - 250	40	6.2	Retained - exceeds 2 X background and HQ > 1
Beryllium	2/6	0.06	1.8 - 2.6	NA	-	Retained - exceeds 2 X background and no suitable threshold available
Cadmium	5/6	0.22	2.3 - 120	0.676/9.6	177.5/12.5	Retained - exceeds 2 X background and HQ > 1
Chromium	6/6	5.01	16.5 - 428	52.3/160	8.2/2.7	Retained - exceeds 2 X background and HQ > 1
Cobalt	4/6	0.47	0.59 - 9.8	50	0.2	Eliminated - does not exceed threshold
Copper	6/6	8.88	10.5 - 38.9	18.7/270	2.1/0.1	Retained - exceeds 2 X background and HQ > 1
Lead	6/6	17.97	30.1 - 966	30.2/218	32.0/4.4	Retained - exceeds 2 X background and HQ > 1
Manganese	4/4	15.39	9.2 - 32.1	460	0.07	Eliminated - does not exceed threshold
Mercury	3/6	0.05	0.03 - 0.13	0.13/0.71	1.0/0.2	Retained - exceeds 2 X background and HQ > 1
Nickel	6/6	2.15	2.3 - 26.6	15.9/42.8	1.7/0.6	Retained - exceeds 2 X background and HQ > 1
Silver	2/6	0.27	0.85 - 1.3	0.733/3.7	1.8/0.4	Retained - exceeds 2 X background and HQ > 1
Tin	1/2	2.85	8.1	NA	-	Retained - exceeds 2 X background and no suitable threshold available
Vanadium	6/6	5.08	6.4 - 34.2	NA	-	Retained - exceeds 2 X background and no suitable threshold available
Zinc	6/6	25.74	24.6 - 1,260	124/410	10.2/3.1	Retained - exceeds 2 X background and HQ > 1
SEMIVOLATILE ORGANIC COMPOUNDS (µg/kg)						
Bis(2-ethylhexyl)phthalate	2/5	1,992.17	467.5 - 570	182/2,647	3.1/0.22	Retained - HQ > 1
Butyl benzyl phthalate	1/5	ND	495	11,000	0.04	Eliminated - does not exceed threshold

TABLE 2-6

ECOLOGICAL CHEMICALS OF POTENTIAL CONCERN IN SEDIMENT - SWMU 5
NAVAL AIR STATION KEY WEST
BOCA CHICA KEY, FLORIDA
PAGE 2 OF 2

Analytes	Frequency of Detection	Average Background Concentration	Range of Detected Values	Ecological Threshold	Hazard Quotient	Reason for Rention or Elimination as an Ecological Chemical of Potential Concern (COPC)
VOLATILE ORGANIC COMPOUNDS (µg/kg)						
Acetone	3/5	30.9	24 - 147	64	2.3	Retained - HQ > 1
Cis-1,2-dichloroethene	1/2	ND	2	23	0.0.9	Eliminated - does not exceed threshold
Methylene chloride	1/6	7.5	12	427	0.03	Eliminated - does not exceed threshold
Tetrachloroethene	4/6	4.33	2.5 - 10.2	530	0.02	Eliminated - does not exceed threshold

NA = No suitable ecological threshold value was available.
ND = Not detected.

TABLE- 2-7

ECOLOGICAL CHEMICALS OF POTENTIAL CONCERN IN SURFACE SOIL - SWMU 5
NAVAL AIR STATION KEY WEST
BOCA CHICA KEY, FLORIDA

Analytes	Frequency of Detection	Average Background Concentration	Range of Detected Values	Ecological Threshold	Hazard Quotient	Reason for Retention or Elimination as an Ecological Chemical of Potential Concern (COPC)
INORGANICS (mg/kg)						
Aluminum	1/1	1,887.29	923	600	1.5	Eliminated - does not exceed 2 X background
Antimony	1/4	0.39	4.20	NA	-	Retained - exceeds 2 X background and no suitable threshold available
Arsenic	4/4	1.29	0.34 - 13	60	0.2	Eliminated - does not exceed threshold
Barium	4/4	10.51	3.7 - 22.3	440	0.05	Eliminated - does not exceed threshold
Beryllium	1/4	0.05	0.26	NA	-	Retained - exceeds 2 X background and no suitable threshold available
Cadmium	3/4	0.15	1.7 - 12.6	20	0.6	Eliminated - does not exceed threshold
Chromium	4/4	6.02	6.4 - 24.7	0.4	61.8	Retained - exceeds 2 X background and HQ > 1
Cobalt	1/4	0.29	0.7	200	0.004	Eliminated - does not exceed threshold
Copper	3/4	5.43	2.2 - 7.2	50	0.1	Eliminated - does not exceed 2 X background
Lead	4/4	15.66	13.8 - 52.1	500	0.1	Eliminated - does not exceed threshold
Manganese	1/1	17.65	8.9	100	0.09	Eliminated - does not exceed 2 X background
Mercury	1/4	0.03	0.04	0.1	0.4	Eliminated - does not exceed 2 X background
Nickel	3/4	1.67	2.4 - 7.6	200	0.04	Eliminated - does not exceed threshold
Tin	1/3	1.94	5.1	0.89	5.7	Retained - exceeds 2 X background and HQ > 1
Vanadium	2/4	3.97	2.7 - 3.2	20	0.2	Eliminated - does not exceed 2 X background
Zinc	4/4	15.22	3.1 - 86.3	200	0.4	Eliminated - does not exceed threshold
VOLATILE ORGANIC COMPOUNDS (µg/kg)						
2-butanone	1/1	ND	9	NA	-	Retained - no suitable threshold available
Acetone	1/1	3.67	35	NA	-	Retained - no suitable threshold available
Cis-1,2-dichloroethene	1/3	ND	1	300	0.003	Eliminated - does not exceed threshold
Methylene chloride	1/3	2.8	20	300	0.07	Eliminated - does not exceed threshold

NA = No suitable ecological threshold value was available.
ND = Not detected.

TABLE 2-8

ECOLOGICAL CHEMICALS OF POTENTIAL CONCERN IN PLANTS - SWMU 5
NAVAL AIR STATION KEY WEST
BOCA CHICA KEY, FLORIDA

Analytes	Frequency of Detection	Average Background Concentration	Range of Detected Values	Ecological Threshold	Hazard Quotient	Reason for Retention or Elimination as an Ecological Chemical of Potential Concern (COPC)
INORGANICS (mg/kg)						
Aluminum	1/1	1,887.29	923	50	18.5	Eliminated - does not exceed 2 X background
Antimony	1/4	0.39	4.2	5	0.8	Eliminated - does not exceed threshold
Arsenic	4/4	1.29	0.34 - 13	10	1.3	Retained - exceeds 2 X background and HQ > 1
Barium	4/4	10.51	3.7 - 22.3	500	0.04	Eliminated - does not exceed threshold
Beryllium	1/4	0.05	0.26	10	0.03	Eliminated - does not exceed threshold
Cadmium	3/4	0.15	1.7 - 12.6	3	4.2	Retained - exceeds 2 X background and HQ > 1
Chromium	4/4	6.02	6.4 - 24.7	1	24.7	Retained - exceeds 2 X background and HQ > 1
Cobalt	1/4	0.29	0.7	20	0.4	Eliminated - does not exceed threshold
Copper	3/4	5.43	2.2 - 7.2	100	0.07	Eliminated - does not exceed 2 X background
Lead	4/4	15.66	13.8 - 52.1	50	1.04	Retained - exceeds 2 X background and HQ > 1
Manganese	1/1	17.65	8.9	500	0.02	Eliminated - does not exceed 2 X background
Mercury	1/4	0.03	0.04	0.3	0.13	Eliminated - does not exceed 2 X background
Nickel	3/4	1.67	2.4 - 7.6	30	0.25	Eliminated - does not exceed threshold
Tin	1/3	1.94	5.1	50	0.1	Eliminated - does not exceed threshold
Vanadium	2/4	3.97	2.7 - 3.2	2	1.6	Eliminated - does not exceed 2 X background
Zinc	4/4	15.22	3.1 - 86.3	50	1.7	Retained - exceeds 2 X background and HQ > 1
VOLATILE ORGANIC COMPOUNDS (µg/kg)						
2-butanone	1/1	ND	9	NA	-	Retained - no suitable threshold available
Acetone	1/1	3.67	35	NA	-	Retained - no suitable threshold available
Cis-1,2-dichloroethene	1/3	ND	1	NA	-	Retained - no suitable threshold available
Methylene chloride	1/3	2.8	20	NA	-	Retained - no suitable threshold available

ND = Not detected.
NA = No suitable ecological threshold value was available.

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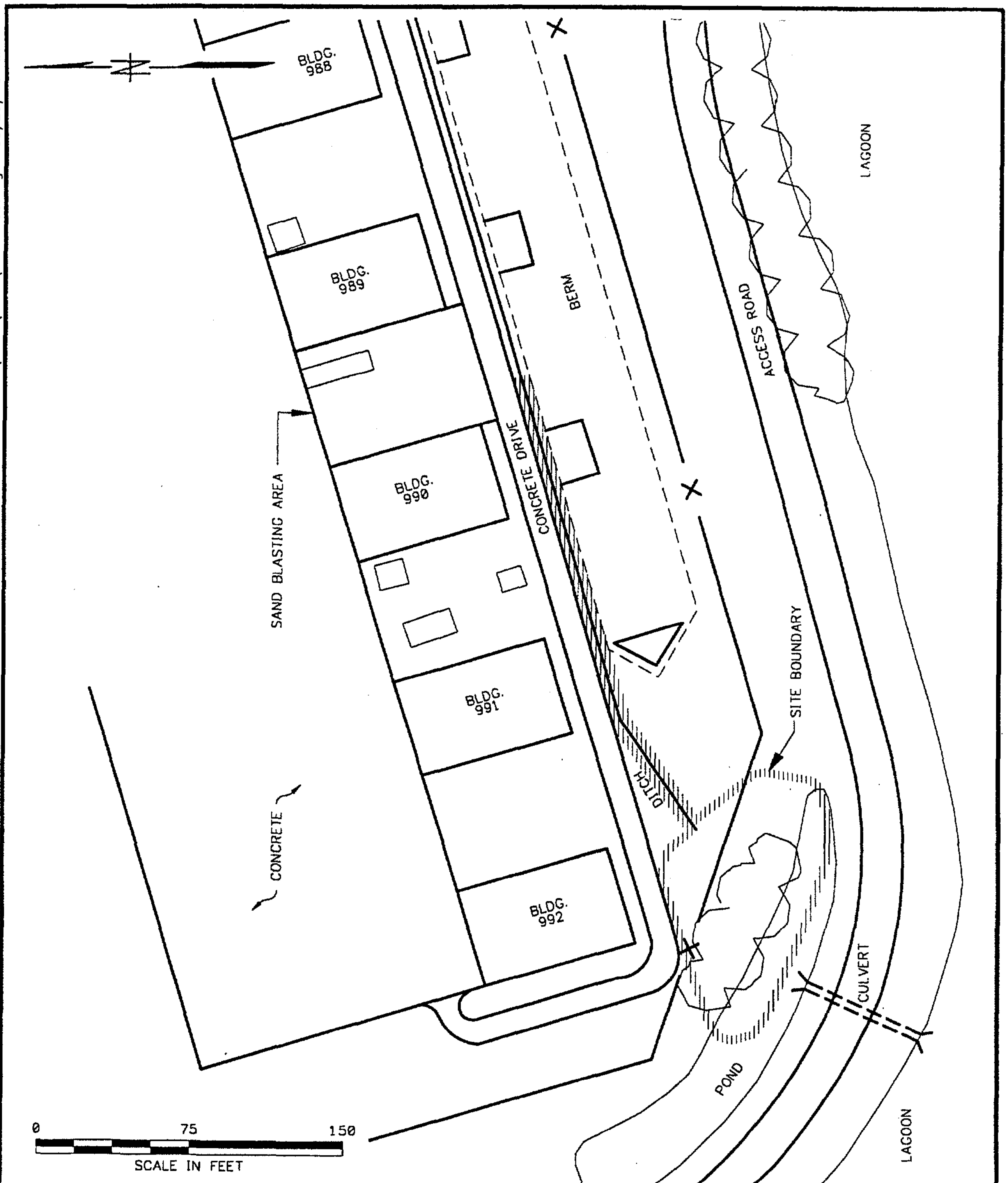
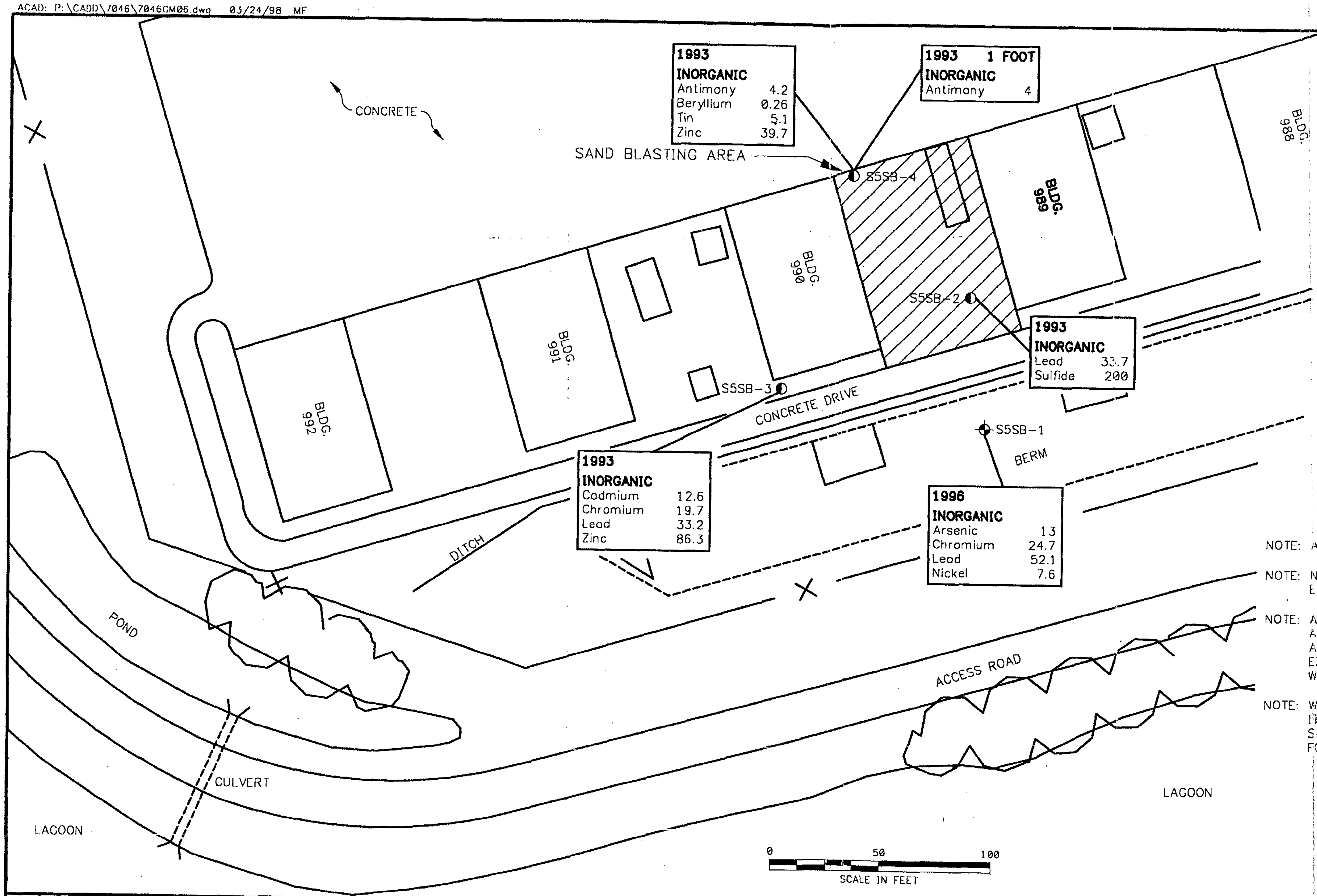


DRAWN BY MF DATE 3/24/98
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

SITE LOCATION NAME
SWMU 5
NAVAL AIR STATION
KEY WEST, FLORIDA

CONTRACT NO. 7046
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 2-1
REV. 0

FORM CADD NO. SDIV_AV.DWG - REV 0 - 1/20/98



PARAMETER	SCREENING VALUE +
INORGANIC	
Antimony	0.79
Arsenic	2.6
Beryllium	0.15
Cadmium	2.5
Chromium	12
Lead	31
Nickel	3.4
Sulfide	98
Tin	3.9
Zinc	30

+ THE SELECTION OF THE NATURE AND EXTENT SCREENING VALUES IS DISCUSSED IN THE SUPPLEMENTAL RFI/RI (B & R ENVIRONMENTAL, 1998)

NOTE: ALL INORGANIC CONCENTRATIONS ARE IN mg/kg.

NOTE: NO ORGANIC PARAMETERS WERE DETECTED IN EXCESS OF SCREENING VALUES.

NOTE: ALL THREE IT SAMPLE LOCATIONS WERE SAMPLED AT THE SURFACE, AT A DEPTH OF 1 FOOT, AND AT A DEPTH OF 2 FEET. THE ONLY DETECTION IN EXCESS OF SCREENING VALUES IN THE SUBSURFACE WAS ANTIMONY AT S5SB-4, AS SHOWN.

NOTE: WHEN A DEPTH IS SHOWN IN THE RESULT BOX, IT INDICATES THE TOP OF A SUBSURFACE SAMPLING INTERVAL. DEPTHS ARE NOT SHOWN FOR SURFACE SOIL SAMPLES.

LEGEND

S5SB-2 ◐ SOIL SAMPLE LOCATION IT CORPORATION (1993)

S5SB-1 ⊕ SOIL SAMPLE LOCATION B&R ENVIRONMENTAL (1996)

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY MF DATE 3/24/98

CHECKED BY DATE

COST/SCHED-AREA

SCALE AS NOTED

SOIL CHEMICAL CONCENTRATIONS EXCEEDING SCREENING VALUES SWMU 5 NAVAL AIR STATION KEY WEST, FLORIDA

CONTRACT NO. 7046

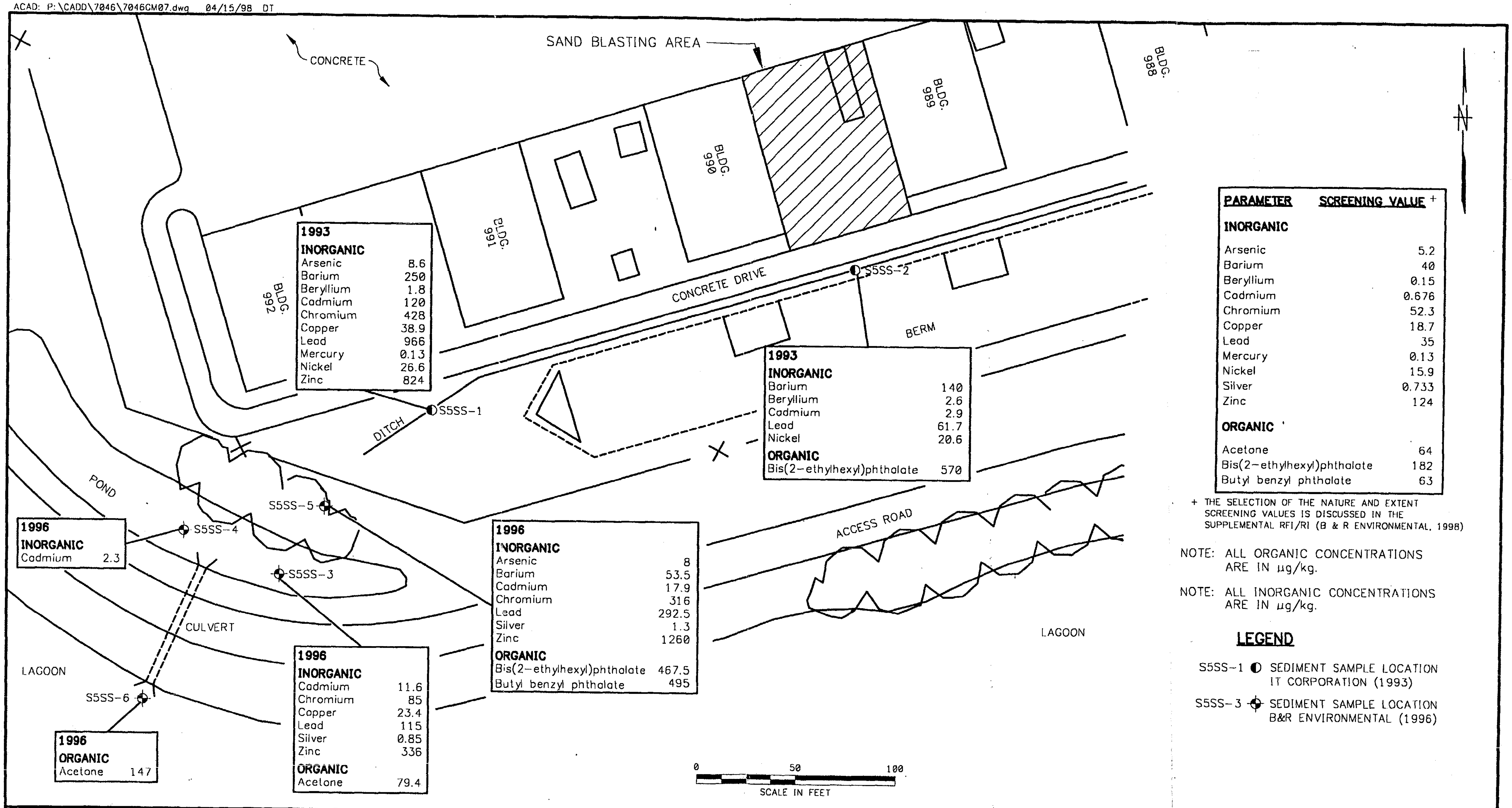
APPROVED BY DATE

APPROVED BY DATE

DRAWING NO. FIGURE 2-2 REV. 0

FORM CADD NO. SDIV_BH.DWG - REV 0 - 1/20/98

ACAD: P:\CADD\7046\7046CM07.dwg 04/15/98 DT



NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

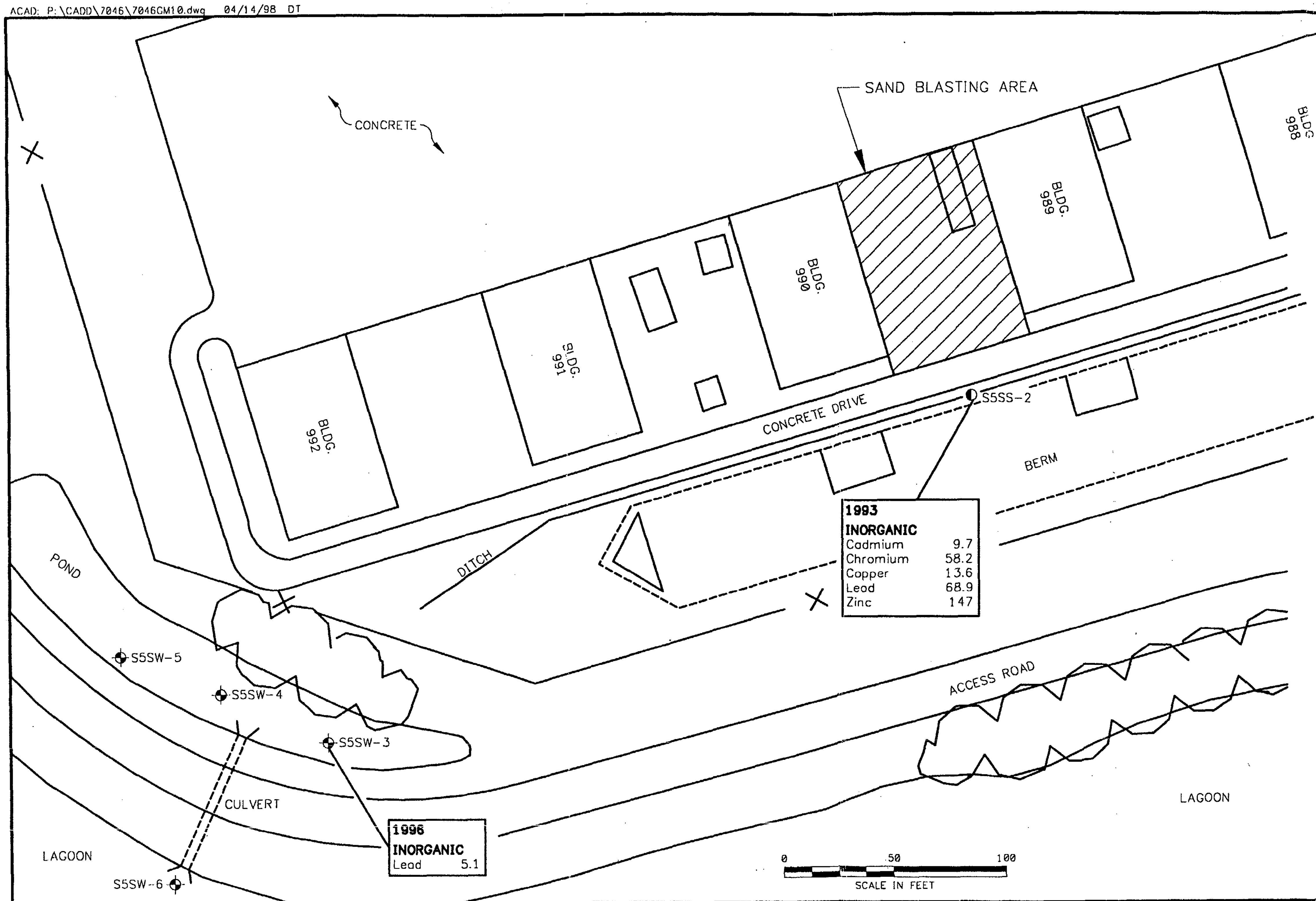
DRAWN BY MF DATE 3/24/98
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

SEDIMENT CHEMICAL CONCENTRATIONS EXCEEDING SCREENING VALUES SWMU 5 NAVAL AIR STATION KEY WEST, FLORIDA

CONTRACT NO. 7046
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 2-3 REV. 0

FORM CADD NO. SDIV_BH.DWG - REV 0 - 1/20/98

ACAD: P:\CADD\7046\7046GM10.dwg 04/14/98 DT



PARAMETER	SCREENING VALUE +
INORGANIC	
Cadmium	0.53
Chromium	5.2
Copper	4.5
Lead	1.32
Zinc	19

+ THE SELECTION OF THE NATURE AND EXTENT SCREENING VALUES IS DISCUSSED IN THE SUPPLEMENTAL RFI/RI (B & R ENVIRONMENTAL, 1998)

NOTE: ALL CONCENTRATIONS ARE IN µg/L.

LEGEND

S5SS-2 ◐ SURFACE-WATER SAMPLE LOCATION IT CORPORATION (1993)

S5SW-3 ⊕ SURFACE-WATER SAMPLE LOCATION B&R ENVIRONMENTAL (1996)

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

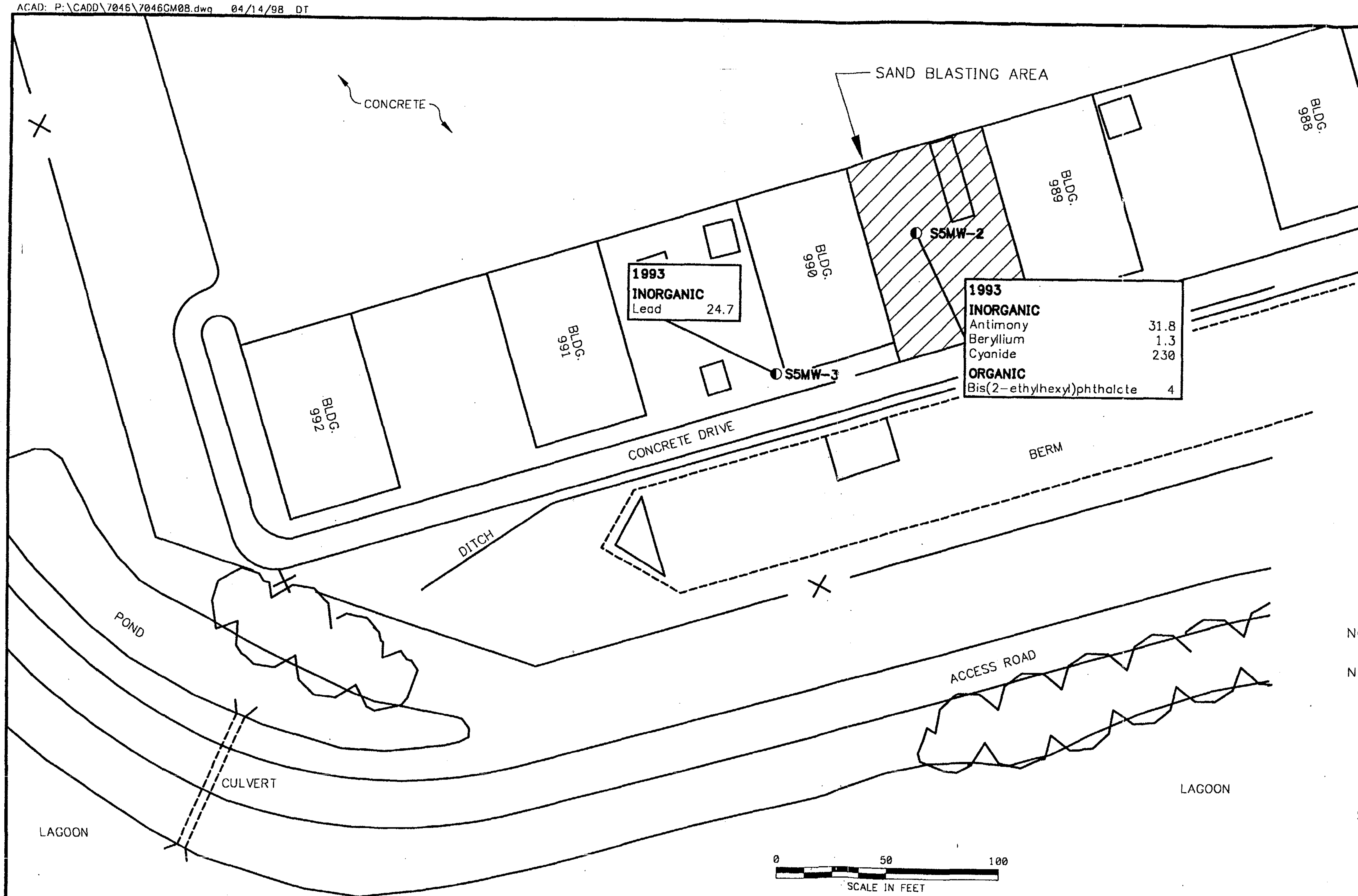
DRAWN BY MF DATE 3/25/98
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

DEPARTMENT OF THE NAVY ★ SOUTHERN DIV FACILITIES ENGINEERING COMD ★

SURFACE-WATER CHEMICAL CONCENTRATIONS EXCEEDING SCREENING VALUES
SWMU 5
NAVAL AIR STATION
KEY WEST, FLORIDA

CONTRACT NO. 7046
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 2-4
REV. 0

FORM CADD NO. SDIV_BI.DWG - REV 0 - 1/20/98



PARAMETER	SCREENING VALUE +
INORGANIC	
Antimony	6
Beryllium	0.008
Cyanide	200
Lead	15
INORGANIC	
Bis(2-ethylhexyl)phthalate	3

+ THE SELECTION OF THE NATURE AND EXTENT SCREENING VALUES IS DISCUSSED IN THE SUPPLEMENTAL RFI/RI (B & R ENVIRONMENTAL, 1998)

NOTE: ALL CONCENTRATIONS ARE IN µg/L.

NOTE: LOCATIONS SAMPLED IN 1993 ARE BOLD.

LEGEND

S5MW-2 ◐ MONITORING WELL LOCATION IT CORPORATION (1993)

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

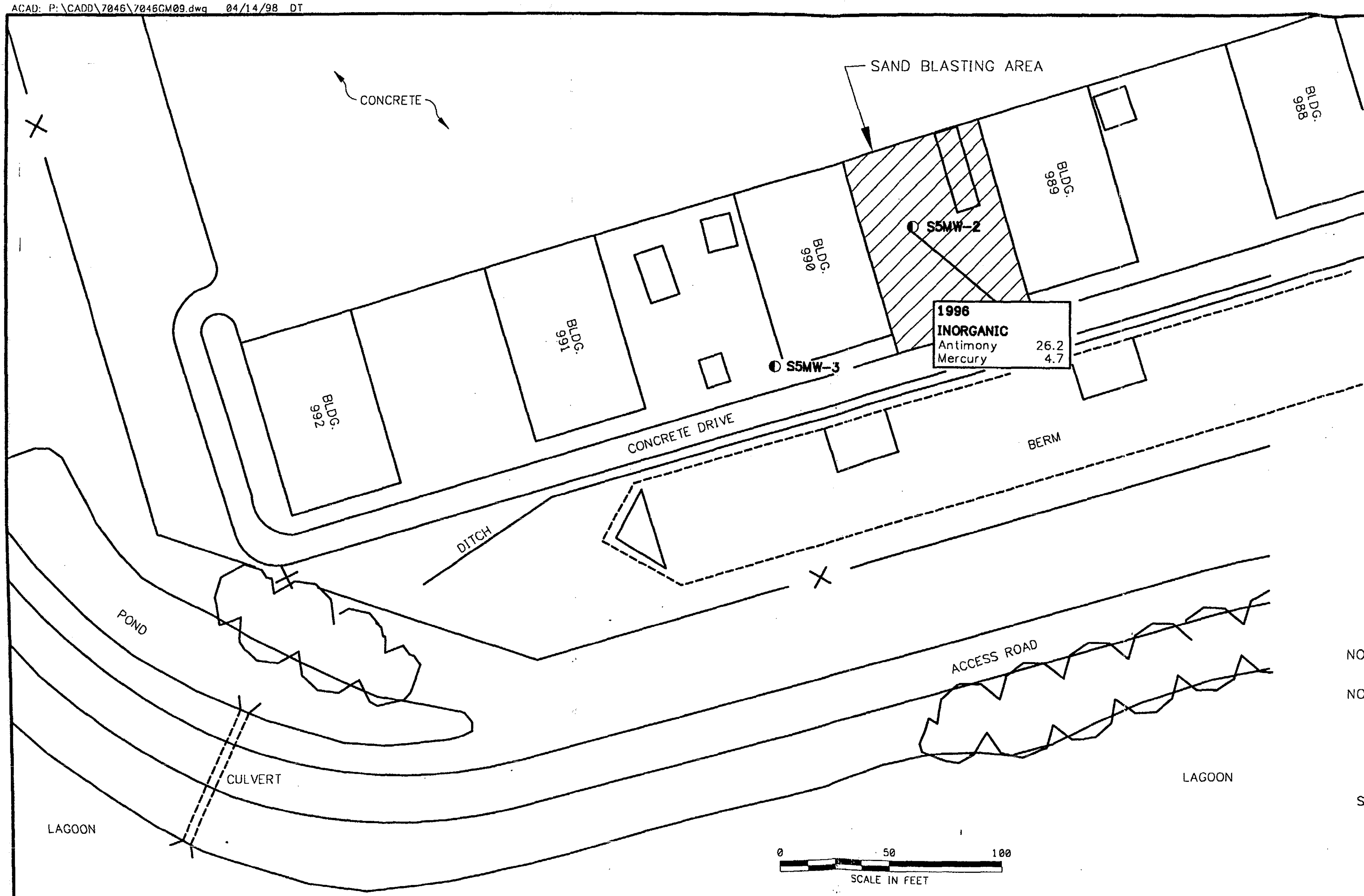
DRAWN BY MF DATE 3/25/98
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

1993 GROUNDWATER CHEMICAL CONCENTRATIONS EXCEEDING SCREENING VALUES
SWMU 5
NAVAL AIR STATION
KEY WEST, FLORIDA

CONTRACT NO. 7046
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 2-5 REV. 0

FORM CADD NO. SDIV_BH.DWG - REV 0 - 1/20/98

ACAD: P:\CADD\7046\7046GM09.dwg 04/14/98 DT



PARAMETER	SCREENING VALUE +
INORGANIC	
Antimony	6
Mercury	2

+ THE SELECTION OF THE NATURE AND EXTENT SCREENING VALUES IS DISCUSSED IN THE SUPPLEMENTAL RFI/RI (B & R ENVIRONMENTAL, 1998)

NOTE: ALL CONCENTRATIONS ARE IN µg/L.

NOTE: LOCATIONS SAMPLED IN 1993 ARE BOLD.

LEGEND

S5MW-2 ◐ MONITORING WELL LOCATION IT CORPORATION (1993)

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY MF DATE 3/25/98
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

DEPARTMENT OF THE NAVY — SOUTHERN DIV FACILITIES ENGINEERING COMD

1996 GROUNDWATER CHEMICAL CONCENTRATIONS EXCEEDING SCREENING VALUES SWMU 5 NAVAL AIR STATION KEY WEST, FLORIDA

CONTRACT NO. 7046
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 2-6 REV. 0

FORM CADD NO. SDIV_BH.DWG - REV 0 - 1/20/98

3.0 CORRECTIVE ACTION OBJECTIVES

The following section describes the development of the proposed Corrective Action Objectives (CAOs) for the NAS Key West SWMU 5, Building A-990 - Sandblasting Area. These CAOs and clean-up standards are based on promulgated federal and state requirements, risk-derived standards, and information gathered during the previous investigations, Supplemental RFI/RI, and additional applicable guidance documents. The development of the CAOs included the consideration of cross-media concentrations, which are concentrations in one medium that are protective of the migration of contaminants into another medium. The cross-media evaluation utilized modeling to determine the groundwater and surface water runoff contaminant fate and transport.

3.1 INTRODUCTION

CAOs are developed for each site as medium-specific and contaminant-specific objectives that will result in the protection of human health and the environment. The development of CAOs for a site SWMU or group of SWMUs is based on human health and environmental criteria, RFI/RI-gathered information, U.S. EPA guidance, and applicable federal and state regulations. Typically, CAOs are developed based on promulgated standards [e.g., Ambient Water Quality Criteria (AWQC)], background concentrations determined from a site-specific investigation, and human health and ecological risk-based concentrations developed in accordance with the U.S. EPA risk assessment guidance. The Supplemental RFI/RI presents a complete description of the nature and extent of contamination, contaminant fate and transport, baseline HHRA, and ERA. In addition, conclusions and recommendations for potential SWMU 5 corrective measures are presented. This section includes a brief discussion of the development of the CAOs for SWMU 5, a brief summary of the Supplemental RFI/RI nature and extent of contamination, HHRA and RGOs development, and the ERA for SWMU 5.

3.2 ARARS, MEDIA OF CONCERN, AND COCS

3.2.1 ARAR Criteria

3.2.1.1 Introduction

The Applicable or Relevant and Appropriate Requirements (ARARs) include the requirements, criteria, or limitations promulgated under the federal and state law that address a contaminant, action, or location at a site.

The definition of ARARs is as follows:

- Any standard, requirement, criterion, or limitation under federal environmental law.

- Any promulgated standard, requirement, criterion, or limitation under a state environmental or facility-citing law that is more stringent than the associated federal standard, requirement, criterion, or limitation.

One of the primary concerns during the development of corrective action alternatives for hazardous waste sites under RCRA is the degree of human health and environmental protection afforded by a given remedy. Consideration should be given to corrective measures that attain or exceed ARARs.

Definitions of the two types of ARARs, as well as other to be considered (TBC) criteria, are given below:

- Applicable Requirements are those clean-up standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or state law that directly and fully address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a RCRA site.

- Relevant and Appropriate Requirements are those clean-up standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, while not "applicable," address problems or situations sufficiently similar (relevant) to those encountered at the RCRA site that their use is well suited (appropriate) to the particular site.

- TBC Criteria are non-promulgated, non-enforceable guidelines or criteria that may be useful for developing remedial actions or necessary for determining what is protective of human health and the environment. Examples of TBC criteria include U.S. EPA Drinking Water Advisories, Carcinogenic Potency Factors, and Reference Doses.

These requirements are included in order to provide the decision makers with a complete evaluation of potential ARARs in developing, identifying, and selecting a corrective measure alternative.

3.2.1.2 ARAR and TBC Categories

ARARs fall into three categories, based on the manner in which they are applied:

- Chemical Specific - Health/risk-based numerical values or methodologies that establish concentration or discharge limits for particular contaminants. Examples of contaminant-specific ARARs include maximum contaminant levels (MCLs) and Clean Water Act (CWA) water quality criteria. Contaminant-specific ARARs govern the extent of site clean-up.

- Location Specific - Restrictions based on the concentration of hazardous substances or the conduct of activities in specific locations. These may restrict or preclude certain remedial actions or may apply only to certain portions of site. Examples of location-specific ARARs include RCRA location requirements and floodplain management requirements. Location-specific ARARs pertain to special site features.

- Action Specific - Technology- or activity-based controls or restrictions on activities related to management of hazardous waste. Action-specific ARARs pertain to implementing a given remedy.

Table 3-1 presents a summary of potential federal and state ARARs and TBCs for corrective measures undertaken for SWMU 5 at NAS Key West.

3.2.1.3 Chemical-Specific ARARs and TBCs

This section presents a summary of Federal and state chemical-specific ARAR criteria of potential concern in the case of SWMU 5. The ARAR criteria provide medium-specific guidance on "acceptable" or "permissible" concentrations of contaminants.

The Safe Drinking Water Act (SDWA) promulgated National Primary Drinking Water Standard MCLs (40 CFR Part 141). MCLs are enforceable standards for contaminants in public drinking water supply systems. They consider not only health factors but also the economic and technical feasibility of removing a contaminant from a water supply system. Secondary MCLs (40 CFR Part 143) are not enforceable but are intended as guidelines for contaminants that may adversely affect the aesthetic quality of drinking water, such as taste, odor, color, and appearance, and may deter public acceptance of drinking water provided by public water systems.

The SDWA also established Maximum Contaminant Level Goals (MCLGs) for several organic and inorganic compounds in drinking water. MCLGs are set at levels of no known or anticipated adverse health effects, with an adequate margin of safety. The NCP [40 CFR Part 300.430(e)(2)(i)] states that MCLGs that are set at levels above zero shall be attained by remedial actions for groundwaters or surface waters that are current or potential sources of drinking water [where the MCLGs are relevant and appropriate under the circumstances of the release based on the factors in Section 300.400(g)(2) of the NCP]. If an MCLG is found not to be relevant and appropriate, the corresponding MCL will be achieved where relevant and appropriate to the circumstances of the release. For MCLGs that are set at zero, the MCL promulgated for that contaminant under the SDWA will be attained by the remedial actions. In cases involving multiple contaminants or pathways where attainment of chemical-specific ARARs will result in a cumulative cancer risk in excess of 1E-04, criteria in paragraph (e)(2)(i)(A) of Section 300.430 (i.e., risk-based criteria) may be considered when determining the clean-up level to be attained. The NCP explains that clean-up levels set at zero (generally the case for carcinogens) are not appropriate because complete elimination of risk is not possible and because "true zero" cannot be detected.

Since the groundwater at SWMU 5 is brackish and not used as a potable water supply, the SDWA is neither applicable nor relevant and appropriate.

The CWA sets U.S. EPA AWQC that are non-enforceable guidelines developed for pollutants in surface waters, pursuant to Section 304(a)(1) of the CWA. Although AWQCs are not legally enforceable, they should be considered as potential ARARs. AWQCs are available for the protection of human health from exposure to contaminants in surface water as well as from ingestion of aquatic biota and for the protection of freshwater and saltwater aquatic life. AWQCs may be considered for actions that involve groundwater treatment and/or discharge to nearby surface waters.

The CAA (42 USC 7401) consists of three programs or requirements that may be ARARs: National Ambient Air Quality Standards (NAAQS) (40 CFR Parts 50 and 53), National Emission Standards for Hazardous Air Pollutants (NESHAPs) (40 CFR Part 61), and New Source Performance Standards (NSPS) (40 CFR Part 60). NESHAPs, which are emission standards for source types (i.e., industrial categories) that emit hazardous air pollutants, are not likely to be applicable or relevant and appropriate for NAS Key West because they were developed for a specific source.

U.S. EPA requires the attainment and maintenance of primary and secondary NAAQS to protect public health and public welfare, respectively. These standards are not source specific but rather are national limitations on ambient air quality. States are responsible for assuring compliance with the NAAQS. Requirements in the U.S. EPA-approved SIP for the implementation, maintenance, and enforcement of NAAQS are potential ARARs.

NSPS are established for new sources of air emissions to ensure that the new stationary sources minimize emissions. These standards are for categories of stationary sources that cause or contribute to air pollution that may endanger public health or welfare. Standards are based upon the best demonstrated available technology (BDAT) .

The Florida SIP (Chapter 62-204 F.A.C.) establishes maximum allowable levels of pollutants in the ambient air necessary to protect human health and public welfare and maximum allowable increases in ambient concentrations for subject pollutants to prevent significant deterioration of air quality. It provides three general classifications for determining which set of prevention of significant deterioration increments apply.

Proposed RCRA Action Levels (40 CFR Part 264) define the chemical concentration in a medium that would make that medium a RCRA-listed waste. Any medium contaminated at or above these levels would be considered hazardous waste and should be managed, transported, and disposed in accordance with federal and RCRA requirements. Because of the regulatory status of proposed, these levels are only TBCs.

Biological Technical Assistance Group (BTAG) Screening Levels (U.S. EPA Region III, 1995b), Oak Ridge National Laboratory Benchmark Toxicity Values (Will & Suter, 1994), and Florida Soil Cleanup Goals (FDEP, 1995b and 1996) are published listings of ARARs and Screening Action Levels (SALs) for soils.

FDEP Sediment Quality Guideline (FDEP, 1994), U.S. EPA Region IV Sediment Screening Values (U.S. EPA, 1995c), Federal Sediment Quality Screening Values (U.S. EPA, 1996b), and U.S. EPA Sediment Quality Benchmark (U.S. EPA, 1996b) are published listings of ARARs and SALs for sediments.

Federal Floodplain Management, Executive Order (E.O. 11988) requires all Federal agencies to avoid, if possible, development and other activities in the 100-year base floodplain. Where the base floodplain cannot be avoided, special considerations and studies for new facilities and structures are needed.

Florida Surface Water Quality Standards (Chapter 62-302 F.A.C.), U.S. EPA Region IV Chronic Surface Water Screening Values (U.S. EPA, 1995c), National Ambient Water Quality Standards , U.S. EPA Region III Marine Standards (U.S. EPA, 1995b), and U.S. EPA Region III Fresh Water Standards (U.S. EPA, 1995b) are published listings of ARARs and SALs for surface water.

Florida Drinking Water Standards, Monitoring, and Reporting (Chapter 62-550 F.A.C.) set forth drinking water quality standards at least as stringent as the National Primary Drinking Water Regulations. MCLs that are promulgated by U.S. EPA are automatically incorporated into the Florida SDWA. If an MCL does not exist for a contaminant, the Florida SDWA requires that no contaminant that creates or has the potential to create an imminent and substantial danger to the public shall be introduced into a public water system.

Since the groundwater at SWMU 5 is brackish and not used as a potable water supply, the Florida SDWA is neither applicable nor relevant and appropriate.

3.2.1.4 Location-Specific ARARs and TBCs

This section presents a summary of federal and state location-specific ARAR criteria of potential concern in the case of SWMU 5. These potential ARARs and TBCs are as follows:

Federal Protection of Wetlands Executive Order (E.O. 11990) requires federal agencies, in carrying out their responsibilities, to take action to minimize the destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands (unless there is no practical alternative to that construction); minimize the harm to wetlands (if the only no practical alternative requires construction in the wetlands); and provide early and adequate opportunities for public review of plans involving new construction in wetlands.

Corrective measures at SWMU 5 may impact regulated wetland areas. Permits from both the state of Florida and the U.S. Army Corps of Engineers will be required if any corrective measures impact regulated wetland areas.

The Endangered Species Act of 1978 (16 USC 1531) (40 CFR Part 502) provides for consideration of the impacts on endangered and threatened species and their critical habitats. Corrective measure actions, if required, would need to be conducted in a manner such that the continued existence of any endangered or threatened species is not jeopardized or its critical habitat is not adversely affected. Consultation with the United States Fish and Wildlife Service is also required.

The Fish and Wildlife Coordination Act (16 USC 661) provides for consideration of the impacts on wetlands and protected habitats. The act requires that federal agencies, before issuing a permit or undertaking federal action for the modification of any body of water, consult with the appropriate state agency exercising jurisdiction over wildlife resources to conserve those resources. Consultation with the United States Fish and Wildlife Service is also required.

The Fish and Wildlife Improvement Act of 1978 (16 USC 742a) and The Fish and Wildlife Conservation Act of 1980 (16 USC 2901) require consideration of the impacts on wetlands and protected habitats.

Federal Floodplain Management, Executive Order (E.O. 11988) requires all Federal agencies to avoid, if possible, development and other activities in the 100-year base food plain. Where the base floodpan cannot be avoided, special considerations and studies for new facilities and structures are needed.

Florida Surface Waters of the State (Chapter 62-301 F.A.C.) and Florida Delineation of Landward Extent of Wetlands and Surface Waters (Chapter 62-340 F.A.C.) define and provide the delineation methodology for determining the extent of surface waters and wetlands. A ditch next to SWMU 5 drains to surface water and may be bounded by wetlands or mangrove habitat.

Florida Ground Water Classes, Standards, and Exemptions (Chapter 62-520 F.A.C.) provides for the designation of the present and future most beneficial uses of all the groundwaters in the state by means of a classification system. The state classification of the groundwater at Boca Chica Key is Class G-III (nonpotable water), which is water in an unconfined aquifer that has a total dissolved solids content of 10,000 milligrams per liter or greater.

3.2.1.5 Action-Specific ARARs and TBCs

This section presents a summary of federal and state action-specific ARAR criteria of potential concern in the case of SWMU 5. These potential ARARs and TBCs are as follows:

RCRA Subtitle C regulates the treatment, storage, and disposal of hazardous waste from its generation until its ultimate disposal. In general, RCRA Subtitle C requirements for the treatment, storage, or disposal of hazardous waste will be applicable if

- The waste is a listed or characteristic waste under RCRA.
- The waste was treated, stored, or disposed (as defined in 40 CFR 260.10) after the effective date of the RCRA requirements under consideration.
- The activity at the CERCLA site constitutes current treatment, storage, or disposal as defined by RCRA.

RCRA Subtitle C requirements may be relevant and appropriate when the waste is sufficiently similar to a hazardous waste and/or the on-site corrective action constitutes treatment, storage, or disposal and the particular RCRA requirement is well suited to the circumstances of the contaminant release and site.

RCRA Subtitle C requirements may also be relevant and appropriate when the corrective action constitutes generation of a hazardous waste. All RCRA Subtitle C requirements must be met if the clean-up is not under federal order and/or when the hazardous waste moves off site.

An exemption from the hazardous waste rules is provided for wastewater treatment units that are tank systems discharging via regulated outfalls [40 CFR 264.1(g)(6), 25 PAC 264.1(c)(8), 40 CFR 260.10, 25 PAC 260.2]. An exclusion from permitting is provided for such facilities under 40 CFR 270.1(c)(2)(4) for owners and operators of wastewater treatment units and permit-by-rule is provided under 25 PAC 270.1(c).

The following requirements included in the RCRA Subtitle C regulations may pertain to the NAS Key West:

- Hazardous waste identification and listing regulations (40 CFR Part 261).
- Hazardous waste generator requirements (40 CFR Part 262).
- Transportation requirements (40 CFR Part 263).
- Standards for owners and operators of hazardous waste TSDFs (40 CFR Part 264).
- Interim status standards for owners and operators of hazardous waste TSDFs (40 CFR Part 265).
- Land disposal restrictions (LDR) (40 CFR Part 268).

Hazardous Waste Identification and Listing Regulations (40 CFR Part 261) define those solid wastes that are subject to regulation as hazardous waste under 40 CFR Parts 262 to 265 and Parts 124, 270, and 271.

A generator that treats, stores, or disposes of hazardous waste on site must comply with RCRA Standards Applicable to Generators of Hazardous Waste (40 CFR Part 262). These standards include manifest, pre-transport (i.e., packaging, labeling, and placarding), recordkeeping, and reporting requirements. The standards are applicable to actions taken at NAS Key West that constitute generation of a hazardous waste (e.g., generation of water treatment residues or excavation of contaminated soils and/or sediments that may be hazardous).

Standards Applicable to Transporters of Hazardous Waste (40 CFR Part 263) are applicable to off-site transportation of hazardous waste from NAS Key West. These regulations include requirements for compliance with the manifest and recordkeeping systems and requirements for immediate action and cleanup of hazardous waste discharges (spills) during transportation.

Standards and Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities (TSDFs) (40 CFR Parts 264 and 265) are applicable to remedial actions taken at NAS Key West and to off-site facilities that receive hazardous waste from the site for treatment and/or disposal and have a RCRA Part B Permit. On-site facilities must also have a RCRA Part B Permit if the site is not a federally ordered CERCLA cleanup. Standards for TSDFs include requirements for preparedness and prevention, releases from SWMUs (i.e., corrective action requirements), closure and post-closure care, use and management of containers, and design and operating standards for tank systems, surface impoundments, waste piles, landfills, and incinerators.

RCRA Land Disposal Restriction (LDR) Requirements (40 CFR Part 268) restrict certain wastes from being placed or disposed on the land unless they meet specific best demonstrated available technology (BDAT) treatment standards (expressed as concentrations, total or in the TCLP extract, or as specified technologies).

RCRA Criteria for Classification of Solid Waste Disposal Facilities and Practices (40 CFR Part 257) establish criteria for use in determining which solid waste disposal facilities and practices pose a reasonable probability of adverse effects on health and thereby constitute prohibited open dumps.

Department of Transportation (DOT) Rules for Hazardous Materials Transport (49 CFR Parts 107 and 171-179) regulate the transport of hazardous materials, including packaging, shipping equipment, and placarding. These rules are considered applicable to wastes shipped off site for laboratory analysis, treatment, or disposal.

National Environmental Policy Act (40 CFR Part 6) requires consideration of potential environmental impacts at NAS Key West of corrective measure actions on wetlands and endangered species.

The CWA, as amended, governs point-source discharges through the NPDES, discharge, dredge, or fill material, and oil and hazardous waste spills to United States waters. NPDES requirements (40 CFR Part 122) will be applicable if the direct discharge of pollutants into surface waters is part of the remedial action.

The Occupational Health and Safety Act (29 USC, Sections 651 through 678) regulates worker health and safety during implementation of remedial actions.

Florida Hazardous Waste Regulations (Chapter 62-730 F.A.C.) essentially parallel RCRA Subtitle C hazardous waste management regulations. Similar to RCRA Subtitle C regulations, Florida regulations include requirements for the following:

- Generators of hazardous waste (Chapter 262).
- Transporters of hazardous waste (Chapter 263).
- New and existing hazardous waste management facilities applying for a permit (Chapter 264).
- Interim status hazardous waste management facilities applying for a permit (Chapter 265).

The above regulations may be relevant and appropriate to on-site remedial actions and applicable to the transport of hazardous waste off site.

Florida Pretreatment Requirements for Existing and New Sources of Pollution (Chapter 62-730 F.A.C.) implement the pretreatment requirements and establish a state NPDES permit program. These rules may be applicable for corrective measures involving a discharge to surface water.

Land Use Restrictions at Environmental Remediation Sites On Board U.S. Navy Installations (CNBJAXINST 5090.2N4) establish a systematic program to govern land use at environmental remediation sites at U.S. Navy Installations.

3.2.2 Media of Concern

Based upon the results of the Supplemental RFI/RI and previous investigations conducted at SWMU 5 involving the HHRAs, the media of concern at SWMU 5 were determined to be soil and sediment.

Although groundwater at SWMU 5 contains several chemicals at concentrations above background, it was not considered a primary medium of concern in the Supplemental RFI/RI HHRA because it is not a current or potential drinking water source. Additionally, ecological receptors are not directly exposed to groundwater. There are no ecological risks for the other media. Therefore, groundwater will not be directly addressed in the CMS in regard to corrective measure alternatives. Although groundwater is not a current drinking water source and is unlikely to be designated as one in the future, contaminant fate and transport modeling was performed to determine the time required for MCL exceedances to attain MCLs through natural processes, such as, advection, adsorption, and dispersion. Four chemicals exceed MCLs (antimony, cyanide, lead, and mercury). The estimated time for cyanide to attain compliance with its MCL is 1.4 years. For the other three exceedances, the estimated time to attain compliance with MCLs is over

30 years. The details of this estimate are provided in Appendix B. In addition, contaminant exceedances to ARARs will be evaluated.

In addition to groundwater, surface water and subsurface soil will not be retained in this CMS as media of concern. Surface water at SWMU 5 is not large in volume and is composed of the water contained within a small pond and ditch found south of the AMID Buildings. The ditch contained no standing water during sampling activities conducted as part of the Supplemental RFI/RI in 1996. It is anticipated that any corrective action for soil will also address the surface water. For instance, excavation and disposal of the soil would remove the source of the surface water contamination which would result in a decrease in concentration of the contaminants in the surface water. Therefore, surface water at SWMU 5 will not be addressed in this CMS report with regards to corrective measure alternatives. Surface water will be a component of any institutional controls and/or monitoring programs. Implementation of corrective measure alternatives for soil will be scheduled during the dry season (December through May) to minimize the presence of surface water.

3.2.3 Chemicals of Concern

The nature and extent of contamination for SWMU 5 were determined in the Supplemental RFI/RI by analyzing samples from soil, sediment, surface water, and groundwater. The objectives of the Supplemental RFI/RI HHRA were to estimate the actual or potential risks to human health resulting from the presence of contamination in each medium and to provide the basis of determining the need for remedial action in the CMS.

A summary of the Supplemental RFI/RI HHRA was provided in Section 2.4.1 of this CMS. Chemicals of Concern (COCs) (Section 2.4.2) for use in this CMS are selected based on two sets of criteria, U.S. EPA Region IV and FDEP soil clean-up goals. The U.S. EPA Region IV criteria for selecting COCs are based on those chemicals that contribute to a significant cancer risk (1E-06) or a non-cancer HQ above 0.1 in conjunction with a receptor scenario having a total risk (combined across pathways) above the level of concern (1E-04 cancer risk or an HI of 1.0). The FDEP approach for selecting COCs includes those chemicals that contribute to a significant cancer risk (1E-06) or a non-cancer HI above 1.0 based on a specific target organ.

As discussed in Sections 3.7.4.2 and 3.7.4.3 of the Supplemental RFI/RI, none of the ecological COPCs identified in Tables 3-25 through 3-39 (of the Supplemental RFI/RI) were retained as final COCs. This conclusion was based on a "weight of evidence" approach, which consisted of an assessment of analytes detected in groundwater, surface water, sediment, soil, fish tissue, and plant foliage. Factors such as frequency of detection of COPCs, the spatial orientation of detections, and comparison to background values were considered. Overall, site-related contaminants do not appear to pose ecological risks. Therefore, no final ecological COCs were identified at SWMU 5.

Soil

Figure 2-2 in Section 2.3 shows chemicals detected in surface soils at SWMU 5. COCs associated with various receptor exposure scenarios were selected from detected chemicals, as explained in the Supplement RI/RFI and in Section 2.4 of this CMS. For SWMU 5, the projected future land use is anticipated to be non-residential; therefore, only COCs determined under non-residential land use scenarios are considered in this CMS. If the future land use for SWMU 5 changes to a residential scenario, COCs and subsequent clean-up goals for SWMU 5 should be re-evaluated. The following surface soil COCs will be evaluated in the CMS for human health risks at SWMU 5.

Inorganics: Arsenic

These arsenic concentrations fall within or slightly exceed the site-specific background concentration. It is selected as a COC because the risks associated with arsenic exceed the 1E-06 risk level.

As discussed above, no ecological soil COCs were identified at SWMU 5.

Sediment

Figure 2-3 in Section 2.4 shows chemicals detected in sediment at SWMU 5. COCs associated with various receptor exposure scenarios were selected from these detected chemicals, as explained in the Supplement RI/RFI and Section 2.4. For SWMU 5, the projected future land use is anticipated to be non-residential; therefore, only COCs determined under non-residential land use scenarios are considered in this CMS. If the future land use for SWMU 5 changes to a residential scenario, COCs and subsequent clean-up goals for SWMU 5 should be re-evaluated. The following sediment COCs will be evaluated in the CMS for human health risks at SWMU 5.

Inorganics: Arsenic

These arsenic concentrations also fall within or slightly exceed the site-specific background concentration.

As discussed above, no ecological sediment COCs were identified at SWMU 5.

Groundwater

Figures 2-5 and 2-6 in Section 2.4 show groundwater chemical concentrations for selected COPCs in the Supplemental RFI/RI report (B&R Environmental, 1998). COCs were selected from these detected chemicals, as explained in the Supplemental RFI/RI. Groundwater is not a current drinking water source and is unlikely to be designated as one in the future. Chemicals above the drinking water standards and ecological COCs were identified for fate and transport modeling. Following a classification of groundwater COCs resulting from the HHRA.

Groundwater was not evaluated as part of the baseline HHRA because it is classified as Class G-III, non-potable water by the FDEP, as summarized in Section 2.5. The surficial aquifer is the principal aquifer of concern at NAS Key West because of the potential groundwater to surface water contaminant migration pathway. Groundwater obtained from the surficial aquifer at Key West has a high salinity and is unsuitable for drinking, as documented in a 1990 groundwater quality sampling study by United States Geological Survey (USGS) (ABB, 1995b). The Monroe County Health Department recognizes the public water supply obtained from the mainland as the only potable water source available on Key West. Even though the groundwater is not potable, the groundwater concentrations at SWMU 5 were compared to tap water RBCs (U.S. EPA 1996) and MCLs (U.S. EPA, 1995a) for comparison purposes, as presented in Tables 2-2 and 2-3.

Cross Media COCs.

COCs were identified that include the consideration of cross-media concentrations (concentrations in one media which are protective of the migration of contaminants into another media). COCs were developed for soil concentrations in a contaminant source area which will not cause surface water concentrations at an exposure point to exceed acceptable concentrations.

Modeling to develop RGO to protect surface water bodies from overland transport of surface soil contaminants was not conducted. This modeling was not performed due to the small size of surface water bodies at SWMU 5, the topography, relatively low levels of contaminants in surface soils, and lack of erosion.

In calculating soil RGOs protective of surface water, the following transport route from soil to surface water was assumed. A portion of the rainwater which falls on the site reaches the groundwater by directly infiltrating into the soils. As the water infiltrates through the contaminated soil, contaminants leach out of the soil and are transported in dissolved form with the water through the unsaturated zone to the groundwater below. The contaminants can then be transported laterally in the groundwater and eventually migrate to a surface water body exposure point. It is assumed that the small pond located at SWMU 5 was assumed as the exposure point which is located approximately 300 feet west-south-west from the site.

Concentrations of chemicals detected in SWMU 5 surface and subsurface soils were screened against: (1) FDEP soil leaching criteria (FDEP, 1995) and (2) the generic Soil Screening Levels (dilution attenuation factor 20) presented in the U.S. EPA Soil Screening Guidance: User's Guide, Appendix A (U.S. EPA, 1996). Those soil concentrations that exceeded the most conservative values of these two criteria were retained as COCs and are as follows:

Inorganics: Aluminum, Cadmium, Chromium, Lead

Organics: Methylene Chloride

Methylene chloride is a common laboratory contaminant.

3.3 REMEDIAL GOAL OPTIONS (RGOS)

RGOs are developed to ensure that contaminant concentration levels remaining are at levels that are protective of human health and the environment. Human health RGO development calculations are included in Appendix A. RGOs are established to

- Protect human receptors from adverse health affects
- Provide compliance with federal and state ARARs

In order to evaluate and develop RGOs for soil that will be protective of surface water, predictive contaminant transport modeling was performed. The following migratory pathway was modeled to determine RGOs for soil:

- Surface water protection from soil leaching with groundwater discharges to surface water.

The development of cross-media RGOs by using groundwater/surface water flow contaminant fate and transport models is presented in Appendix B.

3.3.1 Soil RGOs

Soil RGOs were determined based on the following criteria.

- Protection of human health for the COCs identified in Section 3.2.3.
- Protection of surface water from soil leaching via groundwater to surface water impacts exceeding surface water criteria for chemicals identified in Appendix B.

3.3.1.1 Human Health Risk-Based RGOs

SWMU 5 is located within a restricted access area at the western end of the airfield, adjacent to Building A-990. Only military personnel have access to this location at any one time and the site is not subjected to any pedestrian traffic. Due to the restrictive access, the residential human health pathway scenario remains unlikely at the site, as long as the installation is maintained as an active military base. Therefore, only non-residential exposure pathway RGOs were calculated at SWMU 5. The maintenance worker was eliminated based on recommendations of the NAS Key West Partnering Team (11/18/98). If the land use for the site changes in the future, RGO estimations should be re-evaluated.

RGOs are developed for any non-residential receptor for which any individual contaminant has an Incremental Cancer Risk (ICR) greater than 1E-06 or an HI greater than 1.0 (for a specific target organ) including all exposure pathways (considering all non-residential receptors, media, and routes of exposure). For each scenario, individual chemicals that contributed at least 1E-06 to the ICR or 0.1 to the HI were selected. The RGOs were developed using the representative concentrations that were used in the Supplemental RI/RFI. To develop potential RGOs, the representative concentration was proportioned to yield concentrations with a target cancer risk equal to 1E-06 and a noncarcinogenic HI of 1.0.

At SWMU 5, arsenic was selected as the only soil COC. Noncarcinogenic HIs for all non-residential exposure pathways at SWMU 5 were below 1.0. Therefore, only RGOs for arsenic based on carcinogenic risk are presented in this CMS. Human health risk-based RGOs at SWMU 5 are simplified because arsenic is the only COC in surface soil; therefore it was not necessary to develop a range of RGO levels, instead a single arsenic RGO level was developed for the most sensitive non-residential receptor exposed to surface soil (i.e., the occupational worker) at a risk level of 1E-06 with the alternative selected being no-action. In addition, an arsenic RGO level was developed for restricted site access (institutional controls) for the occupational worker.

Using the standard RGO equation:

RGO = (EPC)(Risk Level)/(Calc Risk Level)

It was determined, under the *no-action* alternative if the exposure concentration (EPC) of arsenic in surface soil is less than a risk-based RGO of 0.46 mg/kg, an acceptable risk of 1E-06 can be achieved for all non-residential exposure pathways. The estimated cancer risks and noncarcinogenic HIs (The calculated risk level in the RGO equation) for each contributing route of exposure (ingestion, dermal contact, and inhalation) for the no-action alternative are shown in Appendix A.

A modified RGO was developed using risks recalculated using revised exposure assumptions for restricted site access (institutional controls). (The recalculated risks and exposure assumptions are shown in Table A-1.) Application of the standard RGO equation under these revised assumptions indicates that if the maximum exposure concentration of arsenic in surface soil is less than a risk-based RGO of 2.2 mg/kg, an acceptable risk range of 1E-06 can be achieved for all non-residential exposure pathways. The estimated cancer risks and noncarcinogenic HIs (The calculated risk level in the RGO equation) for each contributing route of exposure (ingestion, dermal contact, and inhalation) for the restricted site access (institutional controls) alternative are shown in Appendix A.

However, It should be noted that for arsenic, the risk based RGOs of 0.46 mg/kg under the no action alternative and 2.2 mg/kg under restricted site access fall within the reported range of background arsenic concentrations in surface soil (0.63 mg/kg to 2.7 mg/kg). As such, the application of these RGOs as cleanup for arsenic is not practical. Consequently, the FDEP Industrial Soil Cleanup Goal of 3.7 mg/kg for arsenic will be used as an appropriate criterion for determining the need for remedial action.

3.3.1.2 Soil-to-Surface Water (via Groundwater) Protection Based RGOs

There were five chemicals (aluminum, cadmium, chromium, lead, and methylene chloride), which exceeded soil to groundwater leaching criteria. Based on predictive fate and transport modeling results presented in Appendix B, none of these five chemicals are anticipated to exceed criteria for the protection of surface water, assuming soil to groundwater leaching and groundwater to surface water seepage and given the current maximum surface soil and groundwater concentrations.

3.3.2 Sediment RGOs

Sediment RGOs were determined for the COCs identified in Section 3.2.3 The sediment RGOs were based on the following criterion:

- Protection of human health

For the same reasons discussed above for soil RGOs, due to the site's military designation and restrictive access, the residential human health pathway scenario remains unlikely as long as the installation is maintained as an active military base. Therefore, as with surface soil, only non-residential exposure pathway RGOs were calculated for sediment at SWMU 5. If the land use for the site changes in the future, RGO estimations should be re-evaluated.

RGOs are developed for any non-residential receptor for which any individual contaminant has an ICR greater than 1E-06 or an HI greater than 1.0 (for a specific target organ) including all exposure pathways (considering all non-residential receptors, media, and routes of exposure). For each scenario, individual chemicals that contributed to at least 1E-06 to the ICR or 0.1 to the HI were selected as COCs. Sediment RGOs were developed using the representative concentrations from the Supplemental RI/RFI.

At SWMU 5, arsenic was selected as the only sediment COC based on carcinogenic risk levels that exceed 1E-06 in non-residential exposure pathways. Noncarcinogenic HIs for all non-residential exposure pathways at SWMU 5 were below 1.0. Therefore, only RGOs for arsenic based on carcinogenic risk are presented in this CMS. A single arsenic RGO level was developed for the most sensitive non-residential receptor exposed to sediment (i.e., the adolescent trespasser) at a risk level of 1E-06, with the alternative selected being no action. In addition, an arsenic RGO level was developed for restricted site access (institutional controls) for the adolescent trespasser.

Using the standard RGO equation, the RGO developed for sediment is 2.6 mg/kg. If the EPC for arsenic in sediment does not exceed this level, an acceptable risk range of 1E-06 can be achieved for all non-residential receptors. The estimated cancer risks and noncarcinogenic HIs (The calculated risk level in the RGO equation) for each contributing route of exposure (ingestion and dermal contact) for the no-action alternative are shown in Appendix A.

A modified RGO was developed using risks recalculated using revised exposure assumptions for restricted site access (institutional controls). (The recalculated risks and exposure assumptions are shown in Table A-1.) Application of the standard RGO equation under these revised assumptions indicates that if the EPC of arsenic in sediment is less than a risk-based RGO of 9.9 mg/kg, an acceptable risk range of 1E-06 can be achieved for all non-residential exposure pathways. The estimated cancer risks and noncarcinogenic HIs (The calculated risk level in the RGO equation) for each contributing route of exposure (ingestion and dermal contact) for the restricted site access (institutional controls) alternative are shown in Appendix A.

3.3.3 Summary of RGOs Established for Surface Soil and Sediment and Cross-Media Protection

Table 3-2 provides the chemicals, detected maximum levels, and applicable RGOs for SWMU 5. Arsenic in surface soil exceeds criteria for protection of human health under various alternatives. Arsenic in sediment does not exceed criteria for protection of human health under institutional controls.

3.4 CORRECTIVE ACTION OBJECTIVES

Site-specific CAOs specify COCs, media of interest, exposure pathways, and clean-up goals or acceptable contaminant concentrations. CAOs may be developed to permit consideration of a range of treatment and containment alternatives. This CMS addresses soil, sediment, and surface water contamination within SWMU 5. To protect the public from potential current and future health risks, as well as to protect the environment, the following CAOs have been developed for SWMU 5 soil, sediment, and surface water to address the primary exposure pathways:

- Prevent human receptors from contacting contaminants in the soil and sediment at concentrations that would result in adverse effects.
- Prevent soil contaminants from migrating to groundwater (via infiltration) and migrating to surface water.
- Bring SWMU 5 into compliance with contaminant-specific, location-specific, and action-specific federal and state ARARs

The RGOs that would attain these objectives have been discussed in Section 3.3.

3.5 VOLUMES OF CONTAMINATED MEDIA

The volume of contaminated surface soil was estimated based on a comparison of the RGOs and CAOs defined in Sections 3.3 and 3.4, respectively, using standard engineering practice. The values and assumptions used in estimating the volumes of contaminated media are presented in this section.

3.5.1 Contaminated Soil

The contaminated soil volume estimate is based on the protection of industrial workers. Because of the high groundwater table, reported variations in soil depths, and the fact that there were no exceedances of

RGOs below 1 foot, a contamination depth of 1 foot was used. Figure 3-1 presents the estimated areal extent of contaminated soil which exceeds the most stringent (residential) RGOs and those which exceed the modified industrial RGOs. The area of excavation used in calculating the contaminated soil volume is based on exceedances of the modified industrial RGOs. This volume estimate should be somewhat conservative for costing purposes in this CMS and will require additional testing to refine the estimate of the extent of contamination.

Only one sample (out of seven), located south of the sandblasting area, exceeded the modified industrial scenario. This is the only sample from the berm south of the sandblasting area It was assumed for this CMS that the areal extent of contaminated soil is a 50 foot square at the center of which is the detected RGO exceedance. This corresponds to a contaminated soil volume of 2,500 cubic feet or approximately 100 cubic yards. This volume estimate will be used for costing purposes in this CMS and will require additional sampling to refine the estimate of the extent of contamination.

3.5.2 Contaminated Sediment

The sediment in the concrete ditch south of the sandblasting area that was sampled by IT in 1993 and contaminated at levels exceeding RGOs is no longer present. B&R Environmental reported that there was no sediment in the concrete ditch when they were performing the Supplemental RFI/RI sampling at the site. There is no sediment, that is contaminated in excess of the modified industrial RGOs, based on the Supplemental RFI/RI results.

TABLE 3-1

POTENTIAL ARARs AND SALs
CORRECTIVE MEASURE STUDY FOR SWMU 5
NAVAL AIR STATION KEY WEST
BOCA CHICA KEY, FLORIDA
PAGE 1 OF 3

Chemical-Specific Requirements	Rationale
Clean Water Act (33 USC 1251-1376) Federal AWQCs (40 CFR Part 50)	Corrective measures may result in surface-water discharges that could impact aquatic life.
Clean Air Act (42 USC 7401) National Ambient Air Quality Standards (NAAQS) (40 CFR Part 50) National Emission Standards for Hazardous Air Pollutants (NESHAPs) (40 CFR 61.60-61.71) New Source Performance Standards (NSPS) (40 CFR Part 60) Florida State Implementation Plan (SIP) (Chapter 62-204 F.A.C.)	Corrective measures may include treatment of media which could result in emissions to the atmosphere.
Threshold Limit Values, American Conference of Government Industrial Hygienists	May be applicable to air concentrations during implementation of corrective measures.
Proposed RCRA Action Levels (40 CFR Part 264)	Corrective measures may be driven by reducing chemical concentrations in any or all of the media at SWMU 5 to meet the Action Levels.
Benchmark Toxicity Values (EPA Region III, 1995b)	Corrective measures may be driven by reducing chemical concentrations in the soils at SWMU 5 to meet published levels.
Oak Ridge National Laboratory Benchmark Toxicity Values (Will and Suter, 1994)	
FDEP Soil Cleanup Goals (FDEP, 1995b and 1996)	
FDEP Sediment Quality Guideline (FDEP, 1994)	Corrective measures may be driven by reducing chemical concentrations in the sediments at SWMU 5 to meet published levels.
EPA Region IV Sediment Screening Values (EPA, 1995c)	
Federal Sediment Quality Screening Criteria (EPA, 1996b)	
EPA Sediment Quality Benchmark (EPA, 1996b)	
Florida Surface Water Quality Standards (Chapter 62-302 F.A.C.)	Corrective measures may be driven by reducing chemical concentrations in the surface waters at SWMU 5 to meet published levels.
EPA Region IV Chronic Surface Water Screening Values (EPA, 1995c)	
National Ambient Water Quality Standards	
EPA Region III Marine Standards (EPA, 1995b)	
EPA Region III Fresh Water Standards (EPA, 1995b)	
Safe Drinking Water Act MCLs and MCLGs (EPA, 1995a)	Corrective measures may include groundwater remediation to MCLs or MCLGs.
Florida Drinking Water Standards, Monitoring and Reporting (MCLs) (Chapter 62-550 F.A.C.)	
Florida Department of Environmental Protection Guidance (FDEP, 1989)	Corrective measures may include cleanup to FDEP Guidance.

TABLE 3-2

SUMMARY OF RGOs FOR SWMU 5
NAVAL AIR STATION KEY WEST
BOCA CHICA KEY, FLORIDA

Chemical	Reason for Evaluation	Maximum Concentration (mg/kg)	FDEP Industrial Clean Up Goal (mg/kg)	Protection of Human Health	Protection of Human Health*	Protection of Surface Water
Surface Soil						
Arsenic	Surface Soil Human Health COC	13.1	3.7	0.46	2.2	Not Applicable
Lead	Protection of Surface Water	52.1	Not Applicable	Not Applicable	Not Applicable	52000
Aluminum	Protection of Surface Water	923	Not Applicable	Not Applicable	Not Applicable	>1000000
Cadmium	Protection of Surface Water	12.6	Not Applicable	Not Applicable	Not Applicable	3306
Chromium	Protection of Surface Water	24.7	Not Applicable	Not Applicable	Not Applicable	1259
Methylene Chloride	Protection of Surface Water	20	Not Applicable	Not Applicable	Not Applicable	153
Sediment						
Arsenic	Sediment Human Health COC	8.01	7.2	2.6	9.9	Not Applicable

* Modified with Institution Controls

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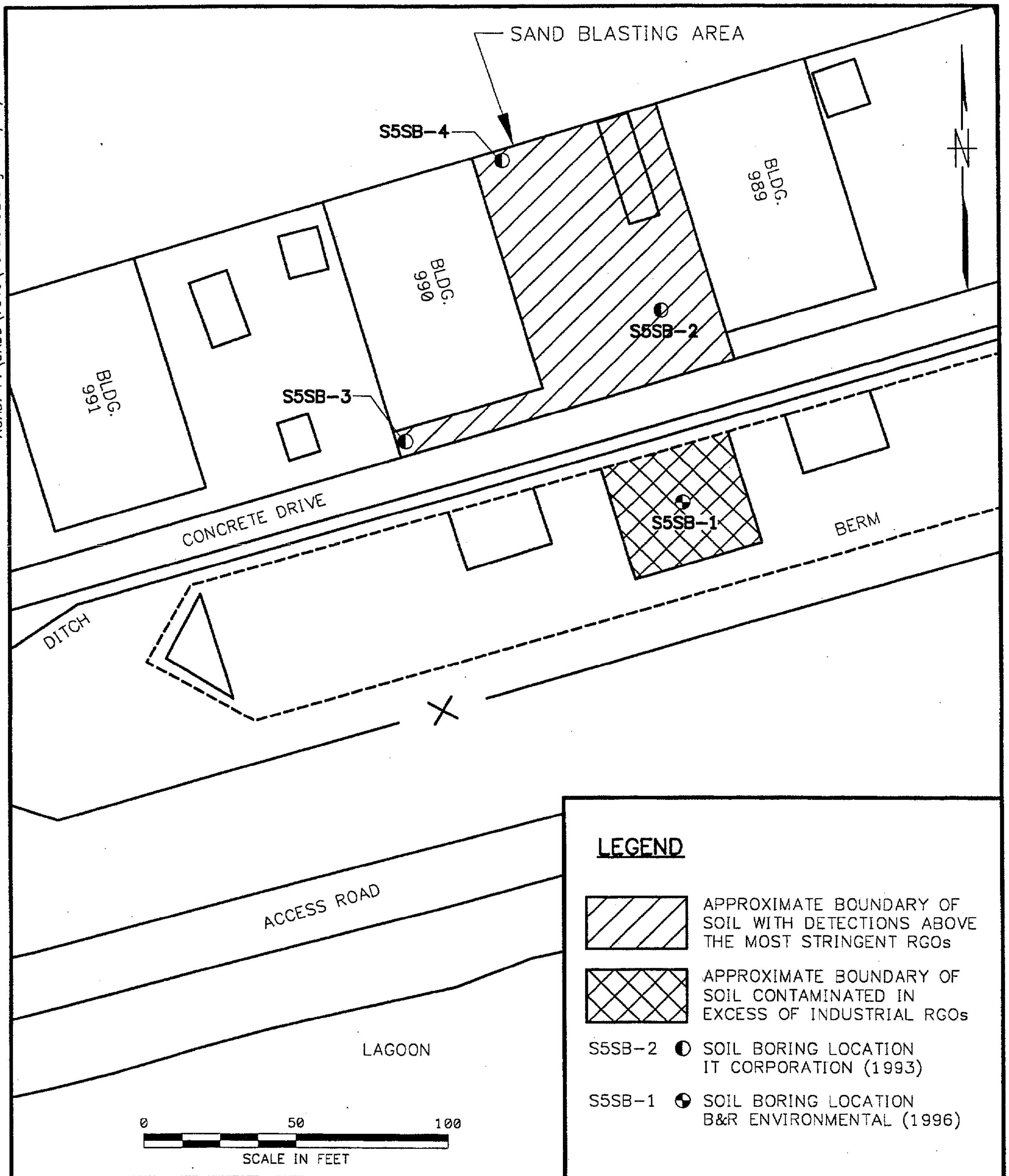

DRAWN BY MF / DATE 3/31/98	DEPARTMENT OF THE NAVY · SOUTHERN DIV FACILITIES ENGINEERING COMD	**AREAL EXTENT OF CONTAMINATED SOIL** **SWMU 5** **NAVAL AIR STATION KEY WEST** **BOCA CHICA KEY FLORIDA**	CONTRACT NO. 7046
CHECKED BY / DATE			APPROVED BY / DATE
COST/SCHED-AREA			APPROVED BY / DATE
SCALE AS NOTED			DRAWING NO. FIGURE 3-1 / REV. 0

FORM CADD NO. SDIV_AV.DWG - REV 0 - 1/20/98

4.0 IDENTIFICATION, SCREENING, AND DEVELOPMENT OF CORRECTIVE MEASURE ALTERNATIVES

4.1 INTRODUCTION

This section presents the identification, screening, and development of the corrective measure alternatives formulated to achieve the CAOs for SWMU 5. Section 3.0 presented the underlying basis for the initial identification and screening of the corrective measure technologies and included the following:

- Identification of ARARs
- Development of CAOs and medium-specific RGOs
- Identification of volumes of contaminated media based on the RGOs

The identification and screening of corrective measure technologies and the development of corrective measure alternatives are based upon the information presented in Section 3.0 and involve the following activities:

- Identification of corrective measure technologies and applicable process options.
- Screening of potential corrective measure technologies and applicable process options.
- Development of corrective measure alternatives by assembling applicable technologies into alternatives that have the potential to achieve the defined CAOs.

4.2 IDENTIFICATION AND SCREENING OF CORRECTIVE MEASURE TECHNOLOGIES AND PROCESS OPTIONS

This section identifies and screens the corrective measure technologies and process options that may be used to achieve the CAOs for SWMU 5. This process was based on the review of current literature, vendor information, and previous experience in developing alternatives for sites with similar medium-specific concerns and releases.

Corrective measure technologies and process options can be grouped according to general response actions. Corrective measure alternatives are then formulated by combining general response actions to completely address the CAOs. When implemented, the corrective measure alternative should be capable of achieving the CAOs, with the exception of the no-action alternative. The categories of general response actions that could be implemented to achieve or address the CAOs for SWMU 5 include the following:

- No Action
- Institutional controls
- Containment
- Removal
- Treatment
- Disposal

Each of the general response actions are discussed below. Corrective measure technologies and process options for each of the general response actions that are potentially applicable to SWMU 5 are identified and screened in Tables 4-1 for soil. The criteria used for screening the technologies and process options are discussed in Section 4.2.7.

4.2.1 No Action

No action is a general response action wherein the status quo is maintained at the site. No action is normally retained to provide a baseline for comparison with other alternatives. No additional activities would be conducted at the site to address remaining contamination. There are no implementability concerns, because the contaminated media are considered to be left "as is." Institutional controls, containment, removal, treatment, or other mitigating actions are not provided to reduce the potential for exposure.

4.2.2 Institutional Controls

Access controls (e.g., physical barriers) and/or site development restrictions in the NAS Key West Master Plan are institutional control options that may be considered to reduce or eliminate pathways of exposure to hazardous substances at the site. Controls could involve the use of groundwater monitoring networks and/or groundwater use restrictions and educational programs. The application of institutional controls alone does not reduce the volume, mobility, or toxicity of the contaminants. Site development restrictions would be implemented in accordance with CNBJAXINST 5090.2N4 (U.S. Navy, 1997) This instruction has been provided as Appendix D.

4.2.3 Containment

Containment involves the application of physical measures to reduce the potential for contaminant migration and thereby reduce the risk to the public and the environment. The contaminated media must be isolated from the primary transport mechanisms (i.e., wind, erosion, surface water, and groundwater) to reduce the migration of contaminants. Contaminated media are isolated by the installation of surface and subsurface barriers that either block or divert any transport media from the contaminants.

4.2.4 Removal

Removal action is a general response action wherein technologies are used to move contaminated media from its present location in order to be treated and/or disposed elsewhere. Treatment and/or disposal process options can be combined with removal process options to develop alternatives.

4.2.5 Treatment

The treatment response action, including both in-situ and ex-situ treatment process options, includes physical, chemical, or solidification designed to reduce the mobility, toxicity, and/or volume of the contaminants present. Treatment can be used with removal and disposal process options to develop alternatives.

4.2.6 Disposal

Disposal technologies include placement of removed or treated materials in an on-site or an off-site permanent disposal facility. Removal options and possibly treatment options can be used with disposal process options to develop alternatives. The toxicity, mobility, or volume of the contaminants is not reduced through the singular application of disposal. This response action would reduce or eliminate exposure pathways related to direct human contact with contaminated material.

4.2.7 Screening Criteria for Corrective Measure Technologies and Process Options

Corrective measure technologies and process options are screened to eliminate those that are not feasible to implement, that rely on technologies unlikely to perform satisfactorily or reliably, or that do not achieve the CAOs within a reasonable time. The corrective measure technologies and process options are also eliminated based on SWMU 5 site-specific and waste-specific conditions.

The screening process focuses on eliminating those technologies and process options that have severe limitations for a given set of waste-specific and site-specific conditions. The screening step also eliminates technologies and process options based on inherent technology limitations. Site, waste, and technology characteristics that were used as screening criteria are described below. Table 4-1 provides the identification and screening of technologies and process options for SWMU 5. Table 4-2 provides a summary of retained technologies for soil.

4.2.7.1 Site Characteristics

Site characteristics include an evaluation of RGOs for SWMU 5 or contaminant concentrations to identify site conditions that may limit or advocate the use of certain technologies. Technologies and process options are evaluated for their applicability and limitations to site conditions, including compatibility with site hydrogeology or soils.

4.2.7.2 Waste Characteristics

Waste characteristics may limit the effectiveness or feasibility of technologies. Technologies and process options are evaluated for their applicability and limitations to the waste characteristics at the site, including contaminant type and concentrations and contaminated media.

4.2.7.3 Technology Limitations

Technology limitations include the level of technology development, performance record, and inherent construction, operation, and maintenance problems. Technologies and process options are evaluated based on their reliability, performance, and proven effectiveness.

4.3 IDENTIFICATION OF CORRECTIVE MEASURE ALTERNATIVES FOR SWMU 5

This section describes the development of the corrective measure alternatives for SWMU 5 considering the information provided in the previous sections. Additional site-specific information and assumptions are provided in this section to further explain the alternative development process. In addition, alternatives are briefly described in this section. A detailed description and analysis of alternatives is provided in Section 5.0.

Soil RGOs were developed via predictive modeling to determine if there are any adverse impacts to surface water. For this effort, RGOs were developed for groundwater to be protective of surface water. Current soil concentrations are substantially below the soil RGOs protective of surface water. Residual contaminants in groundwater and surface water would be addressed through soil and sediment corrective measure alternatives.

Alternatives were developed that address the COCs and exposure pathways for each of the media in order to achieve the CAOs. Although all human health risks were considered acceptable (ICR within the range of

1E-06 to 1E-04 and HI less than 1.0), alternatives were developed to provide a range of corrective measure alternatives to address all contaminants that could potentially affect human receptors.

Based on the results of the risk assessment in the Supplemental RFI/RI, these assumptions were used to develop these alternatives:

- Groundwater at the Florida Keys is classified as nonpotable by the state. Therefore, no corrective measures are proposed for low-level groundwater contamination at SWMU 5.

- SWMU 5 is located within a restricted access area along an active taxiway. Only military personnel have access to this location and the site is not subject to any pedestrian traffic. Because of the restrictive site access, residential exposure to contaminants at SWMU 5 is highly unlikely as long as the installation is maintained as an active military base.

The following alternatives have been developed for SWMU 5:

1. No Action
2. Institutional Controls with Monitoring
3. Remove, Treat, and Dispose of Soil from a Hot Spot above Modified Industrial RGOs; Institutional Controls

Note that containment of soils (i.e., soil cover or capping) was not developed as a corrective measure alternative. The groundwater modeling of the current chemical concentrations showed that there is no mobility concern. Therefore, the alternatives no action, institutional controls, and soil removal were considered to provide a sufficient range of corrective measure alternatives for SWMU 5. A brief description of each alternative is provided in Sections 4.3.1 through 4.3.3.

4.3.1 Alternative 1 - No Action

Under the no-action alternative, the site is maintained at status quo. This alternative is retained to provide a baseline for comparison to other alternatives and, therefore, does not address the contamination of the soils, sediment, surface water, and groundwater. There would be no reduction in toxicity, mobility, or volume of the contaminants from treatment at SWMU 5 other than that which would result from natural dispersion, dilution, or other attenuating factors.

4.3.2 Alternative 2 – Institutional Controls with Monitoring

This alternative consists of one major component, institutional controls (i.e., land-use controls, monitoring, and educational programs). Land-use controls would be imposed to eliminate or reduce the pathways of human exposure to contaminants at the site. In addition, surface water, groundwater, and sediment sampling (quarterly for the first year and annually for the next 9 years) would be conducted. This sampling would be performed based on state and federal regulations and would measure changes in site contamination. Site development restrictions would be implemented, as stipulated in CNBJAXINST 5090.2N4 (U.S. Navy, 1997), and appropriate changes would be made to the NAS Key West Master Plan. Educational programs would inform the public concerning site hazards. Per the NAS Key West MOA with the U.S. EPA and FDEP (NASKW, 1998), the facility will perform quarterly inspections and make an annual report to U.S. EPA and FDEP verifying the integrity of insitutional controls at the site.

4.3.3 Alternative 3 - Remove, Treat, and Dispose of Soil from a Hot Spot Above Modified RGOs; Institutional Controls

This alternative consists of three major components: removal of contaminated soil, transport of contaminated soils for off-site treatment and/or disposal, and institutional controls. Alternative 3 would remove soil contaminated at concentrations in excess of industrial standards and thereby reduce exposure to human receptors.

Approximately 100 cubic yards of contaminated soil above modified industrial RGOs would be excavated from one hot-spot on the berm south of the sandblasting area. A predesign study would be conducted to survey original surface elevations, calculate the area and volume of the excavation, and determine if the soil would need to be handled as RCRA hazardous. Confirmation sampling would be conducted to ensure that the removal of contaminated soil in excess of FDEP Industrial RGOs has been completed. The excavated soil would be stockpiled within the limits of the excavation.

Stockpiled soils would be transported to an off-site RCRA-permitted TSDF for treatment, if required, and disposal. Treatment and disposal options include stabilization/solidification and landfill disposal.

Institutional controls (i.e., land-use controls, monitoring, and educational programs) would be established to eliminate or reduce pathways of exposure to contaminants at the site. Land-use controls would be imposed to eliminate or reduce the pathways of human exposure to contaminants at the site. Monitoring would be conducted to verify that residual contaminants do not pose unacceptable risks. Sediment, surface water, and groundwater sampling would be conducted quarterly for the first year and annually thereafter. This sampling would be performed based on state and federal regulations and to measure decreases in the human health impact. Site development restrictions added to the NAS Key West Master Plan in accordance with CNBJAXINST 5090.2N4 (U.S. Navy, 1997) would implement administrative actions to restrict future site use. Educational programs would inform the public of site hazards. Per the MOA (NASKW, 1998), the facility will perform quarterly inspections and make an annual report to controls placed at the site and will determine whether changes to the controls are required.

TABLE 4-1

PRELIMINARY SCREENING OF REMEDIATION TECHNOLOGIES FOR SOILS
CORRECTIVE MEASURES STUDY
SWMU 5, AMID BUILDING 990 - SAND BLASTING AREA
NAVAL AIR STATION KEY WEST, BOCA CHICA KEY, FLORIDA
PAGE 1 OF 4

TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS	OPTION RETAINED
GENERAL RESPONSE ACTION: NO ACTION				
No Action	No Action	No activities proposed at SWMU 5 to address contamination	Retained as baseline for comparison.	Yes
GENERAL RESPONSE ACTION: INSTITUTIONAL CONTROLS				
Institutional Controls (1)	Limited Site Access	Physical barrier used to restrict access to the site.	Only effective in preventing direct contact regarding human exposure.	Yes
	Site Development Restrictions	Administrative action used to restrict future site use as documented in the NAS Key West Master Plan.	Administrative action is used to prevent direct contact regarding human exposure.	Yes
	Monitoring	Sampling and analysis of environmental media to assess contaminant migration and future environmental impacts.	Effective only to assess contaminant levels on-site and migration off-site. Can be used to determine if conditions are changing in order to indicate the need for further corrective measures.	Yes
	Educational Programs	Educate public concerning site hazards.	Helps to inform the public concerning possible site hazards. However, does not reduce the exposure potential for human receptors. Information for risks can be provided at Restoration Advisory Board meetings.	Yes
GENERAL RESPONSE ACTION: CONTAINMENT				
Soil Cover	Native Soil	Layer of native soil is placed over site to prevent direct contact and ingestion and migration to surface water.	Not effective in reducing toxicity of contaminants, but will provide a barrier for primary exposure pathways. Long-term monitoring and maintenance would be required.	Yes
Capping	Clay Cap/Synthetic Membrane/ Asphalt/ Concrete	Use of impermeable or semipermeable materials constructed over the site to provide a barrier to water infiltration and also prevent direct contact with and ingestion of chemicals, as well as migration to surface water.	Not effective in reducing toxicity of contaminants, but will provide a barrier for primary exposure pathways. Long-term monitoring and maintenance would be required. Leaching of contaminants to groundwater is not a concern based on modeling at SWMU 5.	No
GENERAL RESPONSE ACTION: REMOVAL				
Bulk Excavation	Bulk Excavation (2,4)	Mechanical removal of solid materials using common construction equipment such as bulldozers and highlifts.	Effective in removing contaminated soils. Used in combination with ex situ or off-site treatment or disposal.	Yes
GENERAL RESPONSE ACTION: EX SITU TREATMENT				
Thermal	Onsite Incineration (4,5,7)	Soil is excavated and treated by a mobile or on-site incinerator that employs thermal decomposition via thermal oxidation at high temperature to destroy organics.	Technology has been proven successful for remediating of organic wastes. Not effective for inorganics.	No

TABLE 4-1

PRELIMINARY SCREENING OF REMEDIATION TECHNOLOGIES FOR SOILS
CORRECTIVE MEASURES STUDY
SWMU 5, AMID BUILDING 990 - SAND BLASTING AREA
NAVAL AIR STATION KEY WEST, BOCA CHICA KEY, FLORIDA
PAGE 2 OF 4

TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS	OPTION RETAINED
		GENERAL RESPONSE ACTION: EX SITU TREATMENT		
Thermal (Continued)	Offsite Incineration (4,5,7)	Excavated soil is transported to a licensed incinerator, which has applicable local, state, and Federal permits, that thermally destroys organics in a direct fire unit.	Widely used option for treatment of organic wastes. Not effective for inorganics.	No
	Vitrification (4)	Excavated soil is melted at high temperature to form a glass and crystalline structure with very low leaching characteristics and destroys organics.	Technology is not cost effective nor practical for the concentrations and volume of contaminants.	No
	Low-Temperature Thermal Desorption (4)	Application of heat at relatively low temperature to remove organics from excavated soil by volatilization. Vapor phase, typically is treated by incineration or carbon adsorption.	Technology not effective for inorganics.	No
Physical/ Chemical	Soil Washing/ Solvent Extraction (4,8)	Separation of contaminants from a medium by contact with a liquid with a higher affinity for the COCs. Converts organic and inorganic contaminants to a more concentrated or less toxic form.	Questionable effectiveness for inorganics. Extensive process would be required. Not warranted for small volume	No
	Supercritical Extraction (8)	Extraction of organics using gases at a certain temperature and pressure (critical point) such that their solvent properties are greatly altered.	Ineffective for inorganic COCs.	No
	Stabilization/ Solidification (2,4)	Excavated soil is mixed with cement lime, fly ash, or other pozzolanic materials to form a cement-like or soil-like product. Contaminants are physically bound or enclosed within a stabilized mass (solidification), or chemical reactions between stabilizing agent and contaminants to reduce their mobility (stabilization).	Would be effective in creating monolithic mass to prevent incidental ingestion.	Yes
	Chemical Oxidation (3,4,5)	Oxidation chemical reactions are used to reduce toxicity or transform the contaminant to a compound that is more stable, less mobile, and/or inert. Commonly used oxidizing agents include ozone, chlorine, and hydrogen peroxide.	Ineffective for site COCs.	No

TABLE 4-1

PRELIMINARY SCREENING OF REMEDIATION TECHNOLOGIES FOR SOILS
CORRECTIVE MEASURES STUDY
SWMU 5, AMID BUILDING 990 - SAND BLASTING AREA
NAVAL AIR STATION KEY WEST, BOCA CHICA KEY, FLORIDA

TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS	OPTION RETAINED
			GENERAL RESPONSE ACTION: EX SITU TREATMENT	
Biological	Landfarming (4)	Controlled application of contaminated soil, nutrients, and microbes to land area that is tilled.	Ineffective for inorganics.	No
			GENERAL RESPONSE ACTION: IN SITU TREATMENT	
Thermal	Vitrification (4,6)	Electrodes for applying electricity are used to melt contaminated soil, producing a glass and crystalline structure with very low leaching characteristics and destroys organics.	Technology is not cost effective nor practical for a site where groundwater is at a shallow depth.	No
Physical/ Chemical	Soil Flushing (4,8)	Soil contaminants are extracted with water or other suitable aqueous solutions. Extraction fluid passes through in-place soils using an injection or infiltration process. Contaminants are leached into the groundwater, which are then removed via extraction wells.	Although effective in removing a wide range of inorganic contaminants from coarse-grained soil, there is the potential for uncontrolled migration of contaminants to groundwater. Also, the technology is not as cost-effective as compared to other technologies because of complex treatment train is required for washing fluid.	No
	Soil Vapor Extraction (4)	Vacuum is applied through extraction wells to create a pressure/concentration gradient that induces gas-phase volatiles to diffuse through soil to extraction wells.	Ineffective for inorganics.	No
	Solidification/ Stabilization (2,3,4)	Process where cement, lime, or other pozzolanic materials are mixed with soil in the vadose zone to immobilize contaminants.	Would be effective in creating monolithic mass to prevent incidental ingestion.	Yes
Biological	Biodegradation (4,9)	By circulating water-based nutrient solutions through contaminated soils, enhance naturally occurring microbes biological degrading of organic contaminants.	Technology is not effective for treatment of inorganics.	No
			GENERAL RESPONSE ACTION: DISPOSAL	
Landfill	On-site Landfill (3,7)	Soil is excavated and characterized as required by land disposal restrictions. Hazardous wastes are treated to meet either RCRA or non-RCRA treatment standards prior to land disposal. Soil is then disposed of in a secure, on-site, RCRA-permitted facility.	There is no approved disposal facility currently on-site.	No

TABLE 4-1

PRELIMINARY SCREENING OF REMEDIATION TECHNOLOGIES FOR SOILS
CORRECTIVE MEASURES STUDY
SWMU 5, AMID BUILDING 990 - SAND BLASTING AREA
NAVAL AIR STATION KEY WEST, BOCA CHICA KEY, FLORIDA
PAGE 4 OF 4

TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS	OPTION RETAINED
		GENERAL RESPONSE ACTION: DISPOSAL		
Landfill	Off-site Landfill (3,4,7)	Soil is excavated and characterized as required by land disposal restrictions. Hazardous wastes are treated to meet either RCRA or non-RCRA treatment standards prior to land disposal. Soil is then disposed of in a secure, off-site, RCRA-permitted facility.	RCRA land disposal restrictions may limit wastes eligibility for disposal without treatment. Widely used and easily implemented technology.	Yes

1 United States Environmental Protection Agency. Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final, October 1988.
2 Rogosnewski, P., Bryson H., and Wagner, K., 1995. JRB Associates, Inc. for the U.S. EPA. Remedial Action Technology for Waste Disposal Sites, Noyes Data Corporation.
3 Corbitt, Robert A. Standard Handbook of Environmental Engineering, McGraw-Hill Publishing Company, 1990.
4 United States Department of Defense Environmental Technology Transfer Committee. Remediation Technologies Screening Matrix and Reference Guide, Second Edition, October 1994.
5 Kiang, Yen-Hsiung and Metry, Amir A. Hazardous Waste Processing Technology, Butterworth Publishers, 1982.
6 EM Database, January 1995. US Department of Energy Office of Environmental Management Information Posted on The Internet, January 19, 1995.
7 Dillon, A.P. Pesticide Disposal and Detoxification, Noyes Data Corporation, 1981.
8 ATTIC (Alternative Treatment Technology Information Center), November 1991. EPA/600/M-91/049, US Environmental Protection Agency.
9 Matsumura, Fumio and Murti, C.R. Biodegradation of Pesticides, Plenum Press New York, 1982.

TABLE 4-2

SUMMARY OF RETAINED TECHNOLOGIES FOR SOILS
CORRECTIVE MEASURES STUDY
SWMU 5, AMID BUILDING 990 - SAND BLASTING AREA
NAVAL AIR STATION KEY WEST
BOCA CHICA KEY, FLORIDA

General Response Action	Technology	Process Option
No Action	No Action	No Action
Institutional Controls	Institutional Controls	Limited Site Access
		Site Development Restrictions
		Monitoring
		Educational Programs
Containment	Soil Cover	Native Soil
Removal	Bulk Excavation	Bulk Excavation
Ex Situ Treatment	Physical/Chemical	Stabilization/Solidification
In Situ Treatment	Physical/Chemical	Stabilization/Solidification
Disposal	Landfill	Off-site Landfill

5.0 EVALUATION OF THE CORRECTIVE MEASURE ALTERNATIVES FOR SWMU 5

This section presents a detailed description of each corrective measure alternative developed in Section 4.0, the rationale used to evaluate each corrective measure alternative, and the results of the evaluation for each specific evaluation standard. The evaluation of corrective measure alternatives was conducted in accordance with the U.S. EPA RCRA Corrective Action Plan Guidance (Final) (U.S. EPA, 1994a).

5.1 CORRECTIVE MEASURE ALTERNATIVES

This section describes in detail the corrective measure alternatives developed in Section 4.0.

5.1.1 Alternative 1 - No Action

This is a "walk-away" alternative retained to provide a baseline for comparing the other alternatives. This alternative does not address the soil and sediment contamination at SWMU 5.

5.1.2 Alternative 2 - Institutional Controls with Monitoring

This alternative consists of only one component, institutional controls. This alternative relies upon land-use controls to eliminate or reduce exposure pathways and monitoring the groundwater, sediment, and surface water. Alternative 2 is based upon the assumption that SWMU 5 would continue to be owned and operated by the NAS. Therefore, the base would be secured as a federal facility with perimeter fencing and continued access restrictions.

Institutional controls would consist of maintaining records of the contamination at SWMU 5 in the NAS Key West Master Plan in accordance with CNBJAXINST 5090.2N4 (U.S. Navy, 1997). Also, monitoring of surface water, sediment, and groundwater would be conducted to determine the need for future actions.

The Master Plan would document the presence of contamination at the site and would ensure that, at the time of future land development, the base would be able to take adequate measures to minimize adverse human health and environmental effects. Any future construction activity at SWMU 5 would have to be conducted in compliance with health and safety requirements that would minimize the potential for contaminants to enter the exposure pathways (incidental ingestion and dermal contact of soils) for construction workers on site.

Educational programs to inform the public concerning site hazards would be conducted through Restoration Advisory Board (RAB) meetings, public workshops, and other community relations activities.

Monitoring samples would be collected quarterly for the first year and annually for the next 9 years from three groundwater, surface water, and sediment sampling locations. The location of these samples are shown on Figure 5-1. One new monitoring well would need to be installed. Samples from each location would be analyzed for inorganic compounds. Quality assurance/quality control (QA/QC) samples would also be collected. If after the first year inorganics are not detected at or above industrial action levels agreed to by the NAS Key West Partnering Team (B&R Environmental, January 1998) in a given medium, that medium will cease to be sampled in subsequent sampling events..

Per the NAS Key West MOA with the U.S. EPA and FDEP (NASKW, 1998), the facility will perform quarterly inspections and make an annual report to U.S. EPA and FDEP verifying the integrity of insitutional controls at the site. The site review is required because this alternative allows contaminants to remain at levels that exceed RGOs.

5.1.3 Alternative 3 - Remove, Treat, and Dispose of Soil from a Hot Spot Above Modified RGOs and Institutional Controls

This alternative consists of three major components: soil removal, transport of contaminated soils for off-site disposal, and institutional controls. The block flow diagram for Alternative 3 is shown in Figure 5-2.

Component 1: Soil Removal

Contaminated soil above modified industrial RGOs would be excavated from the site. The estimated area and volume of soil excavation are based upon contaminant concentrations above modified industrial RGOs. A predesign study would be conducted to verify the extent of contamination, survey original surface elevations, determine any potential wetlands impact, and calculate the area and volume of excavation. Approximately 10 samples for inorganics would be taken prior to excavation as part of the predesign study to delineate the extent of contamination. Included in the samples would be sufficient volume of soil to perform TCLP analysis if the sample results exceed 20 times the TCLP limit for any contaminant. The project team would ensure that federal and state permit requirements are satisfied if it is determined that the boundaries of the excavation impact regulated wetlands or mangrove habitat. The area would be mowed and cleared of any vegetation prior to excavation. Soil would be excavated using conventional construction equipment. Typically, mechanical equipment such as backhoes, bulldozers, and front-end loaders are used for excavation. Excavations would be conducted in accordance with the provisions of a site-specific Health and Safety Plan. It is estimated that 100 cubic yards of soil would require excavation, treatment, and disposal from SWMU 5. During removal, excavated soils would be stockpiled, if necessary, within the limits of the excavation. Confirmation sampling would be conducted to ensure that all contaminated soil is removed.

After the contaminated soils have been excavated, the area would be backfilled with clean material from off site and regraded to achieve desired drainage patterns. The final grade would meet the original elevations measured during the initial excavation area survey. The excavation would be backfilled with crushed stone or graded sand to an elevation 6 inches below final grade.

The vegetative layer of topsoil would be retained by covering the site with erosion control blankets. These temporary controls would be implemented until revegetation by recolonization is established.

Component 2: Transport of Contaminated Soil for Off-Site Treatment and Disposal

All stockpiled soil would be loaded into suitable containers for transportation to an approved TSDF with the capability to handle metal-contaminated soil. Potential technologies include stabilization/ solidification and landfill. The treatment process, if required, would convert hazardous contaminants to nonhazardous or less toxic compounds that are more stable, less mobile, and/or inert. The treated soil would then be placed in a RCRA-permitted landfill for final disposal. The transport of the contaminated soil must comply with the state and federal requirements for transportation of hazardous waste.

Component 3: Institutional Controls

Institutional controls would consist of maintaining records of the contamination at SWMU 5 in the NAS Key West Master Plan in accordance with CNBJAXINST 5090.2N4 (U.S. Navy, 1997). Also, monitoring of surface water, sediment, and groundwater (as shown on Figure 5-1) would be conducted to assess the effectiveness of the IRA and determine if there is a need for future actions. Additionally, this alternative includes posting warning signs around SWMU 5 to minimize human exposure to contaminated media.

The Master Plan documents the presence of contamination at the site and would ensure that, at the time of future land development, the base would be able to take adequate measures to minimize adverse human health and environmental effects. Any future construction activity at SWMU 5 must be conducted in compliance with health and safety requirements that would minimize the potential for contaminants to enter the exposure pathways (incidental ingestion and dermal contact of soils) for construction workers on site. Educational programs to inform the public concerning site hazards would be conducted through RAB meetings, public workshops, and other community relations activities.

Monitoring samples would be collected quarterly for the first year and annually for the next 9 years from three groundwater, surface water, and sediment sampling locations. One new monitoring well would be installed. Samples from each location would be analyzed for inorganic compounds. QA/QC samples would also be taken. If after the first year inorganics are not detected in a given medium, that medium will cease to be sampled in subsequent sampling events.

Per the NAS Key West MOA with the U.S. EPA and FDEP (NASKW, 1998), the facility will perform quarterly inspections and make an annual report to U.S. EPA and FDEP verifying the integrity of insitutional controls at the site.

5.2 EVALUATION STANDARDS

The corrective measure alternatives were evaluated in accordance with the Guidance for RCRA Corrective Action Plan (OSWER Directive 9902.3-2A, U.S. EPA May, 1994). This section describes the specific standards to be used in evaluating each of the corrective measure alternatives. The five standards are as follows:

- Protection of human health and the environment
- Media clean-up standards
- Source control
- Waste management standards
- Other factors
  - Long-term reliability and effectiveness
  - Reduction in toxicity, mobility, or volume
  - Short-term effectiveness
  - Implementability
  - Cost

5.2.1 Protection of Human Health and the Environment

The protection of human health and the environment provides an overall evaluation of the remedies that would be appropriate for SWMU 5. This standard considers the extent to which the corrective measure alternative mitigates potential short- and long-term potential exposure to residual contamination and how the remedy protects human health and the environment both during and after implementation of the alternative. In addition, the levels and characterization of contaminants remaining on site, potential exposure pathways, potentially affected populations, the level of exposure to contaminants, and the associated reduction of exposure over time are considered. For management of mitigation measures, the relative reduction of environmental impact for each alternative is determined by comparing residual levels for each alternative with the existing criteria, standards, and guidelines. The ecological considerations for this evaluation standard included potential short- and long-term beneficial and adverse effects of the corrective measure, adverse effects on environmentally sensitive areas, and an analysis on how to mitigate adverse effects.

5.2.2 Media Clean-Up Standards

The media clean-up standard considers whether the corrective measure alternative would achieve the defined CAOs. In addition, this standard includes an assessment of relevant institutional needs for each corrective measure alternative. The effects of federal, state, and local environmental and public standards, regulations, guidance, advisories, ordinances, or community relations on the design, operation, and timing of each alternative are considered.

5.2.3 Source Control

The source control standard evaluates how the corrective measure alternative addresses the source of the release in order to reduce or eliminate, to the extent practicable, further releases that may pose a threat to human health and the environment. This criterion addresses whether source control measures are necessary and what type of source control actions would be appropriate. In addition, any source control measure proposed should include a discussion on how well the method is expected to work given the site situation and previous experiences of the specific technology.

5.2.4 Waste Management Standards

The corrective measure alternative must comply with applicable standards for the management of wastes. This includes a description of how the specific waste management activities would be conducted in order to maintain compliance with all applicable state and federal regulations.

5.2.5 Other Factors

In addition to the first four standards, there are five general factors that are to be addressed as part of the evaluation of corrective measure alternatives. The five general decision factors to be considered under this standard are:

- Long-term reliability and effectiveness
- Reduction in toxicity, mobility, or volume
- Short-term effectiveness
- Implementability
- Cost

5.2.5.1 Long-Term Reliability and Effectiveness

Evaluation of the long-term reliability and effectiveness of the alternatives must consider the corrective measure alternatives performance. Performance considerations include the effectiveness and useful life of the corrective measure. The reliability of a corrective measure includes the operation and maintenance requirements and demonstrated reliability.

5.2.5.2 Reduction in Toxicity, Mobility, or Volume

This factor includes the ability of the corrective measure to reduce the toxicity, mobility, or volume of the contaminants or media through treatment.

5.2.5.3 Short-Term Effectiveness

This factor includes an evaluation of the corrective measure effectiveness in the short-term (less than 6 months), in comparison to the long-term effectiveness, and in particular potential risks to human health and the environment during implementation.

5.2.5.4 Implementability

This factor includes the relative ease of installation (constructability) and the time required to achieve a given level of response.

5.2.5.5 Cost

A cost estimate of the corrective measure includes both estimated capital and operation and maintenance costs. Capitals costs include both direct and indirect costs. Operation and maintenance costs are post-construction activities that may be necessary to ensure the continued effectiveness of a corrective measure.

5.3 EVALUATION OF ALTERNATIVES

This section presents the results evaluation conducted for each corrective measure alternative based on the standards described in Section 5.2.

5.3.1 Alternative 1 - No Action

5.3.1.1 Protection of Human Health and the Environment

Alternative 1 is considered primarily for comparative purposes to the other corrective measures. This alternative would not be protective of human health or the environment. Contaminants would remain in the soil, sediment, and surface water, and potential human exposure through intake routes would continue to exist. Human health risk would remain low as long as the site remains in its current use but would significantly increase in the case of residential development.

Based upon the ERA conducted as part of the RI/RFI process, it appears that existing contaminants at SWMU 5 do not pose significant potential risks to ecological receptors.

5.3.1.2 Media Clean-Up Standards

Alternative 1 would not comply with the media clean-up standards for soil, sediment, or surface water under either the industrial use criteria or the more stringent RGOs (residential and ecological).

5.3.1.3 Source Control

The source of the contamination, sandblasting activities at the site from the early 1970s until 1995, has been eliminated. Alternative 1 would involve no source control because no action would be performed at SWMU 5.

5.3.1.4 Waste Management Standards

There would be no actions to be implemented for Alternative 1 and, therefore, no waste would be generated.

5.3.1.5 Other Factors

Long-Term Reliability and Effectiveness

The current threat to human health would remain since there would be no access controls, removal or treatment of the contaminants. Unless any decrease occurred through natural attenuation, inorganic contaminant concentration would remain in the soil at SWMU 5 at levels greater than the media clean-up standards.

Based on the 1993 and 1996 data, antimony, cyanide, lead and mercury exceed their MCLs in groundwater. All but one of the exceedances were at one monitoring well (S5MW-2). The lead exceedance was at S5MW-3 in 1993 and was not detected in 1996. Modeling indicates that the time necessary for cyanide to attenuate from its current groundwater concentration (230 μg/L) to its MCL (200 μg/L) is 1.4 years. The modeling for antimony, lead, and mercury indicates that the time necessary for these chemicals to attenuate from their current groundwater concentrations (31.8, 24.7, and 4.7 μg/L) to their MCLs (6,15, and 2 μg/L) is over thirty years. The estimates are based on the fate and transport model and includes all natural processes such as dilution due to infiltration and upgradient water, dispersion, and sorption. The details of this modeling are presented in Appendix B.

Additionally, cadmium (12.6 mg/kg at S5SB-2) and methylene chloride (20μg/kg at S5SB-2) were detected in excess of soil to groundwater leaching criteria. Modeling of the predicted soil washout indicated that the time necessary for methylene chloride to attenuate to its MCL is 2 years. Modeling of the predicted soil washout indicated that the time necessary for cadmium to attenuate to its MCL is over thirty years.

There are no long-term management controls for SWMU 5 under this alternative. Therefore, the adequacy and reliability of controls are not applicable. Also, there would be no long-term monitoring programs to assess the migration of contaminants from the site.

Reduction in Toxicity, Mobility, and Volume

Alternative 1 would not reduce toxicity, mobility, or volume of the contaminants at SWMU 5 other than that which would result from natural dispersion, dilution, or other attenuating factors. There would be no treatment processes employed, and therefore no materials would be treated or destroyed.

Short-term Effectiveness

Alternative 1 would involve no action and, therefore, would not pose any risks to on-site workers during implementation and no environmental impacts would be expected. This alternative would not achieve any of the CAOs.

Implementability

Since no actions would occur, this alternative would be readily implementable. The technical feasibility criteria, including constructability, operability, and reliability, are not applicable.

Cost Analysis

There would be no costs associated with the no action alternative.

5.3.2 Alternative 2 - Institutional Controls with Monitoring

5.3.2.1 Protection of Human Health and the Environment

Alternative 2 would be partially protective of human health by restricting site access and land use within and around SWMU 5. Based upon the ERA conducted as part of the RI/RFI process, existing contaminants at SWMU 5 do not pose significant potential risks to ecological receptors.

For this alternative, a number of security measures would be employed. From an HHRA perspective, these actions would reduce but not prevent exposure to the site contaminants. No residential development or excavation would be allowed at the site. Trespassers would be actively discouraged from entering the site. Workers and trespassing adults would be expected to make an effort to avoid ingestion or skin contact with the media because there would be signs posted to warn trespassers of the potential danger from exposure. Workers would be required to use personal protective equipment (PPE). HHRA calculations are in Appendix A.

The ICR from site contaminants for occupational workers is less than 1E-06 under the institutional controls alternative. Most of the risk arises from dermal contact with surface soil. The calculated ICR for occupational workers is 1.1E-07. The ICRs from site contaminants for both adult and adolescent trespassers are also less than 1.0E-04 but would still slightly exceed 1.0E-06 under the institutional controls alternative. Most of the risk arises from dermal contact with surface soil and sediment. The calculated values for these pathways ranged from 2.7E-06 (by adolescents) to 3.2E-06 (by adults). These risks are primarily attributed to arsenic which is present in soil and sediment at concentrations within a slightly greater than background concentration. There were no HIs (non-cancer risk values) greater than 0.1 when calculated under Alternative 2 conditions.

Sampling of groundwater, sediment, and surface water would be included to monitor potential soil contamination migration to the surface water and sediment. Periodic review of the site would be necessary to ensure that contaminant concentrations are not increasing and to determine whether additional measures would be necessary to protect human health and the environment.

5.3.2.2 Media Clean-Up Standards

Alternative 2 would not comply with the media clean-up standards for soil or sediment under either the industrial use criteria or the ARAR/SAL criteria. It would, however, include long-term monitoring to determine whether contaminant concentrations are increasing. Institutional controls would be used to prevent exposure to media with contaminant concentrations above clean-up standards.

5.3.2.3 Source Control

The source of the contamination, sandblasting activities at the site from the early 1970s until 1995, has been eliminated. Alternative 2 would not involve source control because only institutional controls would be implemented.

5.3.2.4 Waste Management Standards

Alternative 2 would involve no removal of contaminated soil or sediment and, therefore, this alternative would not generate any wastes.

5.3.2.5 Other Factors

Long-Term Reliability and Effectiveness

Although no removal would occur in Alternative 2, the current threat to human health would be reduced. This alternative would use institutional controls such as the NAS Key West Master Plan to restrict future use of the site [in accordance with CNBJAXINST 5090.2N4 (U.S. Navy, 1997)]. Therefore, use of the soil or the surficial aquifer groundwater beneath the site could be restricted by prohibiting future development of SWMU 5.

Based on the 1993 and 1996 data, antimony, cyanide, lead and mercury exceed their MCLs in groundwater. All but one of the exceedances were at one monitoring well (S5MW-2). The lead exceedance was at

S5MW-3 in 1993 and was not detected in 1996. Modeling indicates that the time necessary for cyanide to attenuate from its current groundwater concentration (230 µg/L) to its MCL (200 µg/L) is 1.4 years. The modeling for antimony, lead, and mercury indicates that the time necessary for these chemicals to attenuate from their current groundwater concentrations (31.8, 24.7, and 4.7 µg/L) to their MCLs (6,15, and 2 µg/L) is over thirty years. The estimates are based on the fate and transport model and includes all natural processes such as dilution due to infiltration and upgradient water, dispersion, and sorption. The details of this modeling are presented in Appendix B.

Additionally, cadmium (12.6 mg/kg at S5SB-2) and methylene chloride (20µg/kg at S5SB-2) were detected in excess of soil to groundwater leaching criteria. Modeling of the predicted soil washout indicated that the time necessary for methylene chloride to attenuate to its MCL is 2 years. Modeling of the predicted soil washout indicated that the time necessary for cadmium to attenuate to its MCL is over thirty years.

Institutional controls have uncertain long-term effectiveness. The protection of the construction worker and the recreational user in the long term would depend on effective administration and management of the Master Plan. Per the NAS Key West MOA with the U.S. EPA and FDEP (NASKW, 1998), the facility will perform quarterly inspections and make an annual report to U.S. EPA and FDEP verifying the integrity of insitutional controls at the site.

Reduction in Toxicity, Mobility, and Volume

Alternative 2 would not result in reduction in toxicity, mobility, or volume through treatment of the hazardous substances at SWMU 5 other than that which would result from natural dispersion, dilution, or other attenuating factors.

Short-Term Effectiveness

Alternative 2 would involve surface water and sediment monitoring, administration of institutional controls, and potential restriction of residential land use. The short-term risks associated with this alternative would be minimal. Sampling personnel would wear the required personal protective equipment (PPE) and receive the appropriate health and safety training. There would be no potential risk to the community or environmental impacts upon the implementation of institutional controls.

Implementability

Alternative 2 would be readily implementable since SWMU 5 is located within a military facility, where rules and local ordinances can be strictly enforced. Restrictions for future residential property use would involve legal assistance and regulatory approval. Provisions in the NAS Key West Master Plan would be defined and enforced relatively easily because the site is located within a federal facility. Sampling and analysis are also readily implemented.

Cost Analysis

The following costs are estimated for Alternative 2.

Capital Costs: $4,500
O&M Costs: $ 9,800/yr. - $39,200/yr.
Present-Worth: $125,000 estimated over 10 years.

Detailed cost estimates are included in Appendix C. To date, the Navy has spent approximately 7.9 million dollars on IRAs at nine sites/SWMUs/Areas of Concern.

5.3.3 Alternative 3 - Remove, Treat, and Dispose of Soil from a Hot Spot above Modified Industrial RGOs and Institutional Controls

5.3.3.1 Protection of Human Health and the Environment

Alternative 3 would be protective of human health and the environment. This alternative would remove the most contaminated soils remaining at the site (soil with concentrations in excess of modified industrial RGOs). Confirmation samples would be collected from the perimeter of the excavation to ensure that the soil with contaminant concentrations greater than modified RGOs from SWMU 5 are removed.

The ICRs from site contaminants for both adult and adolescent trespassers and occupational workers would be less than 1.0E-06 under this alternative. The calculated values for these pathways range from 2.2E-07 (by adult trespasser) to 7.8E-09 (by occupational workers). There would be no HIs (non-cancer risk values) greater than 0.1 when calculated under Alternative 3 conditions.

The potential for human exposure to contaminated soil would be significantly reduced through implementation of this alternative. The environmental impact of the future migration of remaining soil inorganic contamination to the surface water and sediment would be monitored with quarterly (for the first year) and annual (for the next 9 years) sampling of the sediment, surface water, and groundwater for a minimum of 5 years. Every year, the sampling results would be reviewed to determine if further monitoring would be required.

5.3.3.2 Media Clean-Up Standards

Alternative 3 would achieve modified industrial RGOs for soil through removal of the contaminated soil from SWMU 5. Samples would be collected from the soil remaining after removal to confirm that they met clean-up standards. The contaminated soil would be treated, if required, prior to disposal to comply with LDRs and the TSDF permit. The treatment process would be selected to convert the hazardous contaminants to nonhazardous or less toxic compounds, allowing the soil to meet applicable LDRs. Sediment and surface water sampling would be conducted to assess the decrease of contaminant concentrations in the environment.

5.3.3.3 Source Control

The source of the contamination, sandblasting activities at the site from the early 1970s until 1995, has been eliminated. This alternative would excavate approximately 100 cubic yards of soil, that in excess of modified RGOs, from one hot-spot location. This action would reduce the potential for further releases that could pose a threat to human health.

5.3.3.4 Waste Management Standards

During implementation of Alternative 3, waste management practices would be used to control stormwater runoff from spreading contamination. Contaminated soil would be excavated and stockpiled, if necessary, within the limits of the excavation. The excavated soil would be loaded into suitable containers for transportation to a RCRA-permitted TSDF. If treatment is required, the excavated soil and sediment would be transported to an appropriate facility to convert the hazardous contaminants to nonhazardous or less toxic compounds. The treated soil, which would meet LDRs and the TSDF permit, would then be placed in a RCRA-permitted landfill for final disposal.

Equipment used on site may come in contact with potentially hazardous chemicals (contaminated media). The equipment would be decontaminated prior to leaving site. Decontamination water would be collected, sampled, and if required, properly treated and disposed. Any treatment residuals from implementation of this alternative would be sampled and properly disposed.

5.3.3.5 Other Factors

Long-Term Reliability and Effectiveness

Alternative 3 would provide for long-term effectiveness since excavation can be very effective at removing the most contaminated soil. Sediment and surface water sampling would be conducted to assess the decrease of contaminant concentrations in the environment.

Based on the 1993 and 1996 data, antimony, cyanide, lead and mercury exceed their MCLs in groundwater. All but one of the exceedances were at one monitoring well (S5MW-2). The lead exceedance was at S5MW-3 in 1993 and was not detected in 1996. Modeling indicates that the time necessary for cyanide to attenuate from its current groundwater concentration (230 µg/L) to its MCL (200 µg/L) is 1.4 years. The modeling for antimony, lead, and mercury indicates that the time necessary for these chemicals to attenuate from their current groundwater concentrations (31.8, 24.7, and 4.7 µg/L) to their MCLs (6,15, and 2 µg/L) is over thirty years. The estimates are based on the fate and transport model and includes all natural processes such as dilution due to infiltration and upgradient water, dispersion, and sorption. The details of this modeling are presented in Appendix B.

Additionally, cadmium (12.6 mg/kg at S5SB-2) and methylene chloride (20µg/kg at S5SB-2) were detected in excess of FDEP soil to groundwater leaching criteria (FDEP, 1995). Modeling of the predicted soil washout indicated that the time necessary for methylene chloride to attenuate to its MCL is 2 years. Modeling of the predicted soil washout indicated that the time necessary for cadmium to attenuate to its MCL is over thirty years.

The effectiveness of this alternative would be monitored through confirmation sampling after removal. The effectiveness of the soil treatment, if required, would be confirmed by sampling and testing before the material is placed in a RCRA-permitted landfill. During excavation, PPE would be used and monitoring would be conducted to ensure that exposure of the workers to potentially contaminated material is minimized.

Reduction in Toxicity, Mobility, and Volume

Alternative 3 may utilize treatment of the contaminated soil to reduce the toxicity, mobility, and volume of the waste. If performed, treatment would provide for a reduction in the mobility of the contaminants at SWMU 5. The contaminated soil/sediment would be transported off site to a RCRA-permitted TSDF. After treatment, soil/sediment would be placed in a RCRA-permitted landfill at the facility. The treatment process converts hazardous contaminants to nonhazardous or less toxic compounds that are more stable, less mobile, and/or inert. The potential treatment process is stabilization/solidification.

Short-term Effectiveness

Based on the relatively low concentration of contaminants, the short-term effectiveness for Alternative 3 would be moderate. Site workers would receive the appropriate health and safety training and would wear the required PPE during implementation. The only potential risk to the community would be during transport of the contaminated materials off site for treatment and disposal. There are potential environmental impacts from the implementation of this alternative, since some excavation of wetlands and mangrove areas could occur. After implementation, these areas would be re-established to natural conditions. The potential human exposure to contaminated soil and sediment would be reduced through implementation of this alternative.

Implementability

Alternative 3 is considered to be implementable. Excavation contractors and equipment are readily available for soil and sediment removal. The remedial technologies are well proven and established in the remediation and construction industries. Additional removal of materials, if indicated by confirmation sampling, would require supplemental excavation during the site work. TSDFs are available for treatment of soil contaminated with metals. Sampling and analysis are also readily implementable.

Cost Analysis

The following costs are estimated for Alternative 3.

Capital Costs: $112,000
O&M Costs: $9,800/yr. to $39,200/yr.
Present-Worth: $233,000 estimated over 10 years.

These costs are based on the current hot spot soil result which could not exceed TCLP standards. However, if during the predesign study sample results indicate that TCLP standards are exceeded then the capital costs for soil disposal would increase significantly.

Detailed cost estimates are included in Appendix C. To date, the Navy has spent approximately 7.9 million dollars on IRAs at nine sites/SWMUs/Areas of Concern.

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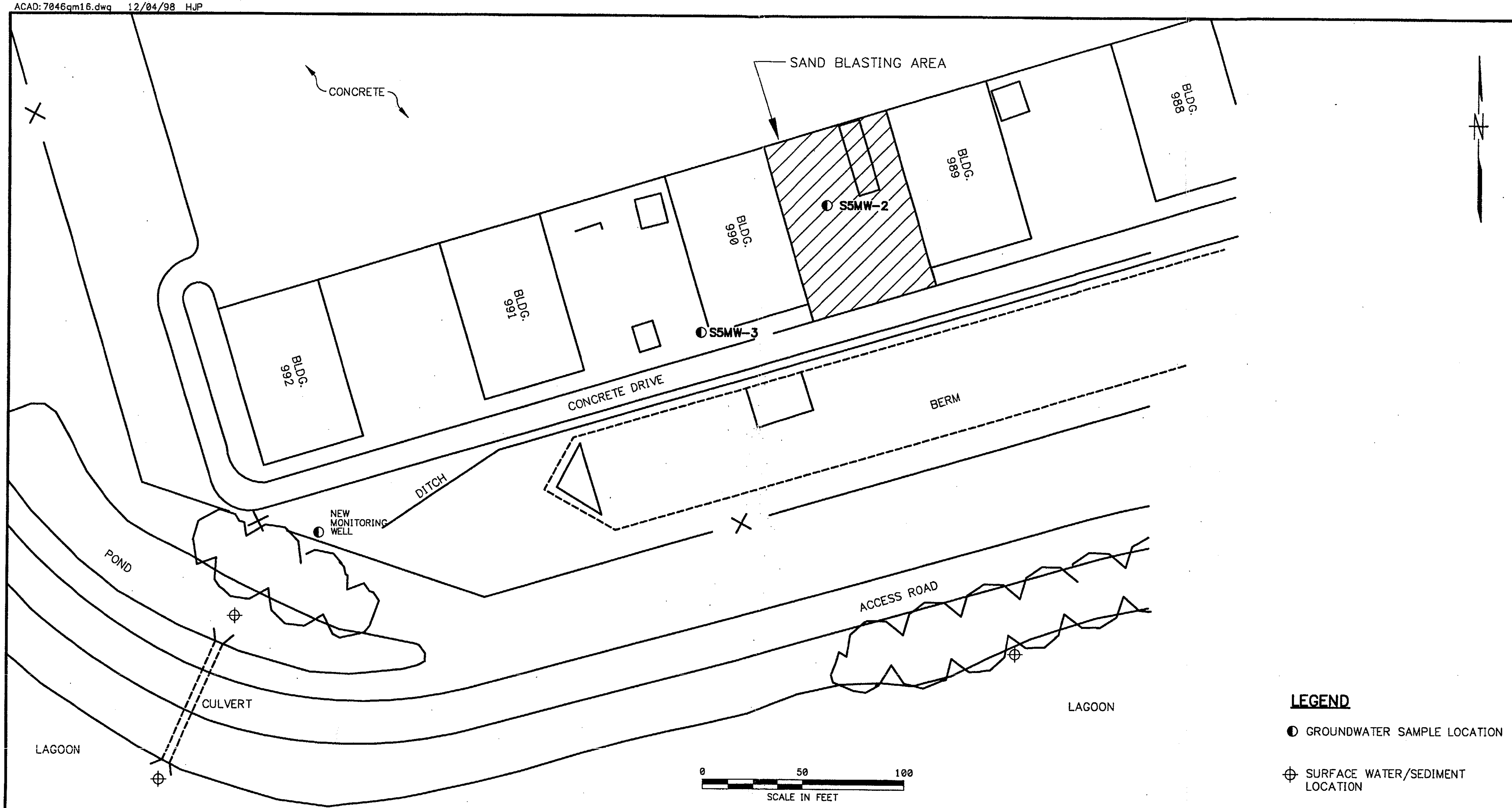

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJP DATE 12/4/98
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

DEPARTMENT OF THE NAVY · SOUTHERN DIV FACILITIES ENGINEERING COMMAND

ALTERNATIVE 2–INSTITUTIONAL CONTROLS WITH MONITORING
SWMU 5
NAVAL AIR STATION
KEY WEST, FLORIDA

CONTRACT NO. 7046
APPROVED BY DATE
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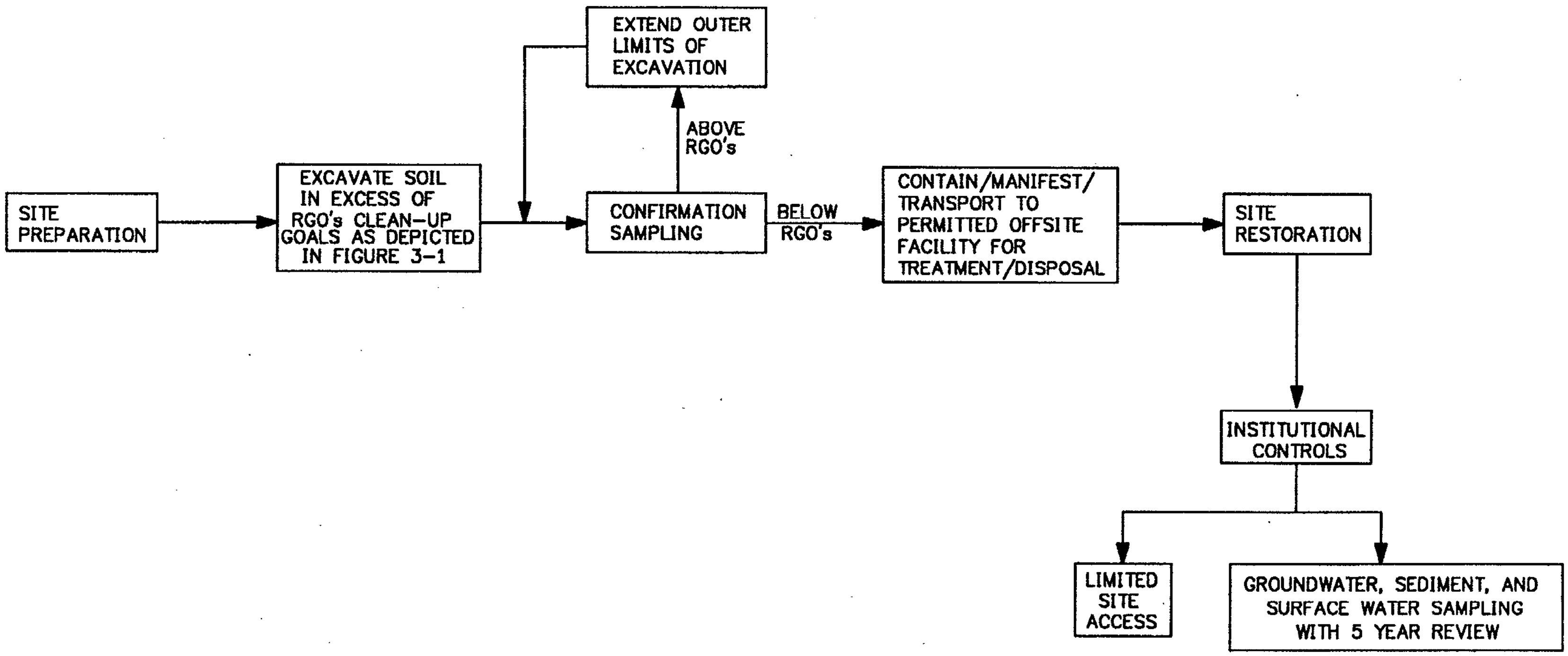
DRAWING NO. FIGURE 5–1 REV. 0

FORM CADD NO. SDIV_BH.DWG – REV 0 – 1/20/98



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BLOCK FLOW DIAGRAM
SWMU 5, ALTERNATIVE 3
NAVAL AIR STATION KEY WEST
BOCA CHICA KEY, FLORIDA

CONTRACT NO. 7046	
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6.0 RECOMMENDATION OF THE FINAL CORRECTIVE MEASURE

6.1 INTRODUCTION

This section presents a comparison of the corrective measure alternatives in Section 5.0 for each evaluation standard. The standards for comparison are identical to those used for the detailed analysis of individual alternatives.

The following corrective measure alternatives are being compared in this section:

- Alternative 1 - No Action
- Alternative 2 - Institutional Controls with Monitoring
- Alternative 3 - Remove, Treat, and Dispose of Soil from a Hot Spot above Modified Industrial RGOs; Institutional Controls.

6.2 COMPARATIVE ANALYSIS OF ALTERNATIVES

A corrective measure alternative is selected based on a comparison between the alternatives using the standards presented in the detailed analysis in Section 5.0. This section presents a comparative discussion of the corrective measure alternatives versus the evaluation standard.

6.2.1 <u>Protection of Human Health and the Environment</u>

The cumulative risks from all the corrective measure alternatives are less than 1.0E-4 for ICR and 1.0 for non-carcinogenic risk (see Appendix A). Based on the risk estimates, there would be a progressive reduction of risks as corrective measures become more aggressive. The ICR for a trespassing adult is 8.6E-06 for Alternative 1 and would be reduced to 3.2E-06 for Alternative 2, and 2.2E-07 for Alternative 3. For the adolescent trespasser, the ICR values are 8.2E-06, 2.7E-06, and 1.9E-07, respectively. For the occupational workers, the ICR values are 2.8E-05, 1.1E-07, and 7.8E-09, respectively. As summarized in Appendix A, Table A-8, non-carcinogenic risk values for trespassers in Alternative 1 are 1.3E-01 and 2.2E-01 for adults and adolescents, respectively. Risk levels are reduced to 2.6E-02 and 3.8E-02 for adults and adolescent trespassers, respectively, for Alternative 2 and 1.8E-03 and 2.6E-03 for Alternative 3. As noted previously, risks for workers were relatively low and somewhat less affected by the controls. The only non-carcinogenic risk above 0.1 for workers is for the occupational workers at 2.0E-01 for Alternative 1.

Soil contaminants at the site do not appear to pose significant potential risks to terrestrial plant and animal receptors. Alternatives 2 and 3 would incorporate a monitoring program consisting of periodic tests of groundwater, surface water, and sediment.

- Alternative 1 would not change the current potential risks to human health or the environment, but could result in significantly increased human health risks under a possible residential scenario.

- Alternative 2 would reduce the risk to human health but would not reduce the risk to the environment. This alternative would monitor the site.

- Alternative 3 would reduce the risk to human health and the environment from contaminants present in soil. This alternative would remove the contaminated soil with concentrations in excess of modified industrial RGOs to meet the media clean-up standards.

6.2.2 Media Clean-Up Standards

This standard considers whether the corrective measure alternative will achieve the media clean-up standards. In addition, this standard includes an assessment of relevant institutional needs for each corrective measure alternative. The effects of federal, state of Florida, and local environmental regulations are also considered.

- Alternatives 1 and 2 would not comply with the media clean-up standards. However, Alternative 2 would monitor the groundwater, sediment, and surface water contaminant levels to assess the level of site contaminants over time.

- Alternative 3 would comply with the modified industrial RGOs for soils but would not comply with all the media clean-up standards for soils. This alternative would monitor the potential for soil contamination to migrate and adversely impact the groundwater, sediment, and surface water.

6.2.3 Source Control

This standard evaluates the corrective measure alternatives for control of the source of contamination so as to reduce or eliminate further releases that may pose a threat to human health and the environment to the furthest extent possible. This standard addresses whether source control measures are necessary and what type of source control actions would be appropriate.

- Alternatives 1 and 2 would not include source control measures. However, the site source, sandblasting activities, was stopped in 1995. Also, Alternative 2 would monitor the groundwater, sediment, and surface water for changes in contaminant levels.

- Alternative 3 would include partial source control measures for the soil. Removal and treatment of the soil above modified industrial RGOs would provide for control of the most contaminated portion of the soil.

6.2.4 Waste Management Standards

The corrective measure alternative must comply with applicable standards for the management of wastes. This standard includes a description of how the specific waste management activities will be conducted in order to maintain compliance with all applicable state and federal regulations.

- Alternatives 1 and 2 would not include removal of any waste materials and, therefore, the standards for management of waste material do not apply.

- Alternative 3 would include the removal and disposal of the soil contaminated at concentrations greater than the modified industrial RGOs. Removal of the soil would be conducted in accordance with RCRA (40 CFR 262, 263, 264, and 268) and state of Florida (Chapter 62-730 F.A.C.) regulatory requirements, as well as equivalent requirements for the state in which the TSDF is located. Since contaminant concentrations may exceed the LDRs, an approved TSDF would be utilized for receipt of the contaminated soil. In addition, a licensed waste hauler would be used for transportation of the containerized waste materials to the permitted TSDF. All applicable RCRA and state of Florida waste management requirements would be adhered to in the containerization, labeling, and manifesting of site waste materials.

6.2.5 Long-Term Reliability and Effectiveness

Evaluation of long-term reliability and effectiveness of the corrective measure alternatives includes an assessment of useful life, operation and maintenance requirements, and demonstrated reliability.

- Alternative 1 would allow the human health risks to remain and possibly increase to a significant degree in the long term if residential development occurs.

- Alternative 2 would allow the residual risk to remain and would monitor the site. Alternative 2 provides for institutional controls, which would be considered relatively reliable and protective of human health in the long term when properly implemented. However, this alternative would monitor the long-term effects of residual contamination on the environment.

- Alternative 3 would remove contaminated soil. It should be relatively protective in the long term of human health but some risks may remain. This alternative would monitor the long-term effects of the soil and sediment removal on the environment.

6.2.6 Reduction in the Toxicity, Mobility, or Volume of Wastes Through Treatment

This standard includes the ability of the corrective measure to reduce the toxicity, mobility, or volume of the contaminated media through treatment.

- Alternatives 1 and 2 do not include treatment; therefore, no reduction in the toxicity, mobility, or volume would be achieved.

- Alternative 3 may include treatment of the soil, if required. Any treatment technologies used would provide for a reduction in the mobility of contaminants in the soil.

6.2.7 Short-Term Effectiveness

This standard includes an evaluation of the potential effects to the workers and community during implementation of the corrective measure. This standard is not applicable to Alternative 1- No Action.

- No significant risks to the community are anticipated for the three alternatives, other than the minimal risk associated with transportation of the contaminated media through the community and during off-site treatment and disposal under Alternative 3.

- Alternative 2 would only have minimal short-term risk to workers during sampling activities. Monitoring would continue until results adequately demonstrate to U.S. EPA and FDEP that protection of off-site residents and the environment is achieved.

- Alternative 3 would have some short-term risk to workers because of the removal and treatment of the contaminated soil. However, the risk to workers would be incrementally higher than Alternative 2, and would be properly controlled by adherence to appropriate Health and Safety procedures, including the wearing of PPE. The time needed to complete the soil removal and treatment action is estimated to be less than 1 year; however, the time needed to complete the monitoring portion of the institutional controls is dependent on approval of the U.S. EPA and FDEP.

6.2.8 Implementability

This standard includes consideration of the relative ease of implementation, availability of equipment and services, the technical complexity of the process, and the ability to obtain required permits. The time needed to complete each corrective measure alternative is also provided.

- This standard is not applicable to Alternative 1, since no remedial action would be implemented.

- Alternative 2 would involve institutional controls and is considered to be readily implementable. It is assumed controls infer administrative access restrictions and will require enforcement to maintain human health protection. Monitoring would continue until results adequately demonstrate to U.S. EPA and FDEP that protection of off-site residents and the environment is achieved.

- Alternative 3 would include the removal of the most contaminated soil. The removal of the contaminated soil is considered to be readily implementable because of the use of proven and commercially available technologies. Likewise, the institutional controls component for groundwater, sediment, and surface water are considered to be implementable. It is assumed administrative access restrictions would require enforcement to maintain human health protection. The time needed to complete the removal and treatment of contaminated soil is estimated to be less than 1 year. The time needed to complete the monitoring component of this alternative would be dependent on the approval of U.S. EPA and FEDP.

6.2.9 Cost

A cost estimate of each of the corrective measures includes both capital, operation, and maintenance costs. Capital costs include both direct and indirect costs. Operation and maintenance costs are post-construction activities that are necessary to ensure the continued effectiveness of a corrective measure.

Alternative	Capital ($)	Operating ($/year.)	Present Worth ($)
1	0	0	0
2	4,500	9,800-39,200	125,000
3	112,000	9,800-39,200	233,000

6.3 SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

Table 6-1 provides a table summarizing the comparative analysis of the corrective measure alternatives for the three alternatives, based on the results of the evaluation presented in Section 6.2.

6.4 RECOMMENDED CORRECTIVE MEASURE ALTERNATIVE

The recommended alternative for this site is Alternative 2 – Institutional Controls with Monitoring. Under this alternative, groundwater, sediment, and surface water would be sampled and analyzed at a frequency yet-to-be determined by the NAS Key West Partnering Team. Further, exposure to soil in the adjacent berm would be managed by implementing appropriate access restrictions to affected soil in said berm. The institutional control alternative is further described below.

By separate MOA with the U.S. EPA and the FDEP, NAS Key West, on behalf of the Department of the Navy, agreed to implement periodic site inspection, condition certification, and agency notification procedures designed to ensure the maintenance by Station personnel of any site-specific land-use controls (LUC) deemed necessary for future protection of human health and the environment. A fundamental premise underlying execution of that agreement was that through the Navy's substantial good-faith compliance with the procedures called for therein, reasonable assurances would be provided to the U.S. EPA and FDEP as to the permanency of those remedies, which included the use of specific LUCs.

Although the terms and conditions of the MOA are not specifically incorporated herein by reference, it is understood and agreed by the Navy, U.S. EPA, and FDEP that the contemplated permanence of the remedy reflected herein shall be dependent on the Station's substantial good-faith compliance with the specific LUC maintenance commitments reflected therein. Should such compliance not occur or should the MOA be terminated, it is understood that the protectiveness of the remedy concurred in may be reconsidered and that additional measures may need to be taken to adequately ensure necessary future protection of human health and the environment.

The proposed alternative, Institutional Controls with Monitoring, is protective of human health and the environment under current industrial land use, complies with State and Federal ARARs, and is cost effective.

TABLE 6-1

SUMMARY OF COMPARATIVE ANALYSIS OF CORRECTIVE MEASURE ALTERNATIVES
SWMU 5 CMS REPORT
NAVAL AIR STATION KEY WEST
BOCA CHICA KEY, FLORIDA
PAGE 1 OF 2

Alternative 1: No Action	Alternative 2: Institutional Controls with Monitoring	Alternative 3: Remove, Treat, and Dispose of Soil from a Hot Spot Above Modified Industrial RGOs; Institutional Controls
Protection of Human Health and the Environment		
Would not be protective of human health. Would not monitor the risks to the environment. Risk could increase in the case of residential development.	Would be protective of human health and would monitor the extent of contamination in the environment.	Would be protective of human health by removing contaminated soil.
Media Clean-up Standards		
Would not comply with media clean-up standards.	Same as Alternative 1.	Would achieve modified industrial soil RGOs. Would not achieve other media clean-up standards.
Source Control		
No new source control would be implemented.	Same as Alternative 1.	The contaminated soil in excess of the modified industrial RGOs would be removed, treated as required, and disposed off site.
Waste Management Standards		
No standards applicable because no waste will be generated.	Same as Alternative 1.	Would comply with all applicable waste management standards during implementation.
Long-Term Reliability and Effectiveness		
No controls would be in place; residual contamination and existing risks would remain	Limited site access would provide control. The site contamination would be measured with long-term monitoring with 5-year reviews to determine need for further action.	Long-term effectiveness of this alternative, which removes some of the primary source, is easily measured with long-term monitoring to assess the decrease of contamination concentrations in the environment.
Reduction in Toxicity, Mobility, or Volume through Treatment		
Would involve no treatment to reduce toxicity, mobility, or volume of the contaminated media.	Same as Alternative 1.	This alternative involves possible treatment of soil. This treatment would reduce contaminant mobility and, to a lessor extent, toxicity. Waste volume would be increased.

TABLE 6-1

SUMMARY OF COMPARATIVE ANALYSIS OF CORRECTIVE MEASURE ALTERNATIVES
SWMU 5 CMS REPORT
NAVAL AIR STATION KEY WEST
BOCA CHICA KEY, FLORIDA
PAGE 2 OF 2

Alternative 1: No Action	Alternative 2: Institutional Controls with Monitoring	Alternative 3: Remove, Treat, and Dispose of Soil from a Hot Spot Above Modified Industrial RGOs; Institutional Controls
Short-Term Effectiveness		
Would not reduce risk of exposure to contamination and would not pose any new risk during implementation.	Would reduce risk of exposure through institutional controls and would pose only minimal risk during long-term monitoring.	There would be some manageable short-term risks during the removal, treatment, and disposal of contaminated soil. Community risk would only be during transport, treatment, and disposal of the contaminated media.
Implementability		
Readily implementable since no action would occur.	Easily implementable because site is located within an active military base where rules can be strictly enforced.	No difficulties are anticipated. Excavation contractors are readily available and the remediation technologies are well proven.
Cost (Total Present Worth)		
$0.00	$125,000	$233,000

Alternative 1 - No Action
Alternative 2 - Institutional Controls with Monitoring
Alternative 3 - Remove, Treat, and Dispose of Soil from a Hot Spot above Modified Industrial RGOs; Institutional Controls

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APPENDIX A

HUMAN HEALTH RISK ASSESSMENT CALCULATIONS
SWMU 5

TABLE OF CONTENTS

SECTION **PAGE**

TABLES

NUMBER **PAGE**

A.1 HUMAN HEALTH RISKS ASSESSMENT CALCULATIONS

A.1.1 REMEDIAL GOAL OPTIONS (RGOS)

As stated in Section 3.3 the likely land use scenario for SWMU 5 is to remain a military base. Therefore, the receptors considered in this RGO determination are Adult and Adolescent Trespassers and Occupational Worker (based on FDEP Selection Criteria). The Maintenance Worker was eliminated based on recommendations of the Partnering Team (11/18/98). If the SWMU 5 were to change to a residential area in the future, then these RGOs should be re-estimated.

Details of the RGO determinations are presented in the Supplemental RFI/RI report (BRE, 1997). They were calculated for several potential receptors at NAS Key West. All exposure pathways (considering all receptors, media, and routes of exposure) with incremental cancer risks (ICRs) of greater than 1E-06 and/or Hazard Indices (HIs) of greater than 1.0 were identified. For each scenario, individual chemicals which contribute at least 1E-06 to the ICR or at least 0.1 to the HI were selected.

Site-Specific RGOs accounted for the same exposure pathways and intake scenarios that were applied in the baseline risk assessment. They were developed by modifying the representative concentrations that were used in the calculation of cancer risk or HQs. The calculated cancer or non-cancer risk values (ICR or HI) for each contributing route of exposure (ingestion, dermal contact, inhalation) were added for each chemical selected. The following equation was then used to determine the relevant RGOs:

RGO concentration = (Exposure Concentration)*(Desired Risk Level)/(Calculated Risk Level)

A.1.2 RISKS FOR CORRECTIVE MEASURE ALTERNATIVES

Human health risk values were re-calculated for each of several proposed corrective measure alternatives by modification of the cancer and non-cancer risks originally determined. In this way, the original input parameters and exposure assumptions remained intact and the original representative concentrations could be used. All original COCs were included in the new risk calculations and whenever appropriate, all original exposure pathways were considered. Exposure to groundwater was not considered because this medium was not determined to be a potential concern to human receptors.

A.1.2.1 Alternative 1 (No Action)

This alternative assumes that there will be no institutional controls, media removal, or media treatment. The site will be left as is and therefore, all human health risks originally calculated would still apply. This option is considered primarily for comparative purposes as the various corrective measures are evaluated.

A.1.2.2 Alternative 2 (Institutional Controls)

This alternative involves limitation of site access and use. Warning signs should be posted and a number of other security measures would be employed. From a human health risk assessment perspective, the effect would be reduced exposure to the site media. No residents or excavation workers would be permitted on site, Trespassers would be actively discouraged from entering the site, and the assumed frequency of exposure would be no more than once a month. Workers and trespassing adults would be expected to make an effort to avoid ingestion or skin contact with the media because of the hazard posting. Occupational exposures were assumed to be reduced to approximately one-250th (0.4%) of the original estimates. Workers would be required to be on site less frequently (frequently (one day per year as opposed to the original estimate of 250 days per year). The reduction factors are shown in table A-1. These factors were multiplied times the associated risks previously estimated to give new risk values. Under Alternative 2, revised risks are shown in Table A-2 and are compared to original risks (the no action alternative) in Table A-3.

Cancer risks for both adult and adolescent trespassers still exceed 1E-06 under the institutional controls alternative. Most of the risk arises from dermal contact with surface soil. The highest cancer risk for the potential receptors are as follows: trespasser adult (2.3E-06; dermal contact with surface soil) and trespasser adolescent (1.7E-06; dermal contact with surface soil). Cancer risks for the occupational worker are less than 1E-06 under the institutional controls alternative. Hazard Indices (summed noncancer risk values) are all below 1.0 for each of the three potential receptors.

A.1.2.3 Alternative 3 (Soil Removal and Institutional Controls)

This alternative includes two separate revisions. The first option includes only soil removal, while the other option includes soil removal and institutional controls. Any soil sample that contains a contaminant that exceeds a RGO would be moved off-site. The RGO concentration is typically selected from a number of values reflecting human health risk, ecological risk, and/or State or Federal screening or cleanup levels, with the lowest value among these typically chosen. For soil under Alternative #3, the RGO selected was the FDEP Industrial Clean-Up Goal for arsenic (3.7 mg/kg).

For the protection of human health, upper range risks from exposure to soil would be limited to the risks associated with the RGO concentrations, which implies that the RGO concentrations would be the maximum soil concentration permitted at the site. Therefore, risks of exposure were recalculated by modifying the representative concentrations that were used in the estimation of cancer risks or HQs to give the new risks at the RGO level. The following equation was used to account for risks after soil removal:

Alternative Risk = (Original Risk Value)/(Original Representative Concentration)*(New Representative Concentration)

The New Representative Concentration arises from recalculating sample statistics to yield the exposure point concentration, after first removing all samples from the data set that exceed FDEP Industrial Cleanup Goals. This was possible at SWMU 5 because arsenic was the only COC selected. Removing the soil sample SBS5-1, which had an arsenic concentration of 13 mg/kg, lowered the representative concentration from 13 mg/kg to 0.9 mg/kg. The risks were re-estimated using the new representative concentration and are shown in Table A-4 and compared to the original risks (the no action alternative) in Table A-5.

Cancer risks for occupational workers still exceed 1E-06 under the first soil removal alternative. Most of the risk arises from dermal contact with surface soil. The cumulative cancer risk for the occupational worker was 2.0E-06, with dermal contact exposure contributing to a significant portion of the cancer risk (1.7E-06). Cancer risks for the adult and adolescent trespasser and the maintenance worker were below 1E-06. Hazard Indices (summed noncancer risk values) are all below 1.0 for each of the three potential receptors.

A modified alternative #3 was estimated for risks at the site. This option assumes removal of the soil sample that exceeds FDEP Industrial Criteria AND factoring in the adjustments for institutional controls as was done under Alternative #2. The factors shown in Table A-1 were again used. When both approaches were considered, the modified alternative #3 cancer risks were all below 1E-06 for the adult and adolescent trespasser and occupational worker. Hazard Indices (summed noncancer risk values) are all below 1.0 for each of the three potential receptors. Under this modified alternative, revised risks are shown in Table A-6 and compared to the original risks (the no action alternative) in Table A-7.

A.1.3 COMPARISON OF RISKS FOR CORRECTIVE MEASURE ALTERNATIVES

The cumulative risks for all 3 corrective measure alternatives are summarized in Table A-8. The data in this table shows a progressive reduction in cancer risks as corrective measure become more aggressive.

The total cancer risk for a trespassing adult is 8.6E-06 with no controls (Alternative #1). The cancer risk progressively decreases to 3.2E-06 (Alternative #2), 7.0E-07 (Alternative #3), and finally to 2.2E-07 (Alternative #3 Modified).

The total cancer risk for a trespassing adolescent is 8.2E-06 with no controls (Alternative #1). The cancer risk progressively decreases to 2.7E-06 (Alternative #2), 6.6E-07 (Alternative #3), and finally to 1.9E-07 (Alternative #3 Modified).

The total cancer risk for a occupational worker is 2.8E-05 with no controls (Alternative #1). The cancer risk decreases to 1.1E-07 (Alternative #2), decreases to 2.0E-06 (Alternative #3), and finally to decreases to 7.8E-09 (Alternative #3 Modified).

Hazard Indices (summed noncancer risk values) are all below 1.0 for each of the three potential receptors under Alternative #1, #2, #3, and #3 With Institutional Controls.

TABLE A-1
Factors for Re-Estimating Cumulative Risks
Corrective Measures Alternative #2 (Institutional Controls) (1)
SWMU 5
NAS Key West

Receptor	Trespassers				Workers	
Exposure Routes	Adult Revised/Original Assumptions	Adult Multiplication Factor	Adolescent Revised/Original Assumptions	Adolescent Multiplication Factor	Occupational Revised/Original Assumptions	Occupational Multiplication Factor
Surface Soil						
Dermal Contact	EF = 12/24	0.5	EF = 12/30	0.4	EF = 1/250	0.004
Incidental Ingestion	EF = 12/24; IR = 50/100	0.25	EF = 12/30	0.4	EF = 1/250	0.004
Inhalation of Dust	EF = 12/24	0.5	EF = 12/30	0.4	EF = 1/250	0.004
Sediment						
Dermal Contact	EF = 12/45	0.27	EF = 12/45	0.27	NA	NA
Incidental Ingestion	EF = 12/45; IR = 50/100	0.13	EF = 12/45	0.27	NA	NA

(1) Exposure assumptions were revised to reflect changes that would result if institutional controls such as warning signs, access restrictions, use restrictions, etc. are implemented. No residents or excavation workers are included because the most likely land use is industrial.

(2) With institutional controls, it is assumed that any trespassing would occur no more than one time per month (12 events/year). Ingestion rate for soil would be limited to one-half of the previous level for adults because it is assumed that hazard posting would increase efforts to limit intake.

(3) The risk ratios are used to develop multiplication factors which are then multiplied by the risks originally estimated to give new risks.

TABLE A-2
Cumulative Risks
Corrective Measures Alternative #2 (Institutional Controls)
SWMU 5
NAS Key West

Incremental Cancer Risk	Trespassers		Workers
Exposure Route	**Adult**	**Adolescent**	**Occupational**
Surface Soil			
Dermal Contact	2.3E-06	1.7E-06	1.0E-07
Incidental Ingestion	1.3E-07	2.5E-07	1.4E-08
Inhalation of Dust	6.0E-15	3.5E-15	1.3E-15
Sediment			
Dermal Contact	7.6E-07	7.0E-07	NA
Incidental Ingestion	4.0E-08	1.1E-07	NA
Total	**3.2E-06**	**2.7E-06**	**1.1E-07**

Hazard Index	Trespassers		
Exposure Route	**Adult**	**Adolescent**	**Occupational**
Surface Soil			
Dermal Contact	1.9E-02	2.4E-02	6.4E-04
Incidental Ingestion	1.0E-03	3.6E-03	8.4E-05
Inhalation of Dust	NA	NA	NA
Sediment			
Dermal Contact	6.2E-03	9.7E-03	NA
Incidental Ingestion	3.3E-04	1.5E-03	NA
Total	**2.6E-02**	**3.8E-02**	**7.2E-04**

Notes:

1. Risks are driven by arsenic in surface soil and sediment
2. Risks are based on removing soil in excess the FDEP Industrial Cleanup Goal for arsenic (3.7 mg/kg)

TABLE A-3
Cumulative Risks
Corrective Measures Alternative #1 Versus Alternative #2* (Institutional Controls)
SWMU 5
NAS Key West

Incremental Cancer Risks	Trespassers				Workers	
Exposure Route	Adult Alternative 1**	Adult Alternative 2	Adolescent Alternative 1**	Adolescent Alternative 2	Occupational Alternative 1**	Occupational Alternative 2
Surface Soil						
Dermal Contact	4.6E-06	2.3E-06	4.2E-06	1.7E-06	2.5E-05	1.0E-07
Incidental Ingestion	5.0E-07	1.3E-07	6.3E-07	2.5E-07	3.4E-06	1.4E-08
Inhalation of Dust	1.2E-14	6.0E-15	8.8E-15	3.5E-15	3.3E-13	1.3E-15
Sediment						
Dermal Contact	2.8E-06	7.6E-07	2.6E-06	7.0E-07	NA	NA
Incidental Ingestion	3.1E-07	4.0E-08	3.9E-07	1.1E-07	NA	NA
Total	**8.2E-06**	**3.2E-06**	**7.8E-06**	**2.7E-06**	**2.8E-05**	**1.1E-07**

Hazard Index	Trespassers				Workers	
Exposure Route	Adult Alternative 1**	Adult Alternative 2	Adolescent Alternative 1**	Adolescent Alternative 2	Occupational Alternative 1**	Occupational Alternative 2
Surface Soil						
Dermal Contact	3.7E-02	1.9E-02	5.9E-02	2.4E-02	1.6E-01	6.4E-04
Incidental Ingestion	4.1E-03	1.0E-03	8.9E-03	3.6E-03	2.1E-02	8.4E-05
Inhalation of Dust	NA	NA	NA	NA	NA	NA
Sediment						
Dermal Contact	2.3E-02	6.2E-03	3.6E-02	9.7E-03	NA	NA
Incidental Ingestion	2.5E-03	3.3E-04	5.5E-03	1.5E-03	NA	NA
Total	**6.7E-02**	**2.6E-02**	**1.1E-01**	**3.8E-02**	**1.8E-01**	**7.2E-04**

Notes:

(*) Exposure assumptions were revised to relect fewer days on site for most receptors, lower intake rates for adults.

Factors used are explained in Table A-1. No residents or excavation workers are included here because residential land use is not expected and excavation is not expected

(**) Alternative 1 assumes no action would be taken; therefore, the risks are the same as previously calculated for the COCs selected.

1. Risks are driven by arsenic in surface soil and sediment
2. Risks are based on removing soil in excess the FDEP Industrial Cleanup Goal for arsenic (3.7 mg/kg)

TABLE A-4
Cumulative Risks
Corrective Measures Alternative #3 (Soil Removal)
SWMU 5
NAS Key West

Incremental Cancer Risk	Trespassers		Workers
Exposure Route	**Adult**	**Adolescent**	**Occupational**
Surface Soil			
Dermal Contact	3.2E-07	2.9E-07	1.7E-06
Incidental Ingestion	3.4E-08	4.3E-08	2.3E-07
Inhalation of Dust	8.2E-16	6.0E-16	2.3E-14
Sediment			
Dermal Contact	1.9E-07	1.8E-07	NA
Incidental Ingestion	2.1E-08	2.7E-08	NA
Total	**5.6E-07**	**5.4E-07**	**2.0E-06**

Hazard Index	Trespassers		Workers
Exposure Route	**Adult**	**Adolescent**	**Occupational**
Surface Soil			
Dermal Contact	2.5E-03	4.1E-03	1.1E-02
Incidental Ingestion	2.8E-04	6.1E-04	1.4E-03
Inhalation of Dust	NA	NA	NA
Sediment			
Dermal Contact	1.6E-03	2.5E-03	NA
Incidental Ingestion	1.7E-04	3.8E-04	NA
Total	**4.6E-03**	**7.5E-03**	**1.2E-02**

Notes:
1. Risks are driven by arsenic in surface soil and sediment
2. Risks are based on removing soil in excess the FDEP Industrial Cleanup Goal for arsenic (3.7 mg/kg)

TABLE A-5
Cumulative Risks
Corrective Measures Alternative #1 Versus Alternative #3* (Soil Removal)
SWMU 5
NAS Key West

Incremental Cancer Risks	Trespassers				Workers	
Exposure Route	Adult Alternative 1**	Adult Alternative 3	Adolescent Alternative 1**	Adolescent Alternative 3	Occupational Alternative 1**	Occupational Alternative 3
Surface Soil						
Dermal Contact	4.6E-06	3.2E-07	4.2E-06	2.9E-07	2.5E-05	1.7E-06
Incidental Ingestion	5.0E-07	3.4E-08	6.3E-07	4.3E-08	3.4E-06	2.3E-07
Inhalation of Dust	1.2E-14	8.2E-16	8.8E-15	6.0E-16	3.3E-13	2.3E-14
Sediment						
Dermal Contact	2.8E-06	1.9E-07	2.6E-06	1.8E-07	NA	NA
Incidental Ingestion	3.1E-07	2.1E-08	3.9E-07	2.7E-08	NA	NA
Total	**8.2E-06**	**5.6E-07**	**7.8E-06**	**5.4E-07**	**2.8E-05**	**2.0E-06**

Hazard Index	Trespassers				Workers	
Exposure Route	Adult Alternative 1**	Adult Alternative 3	Adolescent Alternative 1**	Adolescent Alternative 3	Occupational Alternative 1**	Occupational Alternative 3
Surface Soil						
Dermal Contact	3.7E-02	2.5E-03	5.9E-02	4.1E-03	1.6E-01	1.1E-02
Incidental Ingestion	4.1E-03	2.8E-04	8.9E-03	6.1E-04	2.1E-02	1.4E-03
Inhalation of Dust	NA	NA	NA	NA	NA	NA
Sediment						
Dermal Contact	2.3E-02	1.6E-03	3.6E-02	2.5E-03	NA	NA
Incidental Ingestion	2.5E-03	1.7E-04	5.5E-03	3.8E-04	NA	NA
Total	**6.7E-02**	**4.6E-03**	**1.1E-01**	**7.5E-03**	**1.8E-01**	**1.2E-02**

Notes:

(*) Exposure was revised to include soil removal to FDEP Industrial Standards. No residents or excavation workers are included here because residential land use or excavation of subsurface soil is not expected

(**) Alternative 1 assumes no action would be taken; therefore, the risks are the same as previously calculated for the COCs selected.

1. Risks are driven by arsenic in surface soil and sediment
2. Risks are based on removing soil in excess the FDEP Industrial Cleanup Goal for arsenic (3.7 mg/kg)

TABLE A-6
Cumulative Risks
Corrective Measures Alternative #3 (Soil Removal & Institutional Controls)
SWMU 5
NAS Key West

Incremental Cancer Risk	**Trespassers**		**Workers**
Exposure Route	**Adult**	**Adolescent**	**Occupational**
Surface Soil			
Dermal Contact	1.6E-07	1.2E-07	6.9E-09
Incidental Ingestion	8.6E-09	1.7E-08	9.3E-10
Inhalation of Dust	4.1E-16	2.4E-16	9.1E-17
Sediment			
Dermal Contact	5.2E-08	4.8E-08	NA
Incidental Ingestion	2.8E-09	7.2E-09	NA
Total	**2.2E-07**	**1.9E-07**	**7.8E-09**

Hazard Index	**Trespassers**		**Workers**
Exposure Route	**Adult**	**Adolescent**	**Occupational**
Surface Soil			
Dermal Contact	1.3E-03	1.6E-03	4.4E-05
Incidental Ingestion	7.0E-05	2.4E-04	5.8E-06
Inhalation of Dust	NA	NA	NA
Sediment			
Dermal Contact	4.3E-04	6.7E-04	NA
Incidental Ingestion	2.2E-05	1.0E-04	NA
Total	**1.8E-03**	**2.6E-03**	**5.0E-05**

Notes:

1. Risks are driven by arsenic in surface soil and sediment
2. Risks are based on removing soil in excess the FDEP Industrial Cleanup Goal for arsenic (3.7 mg/kg)

TABLE A-7
Cumulative Risks
Corrective Measures Alternative #1 Versus Alternative #3* (Soil Removal & Institutional Controls)
SWMU 5
NAS Key West

Incremental Cancer Risks	Trespassers				Workers	
Exposure Route	Adult Alternative 1**	Adult Alternative 3	Adolescent Alternative 1**	Adolescent Alternative 3	Occupational Alternative 1**	Occupational Alternative 3
Surface Soil						
Dermal Contact	4.6E-06	1.6E-07	4.2E-06	1.2E-07	2.5E-05	6.9E-09
Incidental Ingestion	5.0E-07	8.6E-09	6.3E-07	1.7E-08	3.4E-06	9.3E-10
Inhalation of Dust	1.2E-14	4.1E-16	8.8E-15	2.4E-16	3.3E-13	9.1E-17
Sediment						
Dermal Contact	2.8E-06	5.2E-08	2.6E-06	4.8E-08	NA	NA
Incidental Ingestion	3.1E-07	2.8E-09	3.9E-07	7.2E-09	NA	NA
Total	**8.2E-06**	**2.2E-07**	**7.8E-06**	**1.9E-07**	**2.8E-05**	**7.8E-09**

Hazard Index	Trespassers				Workers	
Exposure Route	Adult Alternative 1**	Adult Alternative 3	Adolescent Alternative 1**	Adolescent Alternative 3	Occupational Alternative 1**	Occupational Alternative 3
Surface Soil						
Dermal Contact	3.7E-02	1.3E-03	5.9E-02	1.6E-03	1.6E-01	4.4E-05
Incidental Ingestion	4.1E-03	7.0E-05	8.9E-03	2.4E-04	2.1E-02	5.8E-06
Inhalation of Dust	NA	NA	NA	NA	NA	NA
Sediment						
Dermal Contact	2.3E-02	4.3E-04	3.6E-02	6.7E-04	NA	NA
Incidental Ingestion	2.5E-03	2.2E-05	5.5E-03	1.0E-04	NA	NA
Total	**6.7E-02**	**1.8E-03**	**1.1E-01**	**2.6E-03**	**1.8E-01**	**5.0E-05**

Notes:

(*) Exposure assumptions were revised to relect fewer days on site for most receptors, lower intake rates for adults and smaller exposure area for maintenance workers. Factors used are explained in Table A-1. Additionally, exposure assumptions were revised to include soil removal for FDEP Industrial Cleanup Standards. No residents or excavation workers are included here because residential land use or excavation of subsurface soil is not expected

(**) Alternative 1 assumes no action would be taken; therefore, the risks are the same as previously calculated for the COCs selected.

1. Risks are driven by arsenic in surface soil and sediment
2. Risks are based on removing soil in excess the FDEP Industrial Cleanup Goal for arsenic (3.7 mg/kg)

TABLE A-8
Cumulative Cancer and Noncancer Risks
Corrective Measures Alternative #1, #2, #3, and #3 With Institution Controls
SWMU 5
NAS Key West

Incremental Cancer Risk	Trespassers		Workers
Alternative and Medium	**Adult**	**Adolescent**	**Occupational**
Alternative #1			
Surface Soil	5.1E-06	4.8E-06	2.8E-05
Sediment	3.5E-06	3.4E-06	NA
Total	**8.6E-06**	**8.2E-06**	**2.8E-05**
Alternative #2			
Surface Soil	2.4E-06	1.9E-06	1.1E-07
Sediment	8.0E-07	8.1E-07	NA
Total	**3.2E-06**	**2.7E-06**	**1.1E-07**
Alternative #3			
Surface Soil	3.5E-07	3.3E-07	2.0E-06
Sediment	3.5E-07	3.3E-07	NA
Total	**7.0E-07**	**6.6E-07**	**2.0E-06**
Alternative #3 With Institutional Controls			
Surface Soil	1.7E-07	1.3E-07	7.8E-09
Sediment	5.5E-08	5.5E-08	NA
Total	**2.2E-07**	**1.9E-07**	**7.8E-09**

Hazard Index	Trespassers		Workers
Alternative and Medium	**Adult**	**Adolescent**	**Occupational**
Alternative #1			
Surface Soil	4.7E-02	7.8E-02	2.0E-01
Sediment	8.2E-02	1.4E-01	NA
Total	**1.3E-01**	**2.2E-01**	**2.0E-01**
Alternative #2			
Surface Soil	2.0E-02	2.7E-02	7.2E-04
Sediment	6.5E-03	1.1E-02	NA
Total	**2.6E-02**	**3.8E-02**	**7.2E-04**
Alternative #3			
Surface Soil	2.8E-03	4.7E-03	1.2E-02
Sediment	1.8E-03	2.9E-03	NA
Total	**4.6E-03**	**7.5E-03**	**1.2E-02**
Alternative #3 With Institutional Controls			
Surface Soil	1.3E-03	1.9E-03	5.0E-05
Sediment	4.5E-04	7.7E-04	NA
Total	**1.8E-03**	**2.6E-03**	**5.0E-05**

APPENDIX B

DEVELOPMENT OF CROSS-MEDIA REMEDIAL GOAL OPTIONS

TABLE OF CONTENTS

TABLES

NUMBER **PAGE**

FIGURES

NUMBER **PAGE**

B.1.0 INTRODUCTION

The following sections present technical discussions and results of groundwater modeling at SWMU 5 (Boca Chica AIMD Building A-990: Sand Blasting Area) for the Naval Air Station (NAS), Key West, Florida. The modeling work that was performed consisted of the following three tasks:

- The development of Soil Remedial Goal Options (RGOs) that are protective of surface water

- For chemicals in groundwater that exceed maximum contaminant levels (MCLs), estimation of groundwater washout times by natural processes (e.g., advection, sorption, and dispersion)

- For soil concentrations that exceed leaching criteria, estimation of soil washout times via leaching from contaminated soil to groundwater

The modeling was conducted to support the development and evaluation of remedial alternatives for the CMS for SWMU 5.

B.1.1 OBJECTIVES

The objective of the first task was to develop a set of soil RGOs. The soil RGOs are cross-media RGOs that represent concentrations in one medium (in this case, soil), and are protective of human heath and the environment to another medium (in this case, surface water). More specifically, the soil RGO is the soil concentrations in the source area that will not cause surface water concentrations at the exposure point to exceed the acceptable concentrations in the exposure medium (i.e., surface water criteria)

The soil concentrations were estimated at the source medium based on the predetermined surface water concentrations at the exposure point and the contaminant transport pathway (groundwater). The assumed soil concentration was then iteratively changed until the model-predicted concentration at the exposure location was just below the acceptable concentration. The final assumed soil concentration is the cross-media soil RGO. The developed RGOs are intended to be used as conservative comparison values and are not final clean-up values. The soil RGOs were developed through the use of a groundwater flow contaminant fate and transport model.

The second task was to provide a computation of groundwater washout times for chemicals in groundwater exceeding their MCLs. The computations were also accomplished through the use of the same contaminant fate and transport model tool by considering the natural processes affecting contaminant fate and transport in groundwater.

The third task was to calculate soil washout times for chemicals in soil that exceed Federal and state of Florida soil to groundwater criteria. The most conservative soil screening level (SSL) from the following criteria were used for each detected chemical in soil: (1) FDEP soil leaching criteria (FDEP, 1995) and (2) the generic SSLs (dilution attenuation factor 20) presented in the U.S. EPA Soil Screening Guidance: User's Guide Appendix A (U.S. EPA, 1996). U.S. EPA SSLs are developed based on the MCL and therefore are protective of groundwater. The same groundwater model tool was used for the estimation of soil washout time via the migration pathway of leachate generation from contaminated soil to groundwater.

The analysis presented in Appendix B differs from a full fate and transport modeling analysis in that a calibrated groundwater flow and transport model covering the entire site was not developed. In addition, this analysis relies heavily on conservative literature sources of chemical input parameters so that the chemical migration of contaminants is not specifically calibrated to site conditions. The results of this analysis, represent approximate, yet still conservative, results.

B.1.2 REPORT ORGANIZATION

This report has been divided into six sections. Section B.2.0 presents the technical approach used for the development of soil RGOs protective of surface water. Section B.3.0 provides the input data used for the development of soil RGOs protective of surface water. Section B.4.0 provides a technical discussion for the estimation of groundwater washout times by natural process (e.g. advection and dispersion). Section B.5.0 provides a similar discussion of estimation of soil washout times via leaching from contaminated soil to groundwater. Section B.6.0 presents modeling results for each of the three tasks performed for SWMU 5.

B.2.0 SOIL RGOS DEVELOPMENT

The technical approach that was used to develop the soil RGOs is described in the following subsections. The first subsection briefly describes the geology, the hydrogeology, and the pattern of contaminant releases. The second subsection describes the analytical groundwater contaminant fate and transport model used for the task and the associated simplifying assumptions and the supplemental equations. The final subsection describes the groundwater to surface water assumptions used for soil RGO development

B.2.1 SITE CONCEPTUAL MODEL

Rainwater that falls on the site can transport contaminants through runoff and/or by infiltrating into the soil. Runoff can transport contaminants from the surface soils in both the dissolved form and also in solid form sorbed to soil particles being eroded by the runoff. However, overland transport will not be considered as a pathway in this investigation based on the following factors: (1) the flat topography, (2) relatively low levels of contaminant remaining in surface soils, which indicates little or no overland transport is expected, (3) a large portion of SWMU 5 is either occupied by buildings or paved with concrete which asserts a lack of soil erosion, and (4) sandblasting activities have ceased at SWMU 5.

A portion of the rainwater that falls on the site reaches the groundwater by directly infiltrating into the soils. As the water infiltrates through the contaminated soil, contaminants leach out of the soil and are transported in dissolved form with the water through the unsaturated zone to the groundwater below. The contaminants can then be transported laterally in the groundwater and eventually migrate to a groundwater exposure point.

Conceptually, the groundwater contaminant pathway consists of an unsaturated zone and a shallow unconfined aquifer. The unsaturated zone and shallow aquifer consist of surficial oolitic limestone covered by fill materials. The uppermost fill material is a light brown, poorly sorted mixture of sand and limestone varying in thickness from 4 to 5 feet. At SWMU 5, the typical depth to groundwater ranged from 2.79 feet to 2.98 feet. Natural oolitic limestone was encountered below the fill material. The thickness of the oolitic limestone averaged 20 feet below the center of the western half of Key West.

Groundwater flow at SWMU 5 is generally toward the west, based on Figure 3-5 of the RFI/RI report (B&R 1998). As shown in Figure 2, the groundwater flow direction, however, is very likely toward the south. This is because the groundwater gradient in the north-south direction can be greater due to the shorter travel distance to the lagoon at south of the source area. Groundwater can travel horizontally and vertically in the saturated zone.

B.2.2 GROUNDWATER TRANSPORT MODEL

A portion of the rainfall that falls on the site will infiltrate through the unsaturated soil into the groundwater. In this study, upgradient groundwater flow is assumed to be clean (i.e., zero concentration). Upgradient flow will combine infiltrated water and carry dissolved contaminants in the groundwater to the groundwater exposure point. Dissolved contaminants migrate through the groundwater at a slower velocity than the velocity of the groundwater. The velocity of the contaminants is said to be retarded. The amount of the retardation is chemical specific. Also, the contaminants may decay in the environment because of biological and/or chemical processes. Therefore, as contaminants migrate through the groundwater, they may decay and their concentrations will correspondingly decrease. The conceptual model for soil RGO development is shown in Figure 1. Also, the source area for the soil RGO development is shown in Figure 2.

B.2.2.1 Groundwater Model Tool

The groundwater modeling was performed using an analytical contaminant fate and transport model. This groundwater model is implemented on the spreadsheet software Excel 5.0 and Crystal Ball 3.0 and is called ECTran (which stands for Excel-Crystal Ball Transport). The ECTran model (Chiou, 1993) is based on straightforward mass balances and advection/dispersion analytical equations, but can be used to simulate a variety of complex conditions. To date, ECTran and its predecessors have been employed at hazardous waste sites in U.S. EPA Regions III, V, VI, and X to evaluate soil clean-up goals and clean-up time estimations and to support baseline risk assessments. It has been used at DOD, DOE, and industrial sites for both RCRA and CERCLA applications.

The ECTran model simulates vertical contaminant transport with uniform (thickness, concentration, porosity, etc.) layers. The model predicts the concentration downgradient of the source at a single point at a specified distance from the exposure point. This predicted concentration is at the centerline of the contaminant plume.

B.2.2.2 Groundwater Modeling Assumptions And Procedures

Source Area

The source area was selected based on the locations at which contaminants were detected. The source area is designated as a rectangular area with length parallel to groundwater flow direction and width perpendicular to the flow direction.

Layer Simulated in the Model

The uppermost layer simulated in the ECTran model is the unsaturated zone. This layer is assumed to have a uniform thickness of 3 feet. The bottom-most layer simulated in the ECTran model is the shallow unconfined aquifer (saturated zone). This layer is assumed to have a uniform thickness of 20 feet.

Initial Soil and Groundwater Concentrations

An initial soil concentration was assumed in the 3-foot-thick unsaturated layer for soil RGO development of all COCs. The assumed unsaturated soil concentration was then iteratively changed until the model-predicted concentration in the groundwater at the exposure point was just below the acceptable concentration. The final assumed concentration is the soil RGO.

During development of the soil RGOs, the initial groundwater concentration under the source area was assumed to be the maximum detected concentrations of the groundwater samples. The soil via groundwater to surface water RGO is a soil concentration that will not contaminate the surface water body at an unacceptable level at the exposure point.

Modeling Time Frame

The contaminant simulations were continued until the concentration at the exposure point peaked or until the simulation reached 1,000 years. Typically, concentrations of organic chemicals will reach their peak concentrations at the exposure point earlier than inorganic chemicals. The further into the future the model is used to predict contaminant concentrations, the greater uncertainty of the results becomes due to the possibility of land use changes, changes in the properties of the contaminants, or even changes in climate. Due to this uncertainty, model simulations were limited to a 1,000-year time frame. The 1,000-year modeling time frame has been used previously at other government facilities. Some chemicals that move very slowly in the groundwater may not reach the exposure point in 1,000 years and will result in an exposure point concentration of zero and a corresponding RGO concentration of 100 percent (pure product).

Chemical Fate and Transport

Several mechanisms/processes affecting chemical fate and transport in groundwater were accounted for during the development of the RGOs. They include sorption, dilution, advection, dispersion, and chemical/biological decay. Sorption is the reaction that occurs between solute and the surfaces of solids causing the solute to bond to varying degrees to the surface. Dilution occurs because of the mixing of contaminated groundwater with unaffected groundwater. Advection is the primary mechanism responsible for the movement of contaminants as a consequence of groundwater flow. Dispersion occurs because of fluid mixing due to effects of unresolved heterogeneities in the permeability distribution. Decay involves the degradation of a chemical by natural chemical and biological processes.

B.2.3 GROUNDWATER TO SURFACE WATER ASSUMPTIONS USED FOR SOIL RGO DEVELOPMENT

To determine the soil via groundwater to surface water RGO, an acceptable groundwater concentration protective of surface water at the surface water/groundwater interface at the was first calculated. This acceptable groundwater concentration was calculated based on the assumptions and equations presented in this section. The soil RGOs were then developed with the groundwater model and assumptions as described in the previous section, based on the acceptable groundwater concentration protective of the surface water concentrations in the exposure medium (i.e., surface water criteria). The assumed soil concentration under the source was iteratively changed until the model-predicted concentration at the edge of the lagoon was just below the acceptable groundwater concentration. The final assumed source soil concentration is the cross-media soil RGO protective of surface water.

The seepage concentration was based on the flux of contaminants out of the ground divided by the total flow of water out of the ground. The flux of contaminants into the lagoon was based on the chemical-specific velocity of each of the contaminants in the groundwater. The contaminant velocity is the velocity of the groundwater divided by the retardation factor (Domenico, 1982). A retardation factor of 1 would correspond to a chemical that migrates through the groundwater at the same velocity as the groundwater. The higher the retardation factor, the slower the contaminant migrates in the groundwater. The following equation is used to calculate the chemical mass flux in the groundwater at the groundwater/surface water interface:

$$Q_C = \frac{V_{GW}\, A\, C}{R_C} \qquad (1)$$

where:

Q_C = Chemical flux (mass/time)

V_{GW} = Groundwater velocity (length/time)

C = Chemical concentration in the groundwater (mass/length^3) (Predicted with the ECTran model)

A = Cross sectional area of the mass flow ($length^2$)

and R_C is chemical specific retardation factor given by:

$$R_C = 1 + \frac{\rho_b}{n} K_d \quad (2)$$

where:

R_C = Chemical specific retardation factor (dimensionless)

ρ_b = Dry bulk density of soil ($mass/length^3$)

n = Porosity (dimensionless)

K_d = Soil / water partitioning coefficient ($length^3/mass$)

The total flow of groundwater is given by the groundwater velocity multiplied by the cross-sectional area of the groundwater flow. The seep concentration (C_s) is then

$$C_s = \frac{Q_C}{V_{GW} A} \quad (3)$$

After replacing Q_c in Equation 3 by Equation 1, the groundwater velocity and the area cancel out so that the seep concentration is the groundwater concentration divided by the retardation factor.

$$C_s = \frac{C}{R_d} \quad (4)$$

Equation 4 was used to calculate the acceptable groundwater concentration at the groundwater/surface water interface assuming C_s is the surface water exposure criteria. The soil concentration was then iteratively changed until the predicted maximum groundwater concentration at the groundwater/surface water interface was just below the acceptable groundwater concentration based on the surface water exposure criteria.

B.3.0 INPUT DATA FOR MODELING

B.3.1 CHEMICAL INPUT PARAMETERS

The primary chemical input parameters include the soil/water partitioning coefficient, K_d, the exposure criteria, and chemical and biological decay half-lives. The chemical input parameters used in the modeling are discussed below.

Chemicals of Concern (COC)

A chemical is considered a COC if its soil concentration in unsaturated soil exceeds a SSL value or its groundwater concentration exceeds an MCL value in its corresponding medium. The following chemicals were considered COCs based because the chemicals were detected at concentrations that exceeded Federal or state SSLs.

Inorganics: aluminum, cadmium, chromium, lead

Organics: methylene chloride

Table 1 presents a list of COC used for soil RGO development, along with the current maximum detected concentrations. The initial groundwater concentration under the source area was assumed to be the maximum detected concentrations during the development of soil RGOs.

Soil/Water Partitioning Coefficient

Chemical-specific soil/water partitioning coefficients (K_d) were used to estimate each chemical's mobility. A chemical's K_d value is the ratio of its concentration in soil (or sediment) to its concentration in water when the two concentrations are in equilibrium. A high K_d value would be representative of a chemical that has a tendency to bind to the soil and is therefore less mobile in water. Depending on the chemical form of a certain contaminant (specifically for inorganics), the K_d value can vary substantially. No site-specific K_d values were available for NAS Key West. The K_d values used in this evaluation were taken from literature sources.

In order to closely follow the U.S. EPA procedures in the selection of K_d values, K_d values were taken directly from the U.S. EPA's SSL Guidance if available or were calculated based on the procedures proposed in the SSL Guidance (U.S. EPA, 1996).

The K_d values for organic constituents are typically calculated by multiplying the K_{oc} value (soil organic carbon/water partition coefficient) by the foc (fraction of organic carbon) (EPA, 1988). One composite soil sample from SWMU 1 (B&R Environmental, March 1998) was analyzed for foc and the resulting value (i.e., 1.04 mg/kg) was very low compared to typical foc measurements. In addition, it was determined that the soil sample that was analyzed was a surface soil sample and not a sample from the unconfined surficial aquifer. Therefore, it is not appropriate to use this value for determining K_d values. Because of a lack of site-specific data and the potential for foc values to be low in the oolitic limestone of Key West, a conservative foc of 0.001, or 0.1 percent was selected for calculating organic constituent K_d values. This foc value is the lowest acceptable value that can be used in the $K_d = K_{oc}$* foc model (U.S. EPA, 1988). The K_d values and their corresponding sources are presented in Table 2.

Half-Life Decay Constants

The inorganic chemicals are assumed not to decay during migration in the groundwater. Decay of organic contaminants can occur by biological and non-biological mechanisms. This decay is quantified by chemical specific half-life. Half-lives were taken from literature values. Table 2 presents the half-life decay constants used in the modeling.

Exposure Criteria

Surface water criteria were used for the soil RGO development. The surface water action levels used were taken from criteria agreed upon by the NAS Key West Partnering Team. Table 3 presents a summary of the surface water criteria and the corresponding calculated groundwater concentration protective of surface water. Refer to the details outlined in Section B.2.3 for a description of how the acceptable groundwater concentration protective of surface water was calculated.

B.3.2 PHYSICAL INPUT PARAMETERS AT SWMU 5

The groundwater physical input parameters are described in the next two subsections.

B.3.2.1 Surface Water Infiltration and Water Budget

A HELP model (Schroeder et al., 1994) was used to estimate the annual water budget. The results are as follows:

Annual mean precipitation:	37.95 inches per year
Runoff:	0.06 inches per year
Evapotranspiration:	17.943 inches per year
Infiltration:	19.948 inches per year
Change in Storage:	0.005 inches per year

A weighted average infiltration rate of 12.4 inches per year was used for modeling. This is based on a ratio of paved area to unpaved area (Figure 2).

B.3.2.2 Groundwater Physical Input Parameters at SWMU 5

Layer Thickness: As described in the Conceptual Model section, a typical thickness of the unsaturated zone was assumed to be 3 feet. The saturated zone was assumed to be 20 feet thick, the average thickness of the oolitic limestone. Table 4 presents a summary of physical and geologic parameters used for the modeling task.

Source Area Size: In RGO development, it is assumed that the source area corresponds to the rectangular area encompassing the Sand Blasting Area. The size of the rectangle was estimated to be 140 feet long (parallel to groundwater flow direction) by 120 feet wide (perpendicular to flow direction) for all COCs except methylene chloride. The size of source area for methylene chloride was selected as 70 feet by 70 feet (see Figure 2 and Table 4).

Exposure Point: The exposure point for the soil to groundwater RGO was the surface water in the lagoon south of the source area. As described in Section B.2.1, this exposure point will be the most conservative scenario for the development of soil RGOs. The distance to this exposure point is approximately 85 feet (along groundwater flow path direction) for all COCs, with the exception of methylene chloride, which is 135 feet (see Table 4).

Hydraulic Conductivity K: The porous limestone has a reported K of 72 to 1,024 gallons per day per square foot (IT, 1994), or 3.4×10^{-3} cm/sec to 4.83×10^{-2} cm/sec, or 10 to 137 feet/day. An average K of 73 ft/day was selected for modeling.

Gradient: The gradient was calculated to be 0.0017 (IT, 1994).

Effective Porosity: The effective porosity is assumed to be 0.3.

<u>Seepage Velocity:</u> The seepage velocity can be calculated with the following equation.

$$V_{seep} = \frac{KI}{effective\ porosity}$$

Where: K = hydraulic conductivity (73 ft/day)

I = gradient (0.0017)

Effective porosity = 0.3

The seepage velocity is then approximately 150 ft/year.

B.4.0 GROUNDWATER WASHOUT TIMES BY NATURAL PROCESSES

The time required for contaminants in groundwater under the source area to reduce from the maximum detected concentrations to the MCL levels by natural processes was estimated. Chemicals that have exceeded the corresponding MCL were selected for analysis. The analysis also accounted for most natural processes affecting contaminant fate and transport including dilution due to infiltration and upgradient groundwater, dispersion, and sorption. The technical approach and groundwater modeling tool selected were similar to soil RGO development for SWMU 5. Refer to the details outlined for SWMU 5 (Section B.2.0) for a description of the modeling process.

B.4.1 MODELING ASSUMPTIONS FOR GROUNDWATER WASHOUT TIME

The following general assumptions were made for the analysis:

- Washout time was estimated in the saturated layer under the source area.
- Maximum soil concentrations selected from surface soil and subsurface soil samples were used as the initial soil concentrations.
- Assume the source is depleting from the source area, which means non-constant source loading rates.
- Infiltration rates used represent source area-specific weighted average rates. This is based on a ratio of paved area to unpaved area.

The calculation was performed through the use of a groundwater flow contaminant fate and transport model (ECTran model). The time corresponding to when the groundwater concentration under the source reduced to below the MCL level was selected as the washout time.

B.4.2 SITE CONCEPTUAL MODEL

The following subsections provide a summary of model input parameters and simple conceptual model.

The conceptual model for groundwater washout time by natural occurring processes is similar in nature to the soil RGO development. The major difference lies in that a forward computation without an iterative procedure was performed. As depicted in Figure 1, the exposure point is now selected as the groundwater directly beneath the soil source area.

B.4.3 CHEMICAL INPUT PARAMETERS

The primary chemical input parameters include the soil/water partitioning coefficient (K_d) the exposure criteria, and chemical and biological decay half-lives. The chemical input parameters used in the modeling are discussed below.

Chemicals of Concern (COC)

A chemical is considered a COC if its groundwater concentration exceeds an MCL value in its corresponding medium. The following chemicals were considered as COC.

Inorganics: antimony, cyanide, lead, and mercury.

Table 5 presents a list of COC used for groundwater washout time, along with the maximum detected concentrations in surface and subsurface soil since 1993. The initial soil and groundwater concentrations under the source area were assumed to be the maximum detected concentrations sampled since 1993.

Soil/Water Partitioning Coefficient

No site-specific K_d values were available for NAS Key West. The K_d values used in this evaluation were taken from literature sources.

In order to closely follow the U.S. EPA procedures in the selection of K_d values, K_d values were taken directly from U.S. EPA's SSL Guidance, if available, or were calculated based on the procedures proposed in the SSL Guidance (EPA 1996). The K_d values and their corresponding sources are presented in Table 6.

Half-Life Decay Constants

No decay were assumed for inorganic compounds.

Exposure Criteria

The groundwater exposure criteria are the MCLs, which were obtained from Drinking Water Regulations and Health Advisories, (U.S. EPA Washington, D.C., October 1996). Table 7 presents a summary of the groundwater exposure criteria.

B.4.4 PHYSICAL INPUT PARAMETERS

The groundwater physical input parameters are described in the next two subsections.

Surface Water Infiltration and Water Budget

The HELP model results used in the soil RGO development were used to estimate the annual water budget. The weighted average infiltration rates were used for modeling. This is based on a ratio of paved area to unpaved area (Figure 3).

Groundwater Physical Input Parameters

Layer Thickness: As described in the Conceptual Model section, a typical thickness of the unsaturated zone was assumed to be 3 feet. The saturated zone was assumed to be 20 feet thick, representing the average thickness of the porous limestone. Table 8 presents a summary of physical and geologic parameters used for the modeling task.

Source Area Size: The source area for each COC was determined based on the locations of detected concentrations sampled since 1993. The length is measured parallel to groundwater flow direction while the width is measured perpendicular to flow direction (see Figure 3 and Table 8).

Exposure Point: The exposure point for the washout time estimation was the groundwater under the source area.

Hydraulic Conductivity K: A reported average K of 73 ft/day for the porous limestone was selected for modeling (IT, 1994).

Gradient: The gradient was selected to be 0.0017, which is similar to SWMU 1 (IT, 1994).

Effective Porosity: The effective porosity is assumed to be 0.3.

Seepage Velocity: The seepage velocity can be calculated with the same equation as presented in SWMU 5 (Section B.3..2.2). The seepage velocity is calculated to be approximately 150 ft/year.

B.5.0 SOIL WASHOUT TIMES VIA LEACHING FROM SOIL TO GROUNDWATER

Soil washout time is defined as the time required for the contaminant in the unsaturated soil of the source area to reduce from the maximum detected soil concentration to a low-level soil concentration by natural attenuation. And any further migration of the leachate from this low-level soil concentration to the underlying groundwater will not cause the groundwater concentrations in the saturated layer under the source to be greater than MCL levels. The washout time calculations were performed. Chemicals that exceed the soil to groundwater criteria described in Section B.1.1 were selected for the analysis. The computation has also accounted for most natural processes affecting contaminant fate and transport. The technical approach and groundwater modeling tool selected are similar to soil RGO development. Refer to the details outlined in Section B.2.0 for a description of the modeling process.

B.5.1 SITE CONCEPTUAL MODEL

The following subsections provide a summary of model input parameters and simple conceptual model for SWMU 5. The general assumptions made for groundwater washout times are applicable for the analysis. In addition, the site conceptual model for soil washout time by natural occurring process is similar in nature to the groundwater washout time at SWMU 5. Figure 1 can also be referred to for the conceptual model. Again, the exposure point was selected as the groundwater directly beneath the source area. The maximum detection of soil and groundwater concentrations were assumed as the initial concentration, followed by groundwater fate and transport modeling, and the time corresponding to when the groundwater concentration under the source reduced to below the MCL level by natural processes was selected as the soil washout times.

B.5.2 CHEMICAL INPUT PARAMETERS

The primary chemical input parameters include the soil/water partitioning coefficient, (K_d) the exposure criteria, and chemical and biological decay half-lives. The chemical input parameters used in the modeling are discussed below.

Chemicals of Concern (COC)

A chemical is considered a COC if the soil concentrations exceed soil to groundwater criteria in their corresponding media. The following chemicals were considered as COC because the chemicals were detected at concentrations that exceeded Federal and state leaching criteria.

- Inorganics: cadmium
- Organics: methylene chloride

Table 9 presents a list of COC used for soil washout time along with the maximum detected concentrations in surface and subsurface soil since 1993. The initial soil and groundwater concentrations were assumed to be the maximum detected concentrations sampled since 1993.

Soil/Water Partitioning Coefficient

No site-specific K_d values were available for NAS Key West. The K_d values used in this evaluation were taken from literature sources.

In order to closely follow the U.S. EPA procedures in the selection of K_d values, K_d values were taken directly from U.S. EPA's SSL Guidance, if available, or were calculated based on the procedures proposed in the SSL Guidance (EPA, 1996). The K_d values and their corresponding sources are presented in Table 10.

Half-Life Decay Constants

The inorganic chemicals are assumed not to decay during migration in the groundwater. Half-lives were taken from literature values. Table 10 presents the half-life decay constants used in the modeling.

Exposure Criteria

The groundwater exposure criteria are the MCLs, which were obtained from Drinking Water Regulations and Health Advisories, (U.S. EPA Washington, D.C., October 1996). Table 11 presents a summary of the groundwater exposure criteria.

B.5.3 PHYSICAL INPUT PARAMETERS

The groundwater physical input parameters are described in the next two subsections.

Surface Water Infiltration and Water Budget

The HELP model results used in the soil RGO development were used to estimate the annual water budget. The weighted average infiltration rates were used for modeling. This is based on a ratio of paved area to unpaved area (Figure 4).

Groundwater Physical Input Parameters

Layer Thickness: As described in the Conceptual Model section, a typical thickness of the unsaturated zone was assumed to be 3 feet. The saturated zone was assumed to be 20 feet thick, representing the average thickness of the porous limestone. Table 12 presents a summary of physical and geologic parameters used for the modeling task.

Source Area Size: The source area for each COC was determined based on the locations of detected concentrations sampled since 1993. The length is measured parallel to groundwater flow direction while the width is measured perpendicular to flow direction (see Figure 4 and Table 12).

Exposure Point: The exposure point for the washout time estimation was the groundwater under the source area.

Hydraulic Conductivity K: A reported average K of 73 ft/day for the porous limestone was selected for modeling (IT, 1994).

Gradient: The gradient was selected to be 0.0017, which is similar to SWMU 1 (IT, 1994).

Effective Porosity: The effective porosity is assumed to be 0.3.

Seepage Velocity: The seepage velocity can be calculated with the same equation as presented in SWMU 5 (Section B.3.2.2). The seepage velocity is calculated to be approximately 150 ft/year.

B.6.0 RESULTS

The results of the groundwater modeling for soil RGOs, as well as washout times computation, are discussed in the following three sections.

B.6.1 SOIL RGO (PROTECTIVE OF SURFACE WATER) DEVELOPMENT

Soil RGOs protective of surface water were developed for the soil within the source area and are presented in Table 13. In order to calculate the soil RGOs presented in Table 13. If a chemical concentration is detected in the soil in the source area, the soil RGO presented in Tables 13 is appropriate for comparison.

The model-predicted soil RGOs for all COCs at SWMU 5 are well above their maximum detected soil concentrations. Therefore, the current soil concentrations in the source area will not cause the surface water in the lagoon at the south of source area exceeding the surface water criteria. The mechanisms/processes affecting chemical fate and transport in groundwater that were accounted for during the modeling include sorption, dilution, advection, dispersion, and chemical/biological decay.

B.6.2 ESTIMATION OF GROUNDWATER WASHOUT TIMES BY NATURAL PROCESSES

Table 14 presents the results of groundwater washout time by natural processes for chemicals in groundwater exceeding MCL. The predicted time was calculated for the groundwater beneath the source area. The modeling results indicate that the washout times for antimony, lead, and mercury to diminish from the maximum detected concentrations (31.8, 24.7, and 4.7 ug/L) to their MCLs (6.0, 15.0, and 2.0 ug/L) are approximately 79, 1,000, and 65 years, respectively. In comparison, the washout times for cyanide to naturally attenuate in groundwater is much shorter, and takes approximately 1.4 years to reduce from its maximum concentration (230 ug/L) to its MCL (200 ug/L).

B.6.3 ESTIMATION OF SOIL WASHOUT TIMES BY NATURAL PROCESSES

Table 15 presents the results of soil washout times via leaching from contaminated soil to the groundwater under the source area. The modeling results indicate the washout time for cadmium in soil via leaching and natural processes is about 640 years. In comparison, the washout time for methylene chloride is relatively short: approximately 2 years to reduce from the maximum detected soil concentration to a certain low-level soil concentration. Consequently, at this low level soil concentration, any further migration of the leachate to the underlying aquifer will not cause the groundwater concentrations under the source to be greater than the MCL levels.

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TABLE 1
MAXIMUM DETECTED SOIL AND GROUNDWATER CONCENTRATIONS FOR CHEMICALS IN SOIL EXCEEDING SOIL TO GROUNDWATER CRITERIA
SOIL RGOs DEVELOPMENT
SWMU 5, NAS KEY WEST

Chemical	Maximum Detected Concentrations in Surface Soil (1) (mg/kg)	Location	Maximum Detected Concentrations in Subsurface Soil (1) (mg/kg)	Location	Maximum Detected Groundwater Concentrations (2) (ug/L)	Location
Aluminum	923.00	S5SB-1	0.00	NA	0	NA
Cadmium	12.60	S5SB-3	0.95	S5SB-3	4.8	S5MW-3
Chromium	24.70	S5SB-1	5.30	S5SB-3	35.6	S5MW-3
Lead	52.1	S5SB-1	11.3	S5SB-3	24.7	S5MW-3
Methylene Chloride	20	S5SB-2	19	S5SB-4	2	S5MW-3

Notes:

1. The maximum detected concentrations in surface and subsurface soils were based on Tables 3-2 and 3-1, Supplemental RCRA Facility Investigation and Remedial Investigation Report, January 1998 respectively.
2. The maximum detected concentrations in groundwater were based on Table 3-5, Supplemental RCRA Facility Investigation and Remedial Investigation Report, January 1998.

TABLE 2

SOIL PARTITIONING COEFFICIENTS AND HALF-LIVES FOR

CHEMICALS IN SOIL EXCEEDING SOIL TO GROUNDWATER CRITERIA

SOIL RGOs DEVELOPMENT

SWMU5, NAS KEY WEST

Chemicals of Concern	Koc L/kg	Kd L/kg	Ref	Half-Life (4) (years)
INORGANICS				
Aluminum	n/a	1500	2	NA(5)
Cadmium	n/a	75	1	NA
Chromium	n/a	19	1	NA
Lead	n/a	270	3	NA
VOCs				
Methylene Chloride	11.7	0.0117	1	0.15

Organic Kd = foc*Koc, foc is minimum allowable value of 0.001 based on EPA Soil Screening User's Guide, April 1996, and Superfund Exposure Assessment Manual, April 1988.

(1) EPA Soil Screening Guidance User's Guide, April, 1996.
(2) Baes & Sharp et. al., 1984, "A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides through Agriculture," ORNL 5786 Oak Ridges National Laboratory, Oak Ridge, TN.
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(4) Howard et. al., Handbook of Environmental Degradation Rates, 1991.
(5) NA - No deacy are assumed for inorganic chemicals.

TABLE 3

SURFACE WATER CRITERIA PROTECTIVE OF GROUNDWATER FOR CHEMICALS IN SOIL EXCEEDING SOIL TO GROUNDWATER CRITERIA SOIL RGOs DEVELOPMENT SWMU5, NAS KEY WEST

Chemicals of Concern	Partitioning Coefficient Kd L/kg	Retardation Factor Rd	SurfaceWater Criteria (1) ug/L	Groundwater Criteria Protective of Surface Water (2) ug/L
Aluminum	1500	7501	1500	1.13E+07
Cadmium	75	376	9	3.50E+03
Chromium	19	96	50	4.80E+03
Lead	270	1351	5.6	7.57E+03
Methylene Chloride	1.17E-02	1.059	1580	1.67E+03

Notes:
(1) Surface Water Criteria are from Table B-5, Supplemental RFI/RI Report, 1997.
(2) Groundwater Criteria Protective of Surface Water are calculated by multiplying the surface water criteria by their corresponding

TABLE 4
SUMMARY OF PHYSICAL AND GEOLOGIC PARAMETERS
SOIL RGOs DEVELOPMENT
SWMU 5, NAS KEY WEST

Chemical	Source Area (1)		Shallow Aquifer Thickness (2) (ft)	Unsaturated Zone Thickness (3) (ft)	Mixing Depth (4) (ft)	Distance to Exposure Point (5) (ft)
	Length (ft)	Width (ft)				
Aluminum	120	140	20	3	11.4	85
Cadmium	120	140	20	3	11.4	85
Chromium	120	140	20	3	11.4	85
Lead	120	140	20	3	11.4	85
Methylene Chloride	70	70	20	3	10	135

(1) See Figures 1 and 2.

(2) Shallow aquifer thickness is the average thickness of the oolitic limestone below the center of the western half of the Key West.

(3) The unsaturated zone thickness is based on lithologic description of the Supplemental RCRA Facility Investigation and Remedial Investigation Report, January 1998.

(4) The mixing depth was calculated based on equations presented in the reference for ECTran model (Chiou et al, 1993).

(5) Measured from Figure 2.

TABLE 5
GROUNDWATER WASHOUT TIME ESTIMATION BY NATURAL PROCESSES
MAXIMUM DETECTED SOIL AND GROUNDWATER CONCENTRATIONS FOR
CHEMICALS IN GROUNDWATER EXCEEDING MAXIMUM CONTAMINANT LEVELS
SWMU 5, NAS KEY WEST

Chemical	Maximum Detected Concentrations in Surface Soil (1) (mg/kg)	Location	Maximum Detected Concentrations in Subsurface Soil (1) (mg/kg)	Location	Maximum Detected Groundwater Concentrations (2) (ug/L)	Location	Maximum Contaminant Level (MCL) (3) (ug/L)
Antimony	4.20	S5SB-4	4.00	S5SB-4	31.8	S5MW-2	6
Cyanide	0.00	NA	0.00	NA	230	S5MW-2	200
Lead	52.10	S5SB-1	11.30	S5SB-3	24.7	S5MW-3	15
Mercury	0.04	S5SB-1	0.0	NA	4.7	S5MW-2	2

Notes:

1. The maximum detected concentrations in surface and subsurface soils were based on Tables 3-2 and 3-1, Supplemental RCRA Facility Investigation and Remedial Investigation Report, January 1998 respectively.
2. The maximum detected concentrations in groundwater were based on Table 3-5, Supplemental RCRA Facility Investigation and Remedial Investigation Report, January 1998.
3. MCLs were obtained from "Drinking Water Regulations and Health Advisories," USEPA Washington, D.C., October 1996.

TABLE 6
GROUNDWATER WASHOUT TIME ESTIMATION BY NATURAL PROCESSES
SOIL PARTITIONING COEFFICIENTS AND HALF-LIVES FOR
CHEMICALS IN GROUNDWATER EXCEEDING MAXIMUM CONTAMINANT LEVELS
SWMU5, NAS KEY WEST

Chemicals of Concern	Koc L/kg	Kd L/kg	Ref
INORGANICS			
Antimony	n/a	45	1
Cyanide	n/a	10	1
Lead	n/a	270	2
Mercury	n/a	52	1

(1) EPA Soil Screening Guidance User's Guide, April, 1996.
(2) Thibault, D.H., M.I. Sheppard and P.A. Smith, 1990, "A Critical Compilation and Review of Default Soil Solid/Liquid Partition Coefficients, Kd for use in Envoronmental Assessments," AECL 10125, Whiteshell Nuclear Research Center, Pinawa, Manitoba, Canada.
No deacy are assumed for Inorganic chemicals.

TABLE 7

GROUNDWATER WASHOUT TIME ESTIMATION BY NATURAL PROCESSES

GROUNDWATER CRITERIA PROTECTIVE OF GROUNDWATER FOR CHEMICALS IN GROUNDWATER EXCEEDING MAXIMUM CONTAMINANT LEVELS

SWMU5, NAS KEY WEST

Chemicals of Concern	Groundwater Criteria (Maximum Contaminant Level) (1) ug/L
INORGANICS	
Antimony	6
Cyanide	200
Lead	15
Mercury	2

Notes:
(1)Groundwater Water Criteria are the MCLs, and were obtained from "Drinking Water Regulations and Health Advisories," USEPA Washington, D.C., October 1996.

TABLE 8
GROUNDWATER WASHOUT TIME ESTIMATION BY NATURAL PROCESSES
SUMMARY OF PHYSICAL AND GEOLOGIC PARAMETERS
GROUNDWATER WASHOUT TIME BY NATURAL ATTENUATION
SWMU 5, NAS KEY WEST

Chemical	Source Area (1)		Shallow Aquifer Thickness (2) (ft)	Unsaturated Zone Thickness (3) (ft)	Mixing Depth (4) (ft)
	Length (ft)	Width (ft)			
Antimony	30	50	20	3	10
Cyanide	30	50	20	3	10
Lead	90	100	20	3	10
Mercury	50	30	20	3	10

(1) See Figure 3.

(2) Shallow aquifer thickness is the average thickness of the oolitic limestone below the center of the western half of the Key West.

(3) The unsaturated zone thickness is based on lithologic description of the Supplemental RCRA Facility Investigation and Remedial Investigation Report, January 1998.

(4) The mixing depth was calculated based on equations presented in the reference for ECTran model (Chiou et al, 1993).

TABLE 9
SOIL WASHOUT TIME ESTIMATION BY NATURAL PROCESSES
MAXIMUM DETECTED SOIL AND GROUNDWATER CONCENTRATIONS FOR
CHEMICALS IN SOIL EXCEEDING SOIL TO GROUNDWATER CRITERIA
SWMU 5, NAS KEY WEST

Chemical	Maximum Detected Concentrations in Surface Soil (1) (mg/kg)	Location	Maximum Detected Concentrations in Subsurface Soil (1) (mg/kg)	Location	Maximum Detected Groundwater Concentrations (2) (ug/L)	Location	Maximum Contaminant Level (MCL) (3) (ug/L)
Cadmium	12.60	S5SB-3	0.95	S5SB-3	4.8	S5MW-3	5
Methylene Chloride	20.00	S5SB-2	19.00	S5SB-4	2	S5MW-2	5

Notes:

1. The maximum detected concentrations in surface and subsurface soils were based on Tables 3-2 and 3-1, Supplemental RCRA Facility Investigation and Remedial Investigation Report, January 1998 respectively.
2. The maximum detected concentrations in groundwater were based on Table 3-5, Supplemental RCRA Facility Investigation and Remedial Investigation Report, January 1998.
3. MCLs were obtained from "Drinking Water Regulations and Health Advisories," USEPA Washington, D.C., October 1996.

TABLE 10
SOIL WASHOUT TIME ESTIMATION BY NATURAL PROCESSES
SOIL PARTITIONING COEFFICIENTS AND HALF-LIVES FOR
CHEMICALS IN SOIL EXCEEDING SOIL TO GROUNDWATER CRITERIA
SWMU 5, NAS KEY WEST

Chemicals of Concern	Koc L/kg	Kd L/kg	Ref	Half-Life (2) (years)
INORGANICS				
Cadmium	n/a	75	1	NA(3)
VOC				
Methylene Chloride	11.7	0.0117	1	0.15

Organic Kd = foc*Koc, foc is minimum allowable value of 0.001 based on EPA Soil Screening User's Guide, April 1996, and Superfund Exposure Assessment Manual, April 1988.

(1) EPA Soil Screening Guidance User's Guide, April, 1996.
(2) Howard et. al., Handbook of Environmental Degradation Rates, 1991.
(3) NA - No deacy is assumed for Inorganic chemical.

TABLE 11
SOIL WASHOUT TIME ESTIMATION BY NATURAL PROCESSES
GROUNDWATER CRITERIA PROTECTIVE OF GROUNDWATER FOR
CHEMICALS IN SOIL EXCEEDING SOIL TO GROUNDWATER CRITERIA
SWMU 5, NAS KEY WEST

Chemicals of Concern	Groundwater Criteria (Maximum Contaminant Level) (1) ug/L
INORGANICS	
Cadmium	5
VOC	
Methylene Chloride	5

Notes:
(1)Groundwater Water Criteria are the MCLs, and were obtained from "Drinking Water Regulations and Health Advisories," USEPA Washington, D.C., October 1996.

TABLE 12
SOIL WASHOUT TIME ESTIMATION BY NATURAL PROCESSES
SUMMARY OF PHYSICAL AND GEOLOGIC PARAMETERS
SOIL WASHOUT TIME BY NATURAL ATTENUATION
SWMU 5, NAS KEY WEST

Chemical	Source Area (1)		Shallow Aquifer Thickness (2) (ft)	Unsaturated Zone Thickness (3) (ft)	Mixing Depth (4) (ft)
	Length (ft)	Width (ft)			
Cadmium	60	50	20	3	10
Methylene Chloride	70	70	20	3	10

(1) See Figure 4.

(2) Shallow aquifer thickness is the average thickness of the oolitic limestone below the center of the western half of the Key West.

(3) The unsaturated zone thickness is based on lithologic description of the Supplemental RCRA Facility Investigation and Remedial Investigation Report, January 1998.

(4) The mixing depth was calculated based on equations presented in the reference for ECTran model (Chiou et al, 1993).

TABLE 13
SOIL RGOs PROTECTIVE OF SURFACE WATER
CHEMICALS IN SOIL EXCEEDING SOIL TO GROUNDWATER CRITERIA
SOIL RGOs DEVELOPMENT
SWMU 5, NAS KEY WEST

Chemicals of Concern	Soil RGO Protective of Surface Water mg/kg	Maximum Soil Concentrations mg/kg	In Exceedence of Soil RGO?
INORGANICS			
Aluminum	>1E + 06 (1)	923	no
Cadmium	3,306	12.6	no
Chromium	1,259	24.7	no
Lead	5.71E+04	52.1	no
VOCs			
Methylene Chloride	153	20.0	no

(1) Indicates that a pure concentration of the contaminant will not result in exposure in exceedance of criteria.

TABLE 14
PREDICTED GROUNDWATER WASHOUT TIME USING FATE AND TRANSPORT MODELING
CHEMICALS IN GROUNDWATER EXCEEDING MAXIMUM CONTAMINANT LEVELS
SWMU 5, NAS KEY WEST

Chemical	Initial Soil Concentration in Unsaturated Zone (Max detected conc.) (1) (mg/kg)	Initial Groundwater Concentrations (2) (ug/L)	Maximum Contaminant Level (MCL) (3) (ug/L)	Predicted Groundwater Washout Times (4) (years)
Antimony	4.20	31.8	6	79
Cyanide	0.00	230	200	1.4
Lead	52.10	24.7	15	1000
Mercury	0.04	4.7	2	65

Notes:

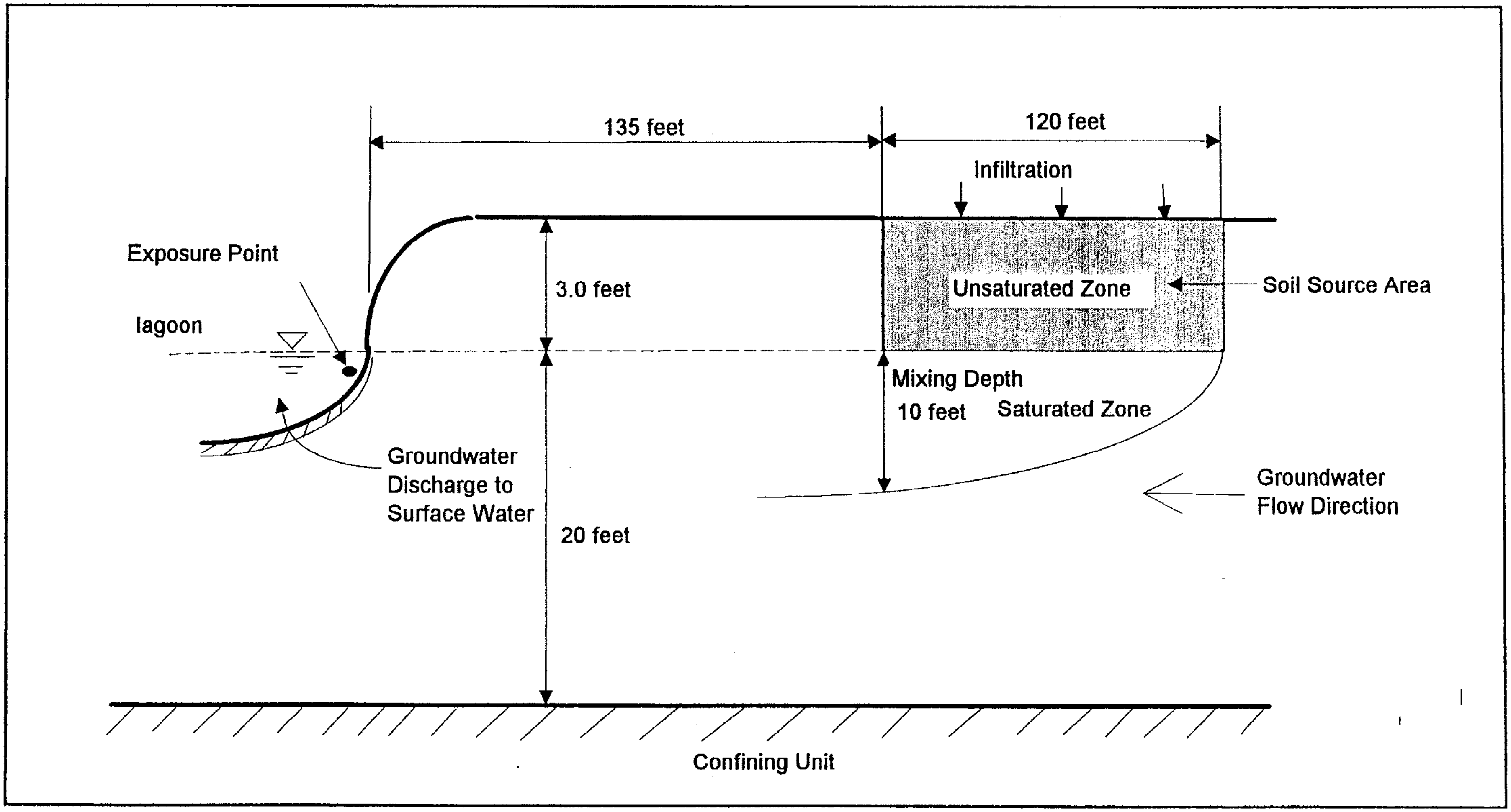
1. The maximum detected concentrations in soils were based on Tables 3-1 and 3-2, Supplemental RCRA Facility Investigation and Remedial Investigation Report, January 1998.
2. The maximum detected concentrations in groundwater were based on Table 3-5, Supplemental RCRA Facility Investigation and Remedial Investigation Report, January 1998.
3. MCLs were obtained from "Drinking Water Regulations and Health Advisories," USEPA Washington, D.C., October 1996.
4. The washout times were calculated at the saturated layer under the source area.

TABLE 15
PREDICTED SOIL WASHOUT TIME USING FATE AND TRANSPORT MODELING CHEMICALS IN SOIL EXCEEDING SOIL TO GROUNDWATER CRITERIA SWMU 5, NAS KEY WEST

Chemical	Initial Soil Concentration (Max detected conc.) (1) (mg/kg)	Initial Groundwater Concentrations (2) (ug/L)	Maximum Contaminant Level (MCL) (3) (ug/L)	Predicted Soil Washout Times (4) (years)
Cadmium	12.60	4.8	5	640
Methylene Chloride	20	2	5	2

Notes:

1. The maximum detected concentrations in surface and subsurface soils were based on Tables 3-2 and 3-1, Supplemental RCRA Facility Investigation and Remedial Investigation Report, January 1998 respectively.
2. The maximum detected concentrations in groundwater were based on Table 3-5, Supplemental RCRA Facility Investigation and Remedial Investigation Report, January 1998.
3. MCLs were obtained from "Drinking Water Regulations and Health Advisories," USEPA Washington, D.C., October 1996.
4. The washout times were calculated at the saturated layer under the source area.



Not to Scale

Figure 1 Conceptual Model for Soil RGOs Development (SWMU 5)

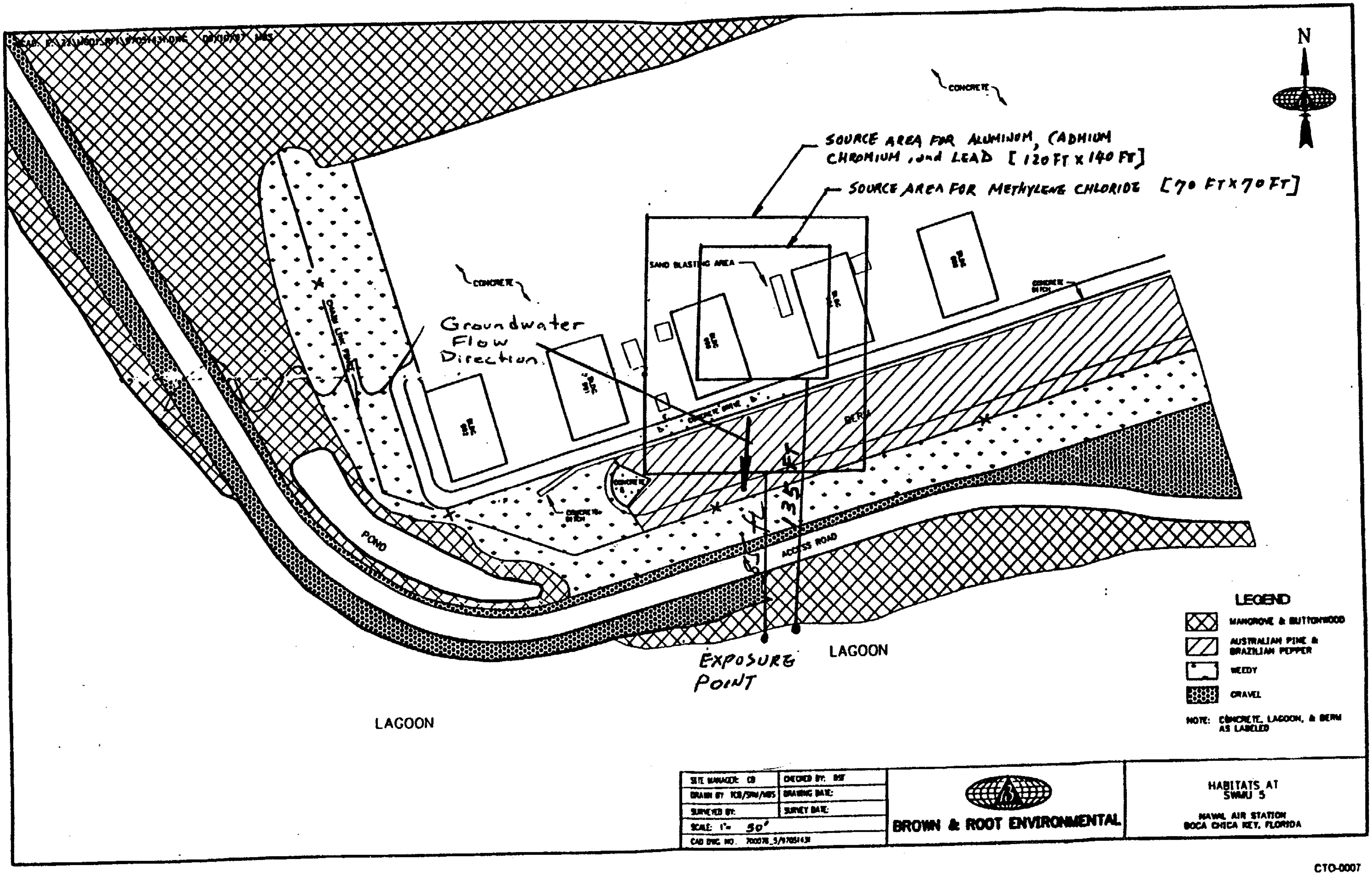


Figure 2 Source Area and Exposure Point for Soil RGO Development (SWMU 5)

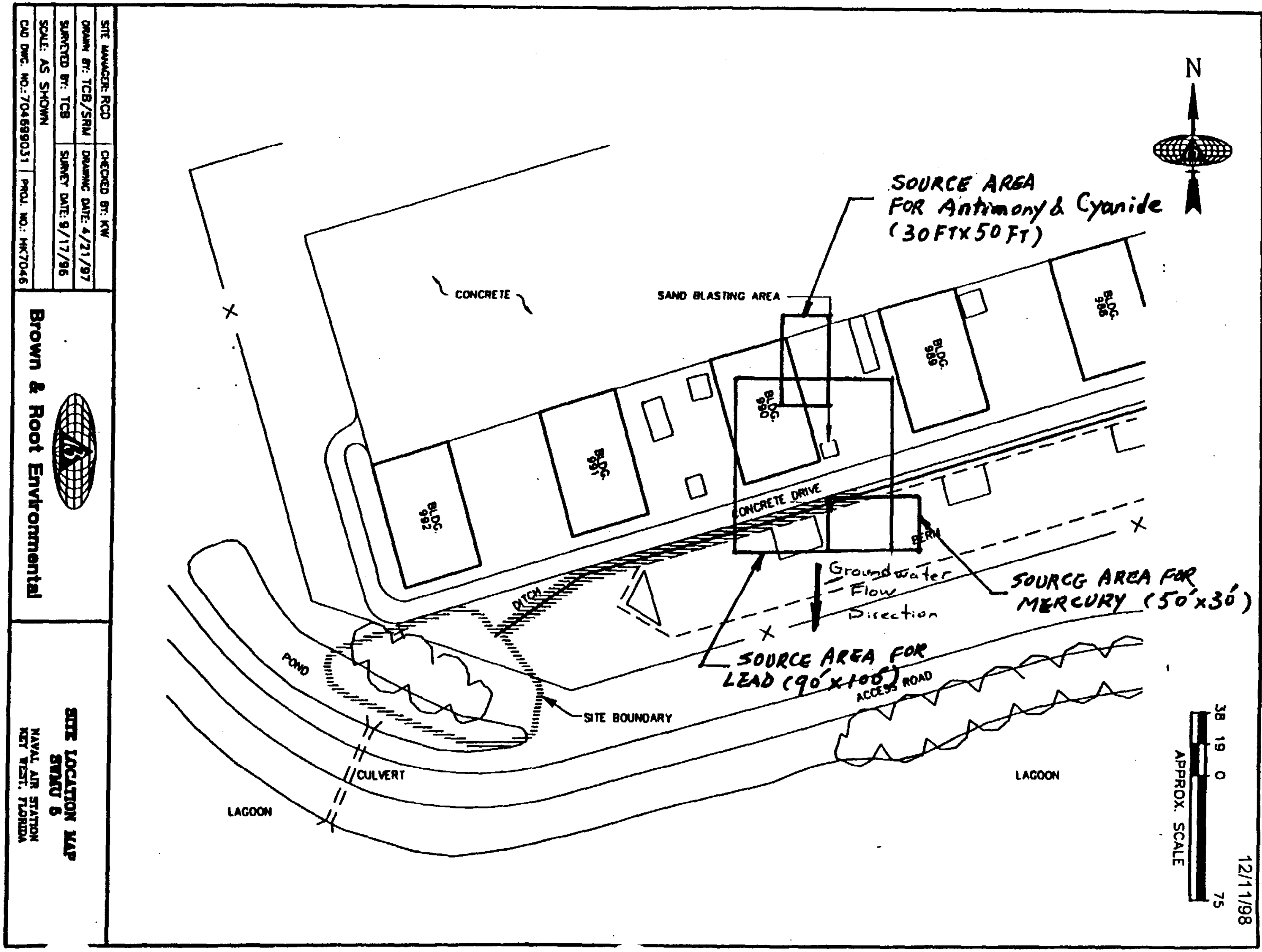


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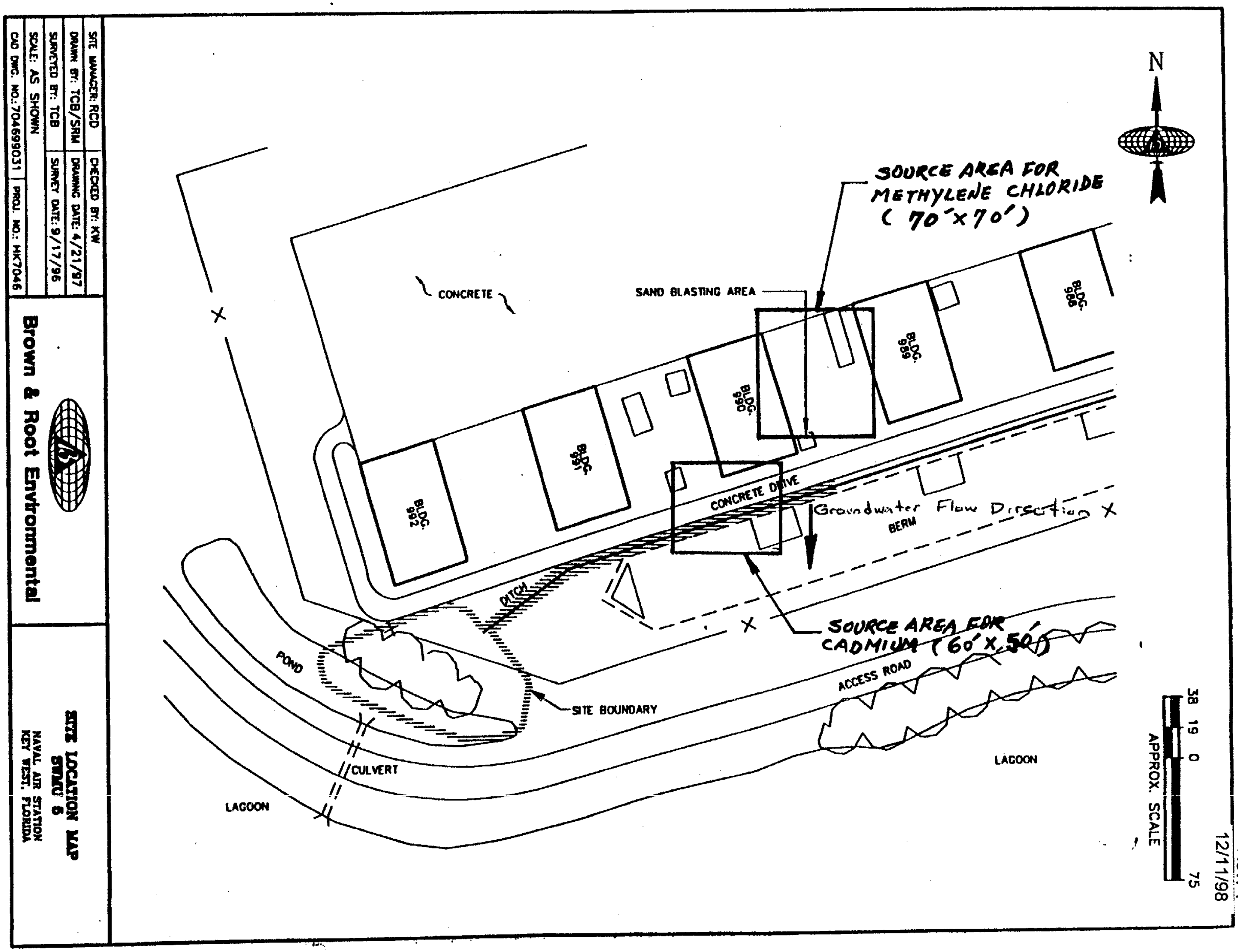
Figure 3 Source Area for Groundwater Washout Time Estimation (SWMU 5)



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APPENDIX C

COST ESTIMATE

NAVAL AIR STATION
Boca Chica Key, Florida
SWMU 5
Alternative No. 2 -Institutional Controls with Monitoring

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Total Cost Subcontract	Total Cost Material	Total Cost Labor	Total Cost Equipment	Total Direct Cost
1.1 Warning Signs	6	ea		$70.00	$15.00	$10.00	$0	$420	$90	$60	$570
1.2 Monitoring Well Installation	1	ls	$2,000.00				$2,000	$0	$0	$0	$2,000
Subtotal							$2,000	$420	$90	$60	$2,570
Overhead on Labor Cost @ 30%									$27		$27
G & A on Labor Cost @ 10%									$9		$9
G & A on Material Cost @ 10%								$42			$42
G & A on Subcontract Cost @ 10%							$200				$200
Total Direct Cost							$2,200	$462	$126	$60	$2,848
Indirects on Total Direct Labor Cost @ 75%									$95		$95
Profit on Total Direct Cost @ 10%											$285
Subtotal											$3,227
Total Field Cost											$3,227
Contingency on Total Field Cost @ 20%											$645
Engineering on Total Field Cost @ 20%											$645
TOTAL COST											**$4,518**

NAVAL AIR STATION
Boca Chica Key, Florida
SWMU 5
Alternative No. 2 -Institutional Controls with Monitoring
Annual Cost

Item	Item Cost Year 1	Item Cost Years 2 - 10	Item Cost every 5 years	Notes*
Sampling	$16,000	$4,000		Collect 6 groundwater, 6 surface water and 6 sediment samples, per sample period, plus travel, living and shipping cost.
Analysis	$7,200	$1,800		6 groundwater, 6 surface water and 6 sediment samples analyzed for inorganics.
Report	$16,000	$4,000		Forty hours per sampling report plus other direct cost
Site Review			$20,000	Analysis Review performed for years 5 & 10
TOTALS	$39,200	$9,800	$20,000	

* Sample numbers include 3 QA/QC samples per medium.

NAVAL AIR STATION
Boca Chica Key, Florida
NAVAL AIR STATION
Boca Chica Key, Florida - SWMU 5
Alternative No. 2 -Institutional Controls with Monitoring
Present Worth Analysis

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$4,518		$4,518	1.000	$4,518
1		$39,200	$39,200	0.935	$36,652
2		$9,800	$9,800	0.873	$8,555
3		$9,800	$9,800	0.816	$7,997
4		$9,800	$9,800	0.763	$7,477
5		$29,800	$29,800	0.713	$21,247
6		$9,800	$9,800	0.666	$6,527
7		$9,800	$9,800	0.623	$6,105
8		$9,800	$9,800	0.582	$5,704
9		$9,800	$9,800	0.544	$5,331
10		$29,800	$29,800	0.508	$15,138
				TOTAL PRESENT WORTH	**$125,252**

NAVAL AIR STATION
Boca Chica Key, Florida
SWMU 5
Alternative No. 3 - Excavate Soil and Treat and/or Dispose Offsite; Institutional Controls

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Total Cost Subcontract	Total Cost Material	Total Cost Labor	Total Cost Equipment	Total Direct Cost
1 MOBILIZATION/DEMOBILIZATION											
1.1 Storage Trailer (1)	1	mo	$500.00				$500	$0	$0	$0	$500
1.2 Construction Survey	1	ls	$4,000.00				$4,000	$0	$0	$0	$4,000
1.3 Equipment Mobilization/Demobilization	1	ls	$5,000.00				$5,000	$0	$0	$0	$5,000
1.4 Decontamination Trailer	1	mo	$1,500.00				$1,500	$0	$0	$0	$1,500
2 DECONTAMINATION											
2.1 Laundry Service	4	wks	$250.00				$1,000	$0	$0	$0	$1,000
2.2 Truck Decon Pad											
a) Concrete Pad - 8"	40	cy		$70.00	$125.00	$5.00	$0	$2,800	$5,000	$200	$8,000
b) Gravel Base - 6"	30	cy		$7.50	$3.33	$8.00	$0	$225	$100	$240	$565
c) Curb	120	lf		$3.07	$1.99	$0.05	$0	$368	$239	$6	$613
d) Collection Sump	1			$1,450.00	$500.00	$220.00	$0	$1,450	$500	$220	$2,170
e) Splash Guard	280	sf		$1.25	$1.00		$0	$350	$280	$0	$630
2.2 Decontamination Services (man-weeks)	1	mo	$1,200.00	$840.00			$1,200	$840	$0	$0	$2,040
2.3 Decon Water	10000	gal	$0.20				$2,000	$0	$0	$0	$2,000
2.4 Decon Water Storage Tank, 6,000 gallon	1	mo		$5,000.00	$400.00		$0	$5,000	$400	$0	$5,400
2.5 Clean Water Storage Tank, 4,000 gallon	1	mo		$3,000.00	$300.00		$0	$3,000	$300	$0	$3,300
2.6 Warning Signs	6	ea		$70.00	$15.00	$10.00	$0	$420	$90	$60	$570
CONTAMINATED SOIL DISPOSAL											
3.1 Excavate Contaminated Soil	100	cy			$1.00	$3.04	$0	$0	$100	$304	$404
3.2 Load Soil	100	cy			$0.51	$0.65	$0	$0	$51	$65	$116
3.3 Haul and Dispose of Contaminated Soil: Nonhazardou	135	ton	$60.00				$8,100	$0	$0	$0	$8,100
3.4 Pre-Design Sampling Analysis	10	ea	$100.00				$1,000	$0	$0	$0	$1,000
3.5 TCLP Analysis - Arsenic	1	ea	$130.00				$130	$0	$0	$0	$130
RESTORATION											
4.1 Confirmatory Sampling Analysis - Metals	5	ea	$100.00				$500	$0	$0	$0	$500
4.2 Backfill Sand	50	cy		$6.00	$2.70	$7.43	$0	$300	$135	$372	$807
a) Place, Spread & Compact	50	cy			$0.84	$2.67	$0	$0	$42	$134	$176
4.3 Backfill Topsoil - 6"	50	cy		$12.50	$2.70	$7.43	$0	$625	$135	$372	$1,132
a) Place & Spread	50	cy			$0.65	$0.86	$0	$0	$33	$43	$76
4.4 Revegetation	3	msf		$24.60	$8.40	$6.68	$0	$74	$25	$20	$119
4.5 Monitoring Well Installation	1	ls	$2,000.00				$2,000	$0	$0	$0	$2,000
Subtotal							$26,930	$15,452	$7,429	$2,035	$51,846
Overhead on Labor Cost @ 30%									$2,229		$2,229
G & A on Labor Cost @ 10%									$743		$743
G & A on Material Cost @ 10%								$1,545			$1,545
G & A on Subcontract Cost @ 10%							$2,693				$2,693
Total Direct Cost							$29,623	$16,997	$10,401	$2,035	$59,056

NAVAL AIR STATION
Boca Chica Key, Florida
SWMU 5
Alternative No. 3 - Excavate Soil and Treat and/or Dispose Offsite; Institutional Controls

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Total Cost Subcontract	Total Cost Material	Total Cost Labor	Total Cost Equipment	Total Direct Cost
Indirects on Total Direct Labor Cost @ 75%									$7,801		$7,801
Profit on Total Direct Cost @ 10%											$5,906
Subtotal											$72,763
Health & Safety Monitoring @ 10%											$7,276
Total Field Cost											$80,039
Contingency on Total Field Cost @ 20%											$16,008
Engineering on Total Field Cost @ 20%											$16,008
TOTAL COST											**$112,054**

NAVAL AIR STATION
Boca Chica Key, Florida
SWMU 5
Alternative No. 3 - Excavate Soils, Offsite Treatment and/or Disposal, Institutional Controls
Annual Cost

Item	Item Cost Year 1	Item Cost Years 2 - 10	Item Cost every 5 years	Notes*
Sampling	$16,000	$4,000		Collect 6 groundwater, 6 surface water and 6 sediment samples, per sample period, plus travel, living and shipping cost.
Analysis	$7,200	$1,800		6 groundwater, 6 surface water and 6 sediment samples analyzed for inorganics.
Report	$16,000	$4,000		Forty hours per sampling report plus other direct cost
Site Review			$20,000	Analysis Review performed for years 5 & 10
TOTALS	$39,200	$9,800	$20,000	

* Sample numbers include 3 QA/QC samples per medium.

NAVAL AIR STATION
Boca Chica Key, Florida
NAVAL AIR STATION
Boca Chica Key, Florida - SWMU 5
Alternative No. 3 - Excavate Soils, Offsite Treatment and/or Disposal, Institutional Controls
Present Worth Analysis

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$112,054		$112,054	1.000	$112,054
1		$39,200	$39,200	0.935	$36,652
2		$9,800	$9,800	0.873	$8,555
3		$9,800	$9,800	0.816	$7,997
4		$9,800	$9,800	0.763	$7,477
5		$29,800	$29,800	0.713	$21,247
6		$9,800	$9,800	0.666	$6,527
7		$9,800	$9,800	0.623	$6,105
8		$9,800	$9,800	0.582	$5,704
9		$9,800	$9,800	0.544	$5,331
10		$29,800	$29,800	0.508	$15,138
				TOTAL PRESENT WORTH	**$232,788**

APPENDIX D

CNBJAXINST 5090.2N4

5-AUG-97

DEPARTMENT OF THE NAVY
COMMANDER NAVAL BASE JACKSONVILLE
BOX 102, NAVAL AIR STATION
JACKSONVILLE, FLORIDA 32212-0102

CNBJAXINST 5090.2
N4

COMMANDER, NAVAL BASE, JACKSONVILLE INSTRUCTION 5090.2

Subj: LAND USE RESTRICTIONS (LURS) AT ENVIRONMENTAL REMEDIATION SITES ON BOARD U.S. NAVY INSTALLATIONS

Ref: (a) Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. § § 9601 *et seq.*
(b) Resource Conservation and Recovery Act (RCRA), 42 U.S.C. §§ 6901 *et seq.*
(c) OPNAVINST 5090.1B

1. Purpose. To establish a systematic program, protective of human health and the environment, governing land use at environmental remediation sites on board selected U.S. Navy installations in the Commander, Naval Base, Jacksonville (COMNAVBASE JAX) Area of Responsibility (AOR).

2. Applicability. This instruction applies to sites undergoing environmental remediation at Naval Air Station, Jacksonville, FL, Naval Air Station Key West, FL, and Naval Station, Mayport, FL.

3. Discussion. The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Resource Conservation and Recovery Act (references (a) and (b)) are the two primary federal laws governing the remediation of sites contaminated with hazardous substances and hazardous wastes. The U.S. Navy created the environmental remediation program to oversee the clean-up of these sites on board Naval facilities. Per reference (c), the Naval Facilities Engineering Command (NAVFAC) has been assigned the responsibility for centralized management of the installation restoration program. Southern Division (SOUTHDIV) is the NAVFAC component responsible for administration of the environmental remediation program for the U.S. Navy installations in the COMNAVBASE JAX AOR. The Florida Department of Environmental Protection (FDEP) and the U.S. Environmental Protection Agency (EPA) Region IV (hereafter referred to as "the agencies") have oversight and coordinating responsibilities over NAVFAC remediation actions. Remediation standards for clean-up of contaminated sites are established to ensure protection for human health and the environment.

a. Environmental restoration is a very costly process. There are an estimated 3300 sites nation-wide on board U.S. Navy and U.S. Marine Corps installations. Currently, the U.S. Navy's nationwide funding level is projected at just under $300 million per year.

b. Tens to hundreds of millions of dollars can be saved through the selection of clean-up remedies which appropriately reflect the current and future land use. However, to be effective, these future LURs must be strictly monitored and enforced. The agencies have expressed concern that the U.S. Navy lacks an effective mechanism to adequately ensure retention of identified LURs. This could allow the U.S. Navy to benefit from less stringent and thereby less costly remediation.

c. Consequently, the agencies are reluctant to accept final agreements (Records of Decision (ROD)) which do not include LURs (AKA institutional controls). This has impacted the "close out" of action at remediation sites on several installations. This instruction establishes a mechanism through which each Naval installation can enter into a Memorandum of Agreement (MOA) with the agencies, promulgate local instructions, develop a process to change land use where required, select optimum land use categories, optimize the use of scarce remediation funds, and ensure the maintenance of the identified land use category.

4. Action

a. Commanding Officers (COs): COs of installations conducting environmental remediation projects shall adopt local instructions which include, at a minimum, the following:

(1) A mechanism to enter into a MOA between the installation (including installation planners, Resident Officer-in-Charge of Construction (ROICC), installation environmental personnel and SOUTHDIV) and the agencies overseeing the present and anticipated land use category on a site-by-site basis. This will allow selection of clean-up standards that are protective of human health and the environment without unnecessary expenditure of limited fiscal resources. The local MOA can be supported and reinforced through RODs, closure permit restrictions (in the case of RCRA corrective actions) and environmental documentations performed under the National Environmental Policy Act (NEPA).

(2) Retention of the identified land use category throughout the specified remediation period. Restrictions on changes in land shall be accomplished through strict adherence to such vehicles as the base master planning process.

(3) A requirement for the installation environmental program manager to conduct routine LUR review of identified remediation sites, with incorporation of this responsibility into the environmental program manager's position description.

(4) A requirement for the installation Environmental Compliance Board (ECB) (developed under paragraph 1-2.14 of reference (c)) to review on a quarterly basis the status of adherence to the LURs.

(5) A requirement to forward an annual report to the agencies (with a copy to SOUTHDIV) certifying retention of the specified LUR category for each affected site on the installation.

(6) The installation CO must follow identification of the proper procedures in order to obtain concurrence from the agencies to change a previously identified LUR for a site. Concurrence of the agencies must be obtained in writing prior to commencing any construction or other activity inconsistent with the previous LUR. Requests for review of a LUR change proposal will consider the degree of change proposed, the effectiveness of the remediation effort to date, any natural remediation which may have occurred since the original remedial actions, etc.

(7) A requirement to notify the agencies if, despite proper precautions, an unauthorized change in land use is discovered by the installation. The change in land use will be reported immediately to the agencies for collaborative determination of an appropriate remedy.

(8) A notation that any funding associated with additional remediation caused by a LUR change (whether approved or unauthorized) will be the responsibility of the installation CO.

b. SOUTHDIV: As the agency responsible for the management of environmental remediation projects, SOUTHDIV shall accomplish the following:

(1) Take the lead in coordinating the drafting of a MOA to establish the specific agreement between each covered installation, the agencies and SOUTHDIV. At a minimum, the MOA will address real estate issues, LURs and remediation requirements.

(2) Support the installation CO, as required, during negotiations with the agencies.

(3) Review the installation's LUR instruction when conducting the tier two Environmental Compliance Evaluation (ECE) in support of the major claimant.

5. Special Note. The FDEP-EPA-U.S. Navy partnering team will view strong participation in this process to govern land use at environmental remediation sites positively, i.e., funding priority will be given to the most efficient site remediations.

KEVIN F. DELANEY

Distribution:
CNBJINST 5605.1
List IV: FA6a, FA6b, FA7a
List II: 26JJ1a, FA47a, FT48a

APPENDIX E

RESPONSE TO REGULATORY COMMENTS MADE TO THE DRAFT CMS FOR SWMU 5 (Rev. 0) DATED APRIL 1998

RESPONSE TO U.S. EPA COMMENTS
DRAFT SWMU 5 CMS, NAS KEY WEST

1. **Comment: Page 1-6, Figure 1-2.** The scale in this figure is not accurate and should be modified accordingly. Also, Sigsbee Key is still labeled Dredgers Key on this map.

   Response: Concur. The scale of the figure will be modified. Additionally, Sigsbee Key will be correctly labeled.

2. **Comment: Page 3-6, Section 3.2.1.4, Paragraph 3.** Executive Order 11988, Statement of Proceedings on Floodplain Management, should be considered as a potential location-specific ARAR or to-Be-Continued (TBC).

   Response: Concur. Executive Order 11988 will be considered as a potential location-specific ARAR or TBC.

3. **Comment: Page 3-13, Last full paragraph.** There is a typo in the first sentence. It is SWMU 5, not SWMU 7.

   Response: Concur. The typographical error will be corrected.

4. **Comment: Page 5-2, Section 5.1.2,2nd to last paragraph.** Please clarify what is meant by "FDEP residential criteria".

   Response: The term "FDEP residential criteria" will be removed from the paragraph. The paragraph will be written to indicate that analytical results will be compared to the industrial action levels agreed to by the NAS Key West Partnering Team in the Site Investigation Work Plan for Ten BRAC Properties, January, 1998.

5. **Comment: Section 5.1.2, General.** The description of Alternative 2 would benefit from the addition of a figure showing where the institutional controls would apply.

   Response: Concur. A figure will be included in Chapter 5 depicting elements of the institutional controls alternative (e.g., sample locations).

6. **Comment: Page A-2, Appendix A, Section A.1.2.2, Alternative 2.** This section states the assumptions associated with enacting institutional controls. This section assumes that trespassers would make a concerted effort to avoid ingestion or contract with the media because of the hazard postings and the occupational workers would be required to spend less time at the site. Both assumptions rely on half of the original "no Action" exposure duration. According to the assumption in this section, occupational workers would be required to spend half as much time at the site as normal. Procedures for tracking this would be required. If institutional controls are adopted as a part of the remedy, then procedure for tracking this should be developed as a part of remedy implementation.

   Response: In conjunction with the Land-Use Controls Implementation Plan (LUCIP), as will be agreed to by the NAS Key West Partnering Team, such concerns will be addressed.

7. **Comment: Page 1 of 2, Appendix C, Alternative 3.** The costing spreadsheet, Line Item 4.1, Confirmatory Sampling Analysis, indicates that metals and polychlorinated biphenyls (PCBs) are to be analyzed This conflicts with the text of the report and the Annual Costs sheets within Appendix C, which indicate only inorganics analyses. It is recommended that the reference to PCBs be removed from the costing spreadsheet.

   Response: Line Item 4.1 incorrectly states that PCBs and metals analysis will be conducted. Only metals analysis will be performed. However, the cost indicated in Line Item 4.1 correctly reflects the costs associated with the analysis of metals. The reference to PCBs will be removed from the costing spreadsheet.

RESPONSE TO FDEP COMMENTS
DRAFT SWMU 5 CMS, NAS KEY WEST

1. **General Comment:** The text in the CMS reports should include language that clearly states FDEP must manage risk to a 1E-06 estimated level of risk.

   Response: Per the agreement with the NAS Key West Partnering Team, carcinogenic risks in excess of 1E-06 will be managed via the LUCIP for SWMU 5.

2. **General Comment:** FDEP requests that risk management tools be implemented at SWMUs 5 and 7.

   Response: Risk management tools shall be discussed and agreed upon by the Partnering Team and included in the Land Use Control Implementation Plan for SWMU 5.

3. **Comment: SWMU 5, Page 6-4.** Modify this page as follows:

   The recommended alternative for this site is Alternative 2 – Institutional Controls with Monitoring. Under this alternative, groundwater, sediment, and surface water would be sampled and analyzed at a frequency yet-to-be determined by the NAS Key West Partnering Team. Further, exposure to soil in the adjacent berm would be managed by implementing appropriate access restrictions to affected soil in said berm. The institutional control alternative is further described below.

   By separate MOA with the U.S. EPA and the FDEP, NAS Key West, on behalf of the Department of the Navy, agreed to implement periodic site inspection, condition certification, and agency notification procedures designed to ensure the maintenance by Station personnel of any site-specific land-use controls (LUC) deemed necessary for future protection of human health an the environment. A fundamental premise underlying execution of that agreement was that through the Navy's substantial good-faith compliance with the procedures called for therein, reasonable assurances would be provided to the U.S. EPA and FDEP as to the permanency of those remedies, which included the use of specific LUCs.

   Although the terms and conditions of the Memorandum of Agreement (MOA) are not specifically incorporated herein by reference, it is understood and agreed by the Navy, U.S. EPA, and FDEP that the contemplated permanence of the remedy reflected herein shall be dependent on the Station's substantial good-faith compliance with the specific LUC maintenance commitments reflected therein. Should such compliance not occur or should the MOA be terminated, it is understood that the protectiveness of the remedy concurred in may be reconsidered and that additional measures may need to be taken to adequately ensure necessary future protection of human health and the environment.

The proposed alternative, Institutional Controls with Monitoring, is protective of human health and the environment under current industrial land use, complies with State and Federal ARARs, and is cost effective.

Response: Concur. The text will be replaced.