DEPARTMENT OF THE AIR FORCE
HEADQUARTERS, 36TH WING (PACAF)
UNIT 14007, APO AP 96543-4007

07 August 2007

36 CES/CEVR
Unit 14007
APO AP 96543-4007

Mr. Mark Ripperda
Project Manager
U.S. Environmental Protection Agency
75 Hawthorne St., H-9-4
San Francisco, CA 94105-3901

Dear Mr. Ripperda

Attached are two copies of the Final Record of Decision (ROD) for Sites 6, 9, and 12. Main Base Operable Unit, Andersen Air Force Base, Guam.

Should you have any questions concerning these reports, please feel free to contact me at (671) 366-4692.

Sincerely

GREGG N. IKEHARA
IRP Program Manager

Attachment:
ROD (2 copies)

cc:
Mr. Mike S. Cruz, GEPA
Ms. Karla Brasaemle, Tech Law Inc.

Checklist for Records of Decision
(AFLSA/JACE Draft 1, 07Feb2005)

***Final Record of Decision for Sites 6, 9, and 12, Main Base Operable Unit, Andersen Air Force Base, Guam* (July 2007)**

Sources

- CERCLA: 42 USC §§ 9617(b) and 9621
- NCP: 40 CFR § 300.430(f)(5)
- OSWER # 9200.1-23P, *A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents,* July 1999, chapter 6
- SAF/IE 7Oct2003 *Air Force Policy on Performance-Based Records of Decision (RODs) for Land Use Control (LUC) Implementation*
- SAF/IEE 27Oct2004 *Air Force Cleanup Program Performance-Based Management Policy*

Site 6	Site 9	Site 12	
Statutory Requirements			
NA 2.14	NA 3.14	NA 4.16	Discussion of any significant changes from proposed plan and reasons for
Yes 5 and 6	Yes 5 and 6	Yes 5 and 6	Response to each significant comment, criticism and new data submitted regarding proposed plan
Yes 5	Yes 5	Yes 5	Must publish notice of ROD and make publicly available before commencing remedial action
Yes 2.7.1.4.3	Yes 3.7.1.4.4 and 3.7.2.4.1	Yes 4.9.1.4.2.5 and 4.9.2.4.1	Must determine action is necessary to be carried out to protect public health or welfare or the environment
Yes 2.13.3	Yes 3.13.3	Yes 4.15.3	Remedy must be cost-effective, taking into account short- and long-term costs, including operation and maintenance, for the entire period of remedy
NA 2.13.5	Yes 3.13.5	NA 4.15.5	Remedy meets preference to have as principal element treatment that permanently and significantly reduces the volume, toxicity or mobility, or explain why not
NA	NA	NA	Offsite transfer and disposal without such treatment least favored alternative where practicable treatment technology available
NA 2.13.4	Yes 3.13.4	Yes 4.15.4	Remedy selected must utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable
Yes 2.13.1	Yes 3.13.1	Yes 4.15.1	Remedy must be protective of human health and the environment, both as to degree of cleanup and control of further releases

Site 6	Site 9	Site 12	
Yes 2.13	Yes 3.13	Yes 4.15	For hazardous substances left onsite, meet ARARs or specify findings for waiver
Yes	Yes	Yes	No permits required for onsite response actions
Yes 2.10	Yes 3.10	Yes 4.12	Actions selected to be in accordance with the NCP to the extent practicable
NCP Requirements			
Yes 1.7 and 6	Yes 1.7 and 6	Yes 1.7 and 6	If NPL facility, EPA must agree with remedy selection
Yes 2.10.2, Tables 2-14 and 2-15	Yes 3.10.2, Tables 3-17 and 3-18	Yes 4.12.2 Tables 4 35 and 4-36	Document all facts, analyses of facts and site-specific policy determinations considered, "..as appropriate, and in a level of detail appropriate to the site…"
Yes 2.10	Yes 3.10	Yes 4.12	Must explain how the nine remedy selection criteria of § 300.430(e)(9)(ii) utilized to select remedy
Yes 2.10.1	Yes 3.10.1	Yes 4.12.1	• Protection of human health and the environment
Yes 2.10.2	Yes 3.10.2	Yes 4.12.2	• Compliance with ARARs
Yes 2.10.4	Yes 3.10.4	Yes 4.12.4	• Long-term protectiveness and permanence
Yes 2.10.5	Yes 3.10.5	Yes 4.12.5	• Reduction of toxicity, mobility or volume through treatment
Yes 2.10.3	Yes 3.10.3	Yes 4.12.3	• Short-term effectiveness
Yes 2.10.6	Yes 3.10.6	Yes 4.12.6	• Implementability
Yes 2.10.9	Yes 3.10.9	Yes 4.12.9	• Cost
Yes 2.10.7	Yes 3.10.7	Yes 4.12.7	• State acceptance (and EPA and local agencies)
Yes 2.10.8	Yes 3.10.8	Yes 4.12.8	• Community acceptance
Yes 2.9.1	Yes 3.9.1	Yes 4.11.1	Must include no action alternative
Yes 2.9.3	Yes 3.9.4	Yes 4.11.3.2	Describe how selected remedy is protective of human health and environment, explaining how it eliminates, reduces or controls human and environmental receptor exposure
Yes Table 2-15	Yes Table 3-18	Yes Table 4-36	ARARs the remedy will achieve
NA Table 2-15	NA Table 3-18	NA Table 4-36	ARARs that will not be met, the specific waiver and justification for the waiver
Yes 2.13.3	Yes 3.13.3	Yes 4.15.3	Explain how the remedy is cost-effective, by providing overall effectiveness proportional to cost

Site 6	Site 9	Site 12	
NA 2.13.4	Yes 3.13.4	Yes 4.15.4	Explain how the remedy utilizes permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent feasible
NA 2.13.5	NA 3.13.5	NA 4.15.5	Meets the preference for remedies employing treatment as a principal element to permanently and significantly reduce toxicity, mobility or volume, and if not, explain why not
Yes 2.8	Yes 3.8	Yes 4.10	Identify, as appropriate, remediation goals the remedy is expected to achieve, for all contaminants, media and pathways of concern
Yes 2.12, Table A-1	Yes 3.12.2, Table A-2	Yes 4.11.3.2, Table A-3	Identify appropriate media locations at which performance shall be measured, to include as appropriate engineering and institutional controls
Yes 2.13	Yes 3.13	Yes 4.15	Describe if hazardous substances will remain on site above levels that would allow for unlimited use and unrestricted exposure, such that a five-year review is required
Yes 2.12, Table A-1	Yes 3.12.2, Table A-2	Yes 4.11.3.2, Table A-3	If appropriate, commit to further analysis and long-term response measures within an appropriate time frame
NA 2.14	NA 3.14	NA 4.16	If the basic features of the remedy differ significantly from that presented in the proposed plan with respect to scope, performance or cost, discuss the changes and the reasons for the change if such changes could be reasonably anticipated (if not reasonably anticipated, need to revise proposed plan and new public comment period)
Yes 5	Yes 5	Yes 5	Respond to significant comments, criticisms and relevant new information submitted during public comment period (responsiveness summary)
Yes 5	Yes 5	Yes 5	Publish notice of availability of ROD in a major local newspaper of general circulation and place in administrative record before the commencement of remedial action
Air Force Policy Requirements			
Yes 1.7	Yes 1.7	Yes 1.7	Generic commitment for AF to implement, monitor, maintain and enforce remedies
Yes 2.8 and 2.12.2	Yes 3.8 and 3.12.2	Yes 4.10 and 4.11.3.2	Remedial objectives, to include for LUCs if a remedial component
Yes	Yes	Yes	Basic description of use and activity restrictions and a general description of the specific actions essential to carry them out. Normally this will include
Yes 2.9.3, Table A.1	Yes 3.9.4, Table A.2	Yes 4.11.3.2, Table A-3	• Annotation in base master plan
Yes 2.9.3, Table A.1	Yes 3.9.4, Table A.2	Yes 4.11.3.2, Table A-3	• Use of base construction review and dig permit systems

Site 6	Site 9	Site 12	
NA Table A.1	Yes 3.9.4, Table A.2	Yes Table A-3	• Fences and signs as appropriate
Yes Table A.1	Yes 3.9.4, Table A.2	Yes 4.11.3.2, Table A-3	Location of LUCs
Yes 2.9.3, Table A.1	Yes 3.9.4, Table A.2	Yes 4.11.3.2, Table A-3	Duration of LUCs
Yes 2.9.3, Table A.1	Yes 3.9.4, Table A.2	Yes 4.11.3.2, Table A-3	Entity(ies) responsible for LUCs
Yes Table A.1	Yes Table A.2	Yes 4.11.3.2, Table A-3	Monitoring frequency of LUCs
Yes Table A.1	Yes Table A.2	Yes Table A-3	Periodic report of LUC monitoring to regulators on an informational basis only, with copies filed in administrative record and information repository
Yes 2.9.3, Table A.1	Yes 3.9.4, Table A.2	Yes 4.11.3.2, Table A-3	Prompt notification to regulators of LUC deficiency/failure along with corrective measures taken or planned
Yes 2.9.3, Table A.1	Yes 3.9.4, Table A.2	Yes 4.11.3.2, Table A-3	Regulator concurrence for significant changes to use and activity restrictions and LUCs
Yes 2.9.3, Table A.1	Yes 3.9.4, Table A.2	Yes 4.11.3.2, Table A-3	Prior notification to regulators for transfer of property subject to LUCs
Yes 2.8	Yes 3.8	Yes 4.10	Cleanup levels based on promulgated standards, or reliable toxicological data that reflect the most current and best science available
Yes 2.8	Yes 3.8	Yes 4.10	Cleanup objectives and levels based upon current and reasonably anticipated (realistic) future land use and ground and surface water beneficial use designations, considering foreseeable mission needs
NA	NA	NA	Must do suitability analysis to determine if ARARs waiver available – if conditions for waiver met, AF/ILEV or AFRPA/DR written approval required

Note: Section numbers provided below response.
NA = not applicable

EPA OSWER Recommended Checklist: *Caveat: EPA guidance is not a source of legal requirements that fall within the CERCLA § 120 (a)(1) waiver of sovereign immunity. They do not constitute CERCLA implementing guidelines, rules regulations and criteria we must comply with under CERCLA § 120(a)(2). However, such guidance does represent years of accumulated experience and knowledge of both EPA, other regulators, and the regulated community, and*

provides a very helpful format to flush out and ensure the legal requirements above are met. Keep in mind that AF performance-based policy should be applied so that the document is streamlined, tailored, and performance oriented.

Further remember that ROD is both a legal document upon which any legal review is based (42 USC § 9613(j)(1)) and the "playbook" upon which remedy execution and implementation is based. If the ROD is not written in a reasonably understandable and thorough manner, it can't meet these fundamental requirements. Addressing the matters identified in the EPA OSWER checklist will further help ensure the above identified legal requirements have been sufficiently addressed and reasonably explained.

The EPA checklist can be found at pages 6-59 through 6-54 in the above referenced OSWER

THE UNITED STATES AIR FORCE

INSTALLATION RESTORATION PROGRAM

FINAL

RECORD OF DECISION
FOR
SITES 6, 9, AND 12
MAIN BASE OPERABLE UNIT

ANDERSEN AIR FORCE BASE, GUAM

August 2007

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13. ABSTRACT ***(Maximum 200 words)***

This Record of Decision (ROD) presents the rationale for selection of the preferred cleanup alternatives for Installation Restoration Program (IRP) Sites 6, 9, and 12 located in the Main Base Operable Unit at Andersen AFB, Guam. This ROD summarizes the history, environmental background, extent of contamination, associated human health and ecological risks, evaluation of remedial alternatives, public involvement, and the preferred remedies for these sites.

14. SUBJECT TERMS

- *Andersen AFB*
- *Remedial Investigation/Feasibility Study*
- *Installation Restoration Program*
- *Record of Decision*
- *Human Health Risk Assessment*
- *Ecological Risk Assessment*
- *Public Involvement*

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LIST OF ACRONYMS AND ABBREVIATIONS

95UCLM	95th percentile upper confidence limit of the mean
ADI	average daily intake
AFB	Air Force Base
AR	Administrative Record
ARAR	Applicable or Relevant and Appropriate Requirement
Battelle	Battelle Memorial Institute, Columbus
BCP	Base Comprehensive Plan
bcy	bank cubic yards
bgs	below ground surface
BTV	Background Threshold Value
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CES	Civil Engineer Squadron
CEVR	Civil Engineer Environmental Flight
CFR	Code of Federal Regulations
COC	Contaminant of Concern
COPC	Contaminant of Potential Concern
CSM	Conceptual Site Model
CRP	Community Relations Plan
CT	central tendency
CU	Consolidation Unit
cy	cubic yard
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethene
DDT	dichlorodiphenyltrichloroethene
DSI	Detailed Site Inventory
EA	EA Engineering, Science, and Technology, Inc.
EOD	Explosive Ordnance Disposal
EPC	Exposure Point Concentration
ERA	Ecological Risk Assessment
ESD	Explanation of Significant Difference
ESE	Environmental Science and Engineering
EQ	Ecological Quotient
FFA	Federal Facility Agreement
FS	Feasibility Study

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

GESL	Guam Endangered Species List
Guam EPA	Guam Environmental Protection Agency
GovGuam	Government of Guam
HARM	Hazard Assessment Rating Methodology
HASP	Health and Safety Plan
HEAST	Health Effects Assessment Summary Table
HHRA	Human Health Risk Assessment
HI	Hazard Index
HSWA	Hazardous and Solid Waste Act of 1982
HQ	hazard quotient
IC	Institutional Controls
ICF	ICF Technology, Inc.
IRP	Installation Restoration Program
IRIS	Integrated Risk Information System
LADI	lifetime average daily intake
LEAD99D	Lead Version 0.99D
LOAEL	Lowest Observed Adverse Effects Level
LUC	Land Use Control
LUCMP	Land Use Control Management Plan
MCL	Maximum Contaminant Level
mg/kg	milligrams per kilogram
mg/kg/day	milligrams per kilogram per day
mg/kg-bw/day	milligrams of Chemical per kilogram of body weight per day
µg/dL	micrograms per deciliter
µg/L	micrograms per Liter
mm	millimeter
MMRP	Military Munitions Response Program
MSA	Munitions Storage Area
msl	mean sea level
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NiCd	Nickel-Cadmium
NOAEL	No Observed Adverse Effect Level
O&M	Operation and Maintenance
OEW	ordnance and explosive waste
OHM	OHM Remediation Services Corp.
ORNL	Oak Ridge National Laboratory
OU	Operable Unit

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
POL	petroleum, oil, and lubricants
PRG	Preliminary Remediation Goal
RAB	Restoration Advisory Board
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RfDs	reference doses
RG	Remedial Goal
RI	Remedial Investigation
RIC	reactivity-ignitability-corrosivity
RI/FS	Remedial Investigation/Feasibility Study
RME	Reasonable Maximum Exposure
ROC	receptor of concern
ROD	Record of Decision
RPM	Remedial Program Manager
SAIC	Science Applications International Corporation
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act of 1986
SF	Slope Factor
SVOC	semivolatile organic compound
TAL	Target Analyte List
TBC	To Be Considered
TCLP	Toxicity Characteristic Leaching Procedure
TRV	Toxicity Reference Volumes
TSP	triple super phosphate
UCL	Upper Confidence Limit
UCLM	Upper Confidence Limit on the Mean
USAF	United States Air Force
USC	United States Code
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
UXO	Unexploded Ordnance
VOC	volatile organic compound
WSA	Weapons Storage Area

1. DECLARATION FOR SITES 6, 9, AND 12

1.1 Site Name and Location

Installation Restoration Program (IRP) Site 6/Landfill 8 (Site 6), Site 9/Landfill 13 (Site 9), and Site 12/Landfill 17 (Site 12) are located in the Main Base Operable Unit (OU) at Andersen Air Force Base (AFB), Guam. The locations of Guam, Andersen AFB, the Main Base OU, and the three sites are identified in Figures 1-1 through 1-6. The Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) identification number for Andersen AFB is GU6571999519.

1.2 Statement of Basis and Purpose

This Record of Decision (ROD) is a decision document prepared for Sites 6, 9, and 12. The purpose of this ROD is to present the public with a consolidated source of information regarding the history, environmental background, extent of contamination, associated human health and ecological risks, evaluation of remedial alternatives, public involvement, and the proposed selected remedy.

This decision document presents the selected remedy for Sites 6, 9, and 12, which were chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan of 1990 (NCP). This decision is based on the Remedial Investigation/Feasibility (RI/FS) for Sites 6, 9, and 12 and the Administrative Record (AR) files for these sites. The AR for the Main Base OU includes pertinent IRP documents, correspondence, and material related to the CERCLA investigations and cleanups. The Andersen AFB AR files, RI/FS for Sites 6, 9, and 12, and other pertinent documents are available for public review at the Robert F. Kennedy Library at the University of Guam and the Nieves M. Flores Memorial Library in Hagåtña.

The Air Force is selecting these remedies with the concurrence of the United States Environmental Protection Agency (USEPA) and the Guam Environmental Protection Agency (Guam EPA), under the guidelines established in the Federal Facilities Agreement (FFA) signed in February 1993 by representatives of USEPA Region 9, Guam EPA, and the United States Air Force (USAF).

1.3 Assessment of the Sites

The response actions selected in this ROD are necessary to protect public health and/or the environment from actual or threatened releases of hazardous substances from Sites 6, 9, and 12, which may present an imminent and substantial endangerment to public health or the environment.

1.3.1 Site 6

The contaminants of concern (COCs) that were identified in surface soils at Site 6 include aluminum and chromium. The COCs that were identified in subsurface soils at Site 6 include aluminum, antimony, and chromium. These COCs pose potential risks to human health (resident adults and children), but no unacceptable risks to the ecological receptors were identified. Additionally, a small area of remaining drum remnants was observed at the site that may pose physical safety risks and/or a potential contaminant source for the future.

1.3.2 Site 9

The COCs that were identified in surface soils at Site 9 include antimony, chromium, copper, and benzo(a)pyrene. The COCs that were identified in subsurface soils at Site 9 include antimony, copper, and lead. These COCs pose potential risks to human health (resident adults and children), but no unacceptable risks to the ecological receptors were identified. Additionally, unexploded ordnance (UXO) observed at Site 9 in the portion of the site located below the cliffline is a safety hazard that should be addressed by Air Force Explosive and Ordnance Disposal (EOD) personnel. Lead concentrations in surface soil below the cliffline were identified as a potential source of risk to the Mariana crow, yellow bittern, and terrestrial plants. Copper and zinc concentrations in surface soil below the cliffline were identified as a potential source of risk for terrestrial plants and soil invertebrates (earthworms).

1.3.3 Site 12

Area A

The COCs that were identified in surface soil at Site 12 Area A include antimony, arsenic, copper, lead, manganese, benzo(a)pyrene, dichlorodiphenyldichloroethene (DDE), dichlorodiphenyltrichloroethene (DDT), and dieldrin. The COCs that were identified in subsurface soils at Site 12 Area A include lead, benzo(a)anthracene, benzo(a)pyrene, and DDE. These COCs pose potential unacceptable risks to human health (resident adults and children). The COCs that were identified as posing potential unacceptable risks to the ecological receptors include copper, lead, dichlorodiphenyldichloroethane (DDD), DDE, and DDT.

Area B

The COCs that were identified in surface soils at Site 12 Area B include aluminum, antimony, arsenic, chromium, lead, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-c,d)pyrene. The COCs that were identified in subsurface soils at Site 12 Area B include aluminum, chromium, lead, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-c,d)pyrene. These COCs pose potential unacceptable risks to human health (resident adults and children). The COCs that were identified as posing potential unacceptable risks to the ecological receptors include lead and zinc.

Area C

There were no COCs identified for the surface and subsurface soils at Site 12 Area C.

Area D

There were no COCs identified for the surface and subsurface soils at Site 12 Area D.

Area E

Manganese was the only COC that was identified in surface soils at Site 12 Area E. However, the maximum detected concentration of manganese (3,490 milligrams per kilogram [mg/kg]) is less than its background threshold value (BTV) (5,500 mg/kg); therefore, no cleanup for manganese is required. There were no COCs identified in the subsurface soils at Site 12 Area E. There were no COCs that were identified as posing potential unacceptable risks to the ecological receptors at Site 12 Area E.

Area F

The COCs that were identified in surface soils at Site 12 Area F include cadmium and nickel. These COCs pose potential unacceptable risks to both human health (resident adults and children) and ecological receptors. There were no COCs identified in the subsurface soils at Site 12 Area F.

1.4 Description of the Selected Remedies

The preferred cleanup alternatives presented in this ROD are necessary response actions to protect human health and the environment at Sites 6, 9, and 12 and are summarized as follows:

Site	Selected Alternatives
Site 6	Institutional Controls
Site 9	Soil Removal with Treatment and Institutional Controls
Site 12 Areas A, B, and F	Soil Removal and Institutional Controls
Site 12 Areas C, D, and E	No CERCLA Remedial Action Required

1.4.1 Site 6

The *Institutional Controls* alternative is the preferred remedial alternative for Site 6 and would control exposure to resident children and adults by prohibiting development of the land for residential use. Due to its close proximity to the Consolidation Unit (CU) and the Munitions Storage Area (MSA), there is no likelihood that Site 6 would be developed for future residential use. As a conservative measure, signs would be posted to inform occasional users/trespassers not to disturb the subsurface soil. All work conducted at the site would require a work clearance permit that must be approved by the Andersen AFB Civil Engineer Squadron.

Additionally, approximately 5 cubic yards (cy) of asphalt, drums containing asphalt, and drum remnants are required for removal from Site 6 as part of the surface preparation activities for the *Institutional Controls* alternative. The debris includes asphalt material, which if not removed, is a potential continued source of PAH contamination. Removal of this debris will be similar to the removal action previously performed in 2000 (OHM Remediation Services Corp. [OHM], 2001).

Under this *Institutional Controls* alternative, the Base Comprehensive Plan (BCP) would have to be amended to prevent any facility development at the site. The public would be informed by publication of fact sheets and brochures.

1.4.2 Site 9

The *Removal of COC-impacted Surface and Subsurface Soil and Treatment Using Triple Super Phosphate (TSP)* above the cliffline is the preferred remedial alternative for Site 9. This alternative uses remedial goals (RGs) for both surface and subsurface soil removal under the future resident adult and children scenario at a cancer target risk of 10^{-5} (i.e., a one-in-one-hundred-thousand increase in cancer risk) and the non-cancer endpoint of hazard quotient (HQ) = 1 for non-carcinogens. The soil removal consists of excavating and disposing of impacted surface soil to a depth of one foot below ground surface (bgs) and subsurface soil to a depth of 4 feet bgs. Soil will be removed from an approximately 30-foot diameter centered around 'hot-spot' samples. This alternative would satisfy the CERCLA statutory preference of not transporting and disposing of hazardous or impacted materials off site when practical treatment technologies are available. In this alternative, TSP would be used to treat the COC-impacted surface and subsurface soil.

It was determined that the physical stressors that would be imposed on the habitat by removing the chemical stressors (copper-, zinc-, and lead-contaminated soil) would result in destruction of more habitat than it would protect. As such no cleanup below the cliffline is recommended to protect ecological receptors. Institutional controls, deed restrictions, and associated annual operation and maintenance (operation and maintenance [O&M]; annual site inspections to document that the Institutional Controls (ICs) and deed restrictions are being enforced) costs will be necessary for the approximately 3.5 acres of Site 9 located below the cliffline.

The presence of UXO at the lower portion of Site 9, below the cliffline, is a potential safety hazard. As the UXO is not eligible for removal using Environmental Restoration Authorization funds it will be removed in a separate action by the Andersen AFB EOD personnel.

1.4.3 Site 12

Areas A, B, and F

The *Soil Removal Protective of Ecological Receptors with Institutional Controls* is the preferred remedial alternative for Areas A, B, and F of Site 12. This alternative consists of excavating and disposing of COC-impacted soil/fill in areas where COCs exceed the ecological RGs. In

addition, institutional controls will be required to restrict exposure of future residential receptors to remaining contamination.

Soil with COC concentrations exceeding the RGs for this selected alternative would be excavated from each impacted area. Soil would be excavated and removed to a 2-foot depth for surface soils. No subsurface soils (soils deeper than 2 feet bgs) would be removed under this remedial alternative. The COCs in the soil at Areas A, B, and F are metals, pesticides, and/or polycyclic aromatic hydrocarbons (PAHs), which are relatively immobile and not expected to migrate to groundwater.

Areas C, D, and E

No Action is proposed for Areas C, D, and E because the results of the human health risk assessment (HHRA) and ecological risk assessment (ERA) indicate that there are no unacceptable risks to human or ecological receptors in these three areas.

1.5 Statutory Determination

The Selected Remedies for Sites 6, 9, and 12 (Areas A through F) are protective of human health and the environment, comply with Federal and Territory of Guam requirements that are applicable or relevant and appropriate to the remedial action, and are cost-effective. None of the Selected Remedies are permanent solutions because some COC-impacted soil will remain on site and require the inclusion of *Institutional Controls* so they are protective of human health and the environment. However, because there will be removal of some COC-impacted soil for Sites 9 and 12 (Areas A, B, and F), those Selected Remedies will reduce the toxicity, mobility, or volume of hazardous substances. Because no unacceptable risks to human health or the environment were identified at Site 12 Areas C, D, and E, no remedial action is required to achieve a permanent solution. Therefore, No Action is proposed for Site 12 Areas C, D, and E. Additionally, the Selected Remedy for Site 9 utilizes alternative treatment technologies to the extent practicable.

Because each of the cleanup alternatives selected for Sites 6, 9, and 12 will result in some hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years after initiation of the remedial actions to assure that the remedies are or will be protective of human health and the environment.

It should be noted that the OEW and UXO present at Site 9 (below the cliffline) pose a potential threat to human health by way of detonation. The investigations and cleanup of OEW and UXO at Site 9 are being addressed under the MMRP being conducted at Andersen AFB. Periodic review of Site 9 may be necessary to ensure that engineering or institutional controls remain intact and functional at the site until such a time that OEW/UXO are cleared from the area and no longer pose a potential threat.

1.6 ROD Data Certification Checklist

The following information is included in the Decision Summaries, Parts 2, 3 and 4 (Sites 6, 9, and 12, respectively) of this ROD, along with reference tables, figures, and section numbers for each of the three sites.

1.6.1 Site 6

- COCs and their respective concentrations for Site 6 are presented in Tables 2-2 and 2-3 and Figures 2-7 and 2-8.

- Summaries of human health risks are presented in Tables 2-4 and 2-5; and the baseline ecological risks are presented in Tables 2-6 through 2-9 and Figures 2-4 and 2-6. The summary of site risks is presented in Section 2.7.

- The established cleanup levels for each COC are presented in Table 2-10 and Figures 2-7 and 2-8.

- The principal threats from COC sources are discussed in Section 2.11.

- The current and reasonably anticipated future land use and current and potential future uses of groundwater in are presented in Section 2.6.

- The estimated present-worth remedial costs, including the projected number of years over which the remedial cost was estimated, are presented in Tables 2-12 and 2-13 and in Sections 2.10 and 2.12.

- Key factors that led to selection of *Institutional Controls* as a preferred cleanup alternative are presented in Section 2.13.

1.6.2 Site 9

- COCs and their respective concentrations in surface and subsurface soil at Site 9 are presented in Tables 3-2 and 3-3 and displayed in Figures 3-6 and 3-7.

- The risks represented to human receptors by each COC in surface and subsurface soil are presented in Tables 3-4 and 3-5. The ecological risks are presented in Tables 3-6 through 3-11.

- The established cleanup levels for each COC are presented in Table 3-12.

- The principal threats from COC sources are discussed in Section 3.11.

- The current and reasonably anticipated future land use and current and potential future uses of groundwater are presented in Section 3.6.

- The estimated present-worth remedial costs, including the projected number of years over which the remedial cost was estimated, are presented in Tables 3-14 through 3-16 and in Sections 3.10 and 3.12.

- Key factors that led to selection of *Soil Removal with Treatment* and *Institutional Controls* as a preferred cleanup alternative are presented in Section 3.13.

1.6.3 Site 12 (Areas A through F)

- COCs and their respective concentrations for Site 12 (Areas A through F) are presented in Tables 4-2 through 4-7 and Figures 4-18 and 4-24.

- The baseline human health risks represented by each COC are presented in Tables 4-8 through 4-16; and the baseline ecological risks are presented in Tables 4-17 through 4-20 and Figures 4-16 and 4-17. The summary of site risks is presented in Section 4.10.

- The established cleanup levels for each COC are presented in Tables 4-22 through 4-24 and Figures 4-18 and 4-24.

- The principal threats from COC sources are discussed in Section 4.14.

- The current and reasonably anticipated future land use and current and potential future uses of groundwater are presented in Section 4.8.

- The estimated present-worth remedial costs, including the projected number of years over which the remedial cost was estimated, are presented in Tables 4-29 through 4-34 and in Sections 4.13 and 4.15.

- Key factors that led to selection of *Soil Removal Protective of Ecological Receptors, Institutional Controls, and No Action* as a preferred cleanup alternative are presented in Section 4.16.

Additional background information regarding the environmental investigations at Sites 6, 9, and 12 can be found in the RI/FS for these sites which is available in the AR files at the Robert F. Kennedy Library at the University of Guam or the Nieves M. Flores Memorial Library in Hagåtña.

1.7 Authorizing Signatures and Supported Agency Acceptance of the Remedy

The following signature pages document that the USAF and the USEPA Region 9 have co-selected, and the Guam EPA concurs with the selected cleanup alternatives for Sites 6, 9, and 12, as presented in this ROD.

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This signature page documents that the USAF has co-selected the remedy with the USEPA and approves of the *Institutional Controls* cleanup alternative for Site 6; the *Soil Removal and Treatment* cleanup alternative for Site 9; the *Soil Removal and Institutional Controls* cleanup alternative for Site 12 Areas A, B, and F; and the *No Action* cleanup alternative for Site 12 Areas C, D, and E; as presented in this ROD.

Douglas H. Owens

DOUGLAS H. OWENS
Brigadier General, USAF
Commander

5 Sep 07
Date

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This signature page documents that the USEPA Region 9 has co-selected the remedy with the Air Force and approves of the *Institutional Controls (IC)* cleanup alternative for Site 6; the *Soil Removal and Treatment* cleanup alternative for Site 9; the *Soil Removal and IC* cleanup alternative for Site 12 Areas A, B, and F; and the *No Action* cleanup alternative for Site 12 Areas C, D, and E; as presented in this ROD.

Joel D. Christ ACTING for

Kathleen Johnson
Chief, Federal Facility and Site Cleanup Branch
U.S. Environmental Protection Agency, Region 9

9/5/07
Date

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This signature page documents that the Guam EPA concurs with the *Institutional Controls (IC)* cleanup alternative for Site 6; the *Soil Removal and Treatment* cleanup alternative for Site 9; the *Soil Removal and IC* cleanup alternative for Site 12 Areas A, B, and F; and the *No Action* cleanup alternative for Site 12 Areas C, D, and E; as presented in this ROD.

Lorilee T. Crisostomo
Administrator
Guam Environmental Protection Agency

9-7-2007
Date

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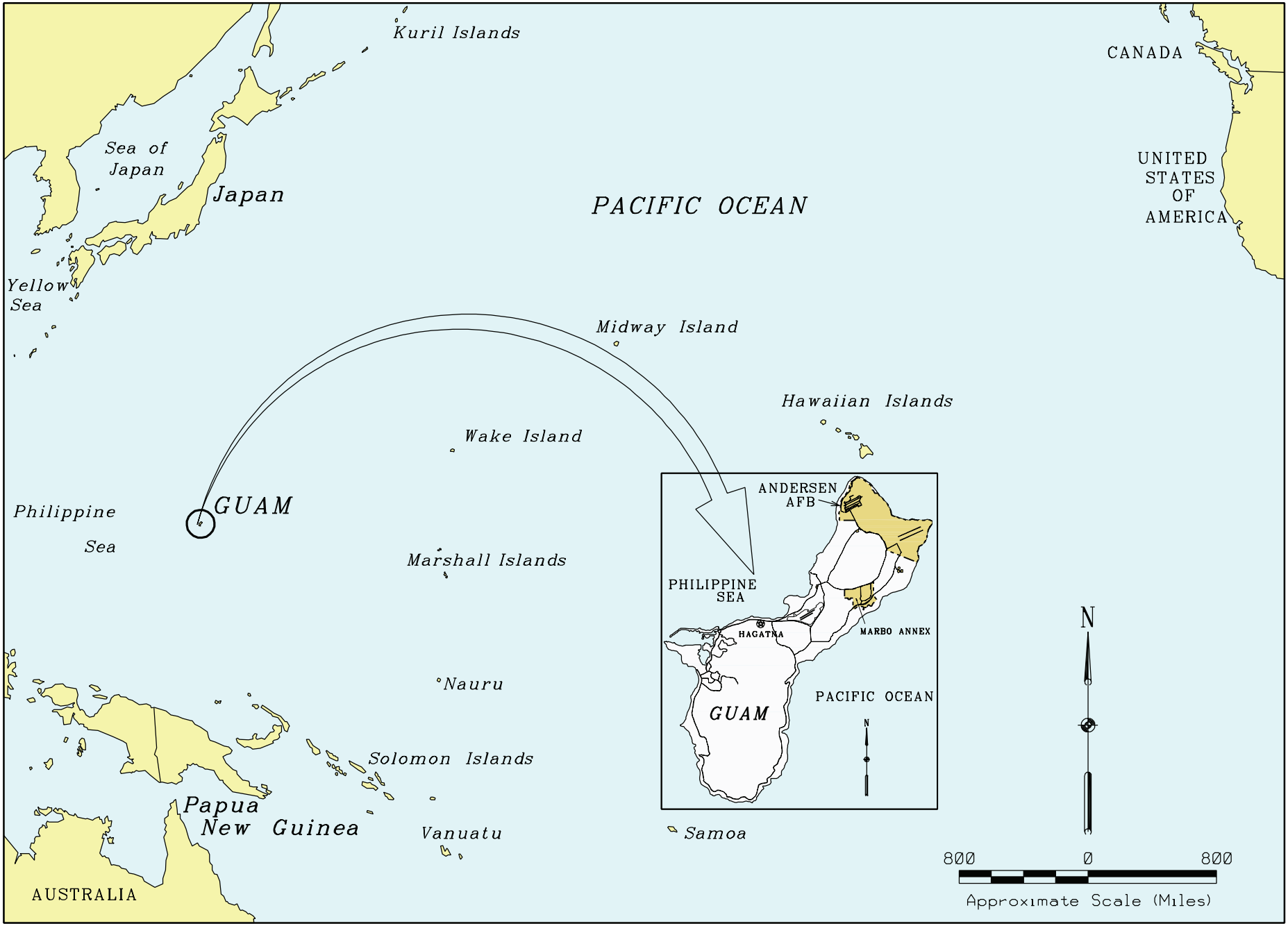


Figure 1-1. Location Map of Guam.

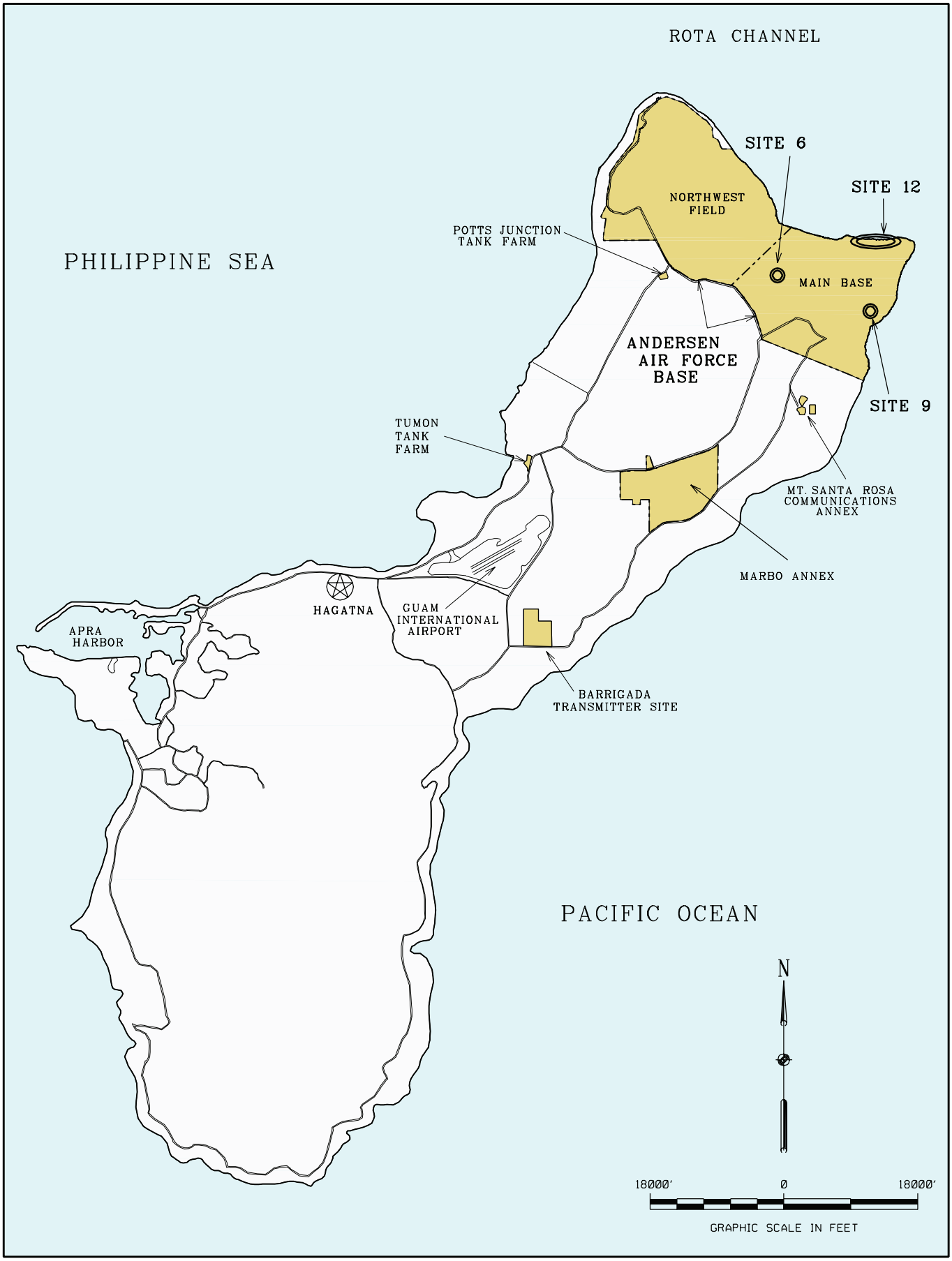


Figure 1-2. Location Map of Site 6, Site 9, and Site 12 on Andersen Air Force Base, Guam.

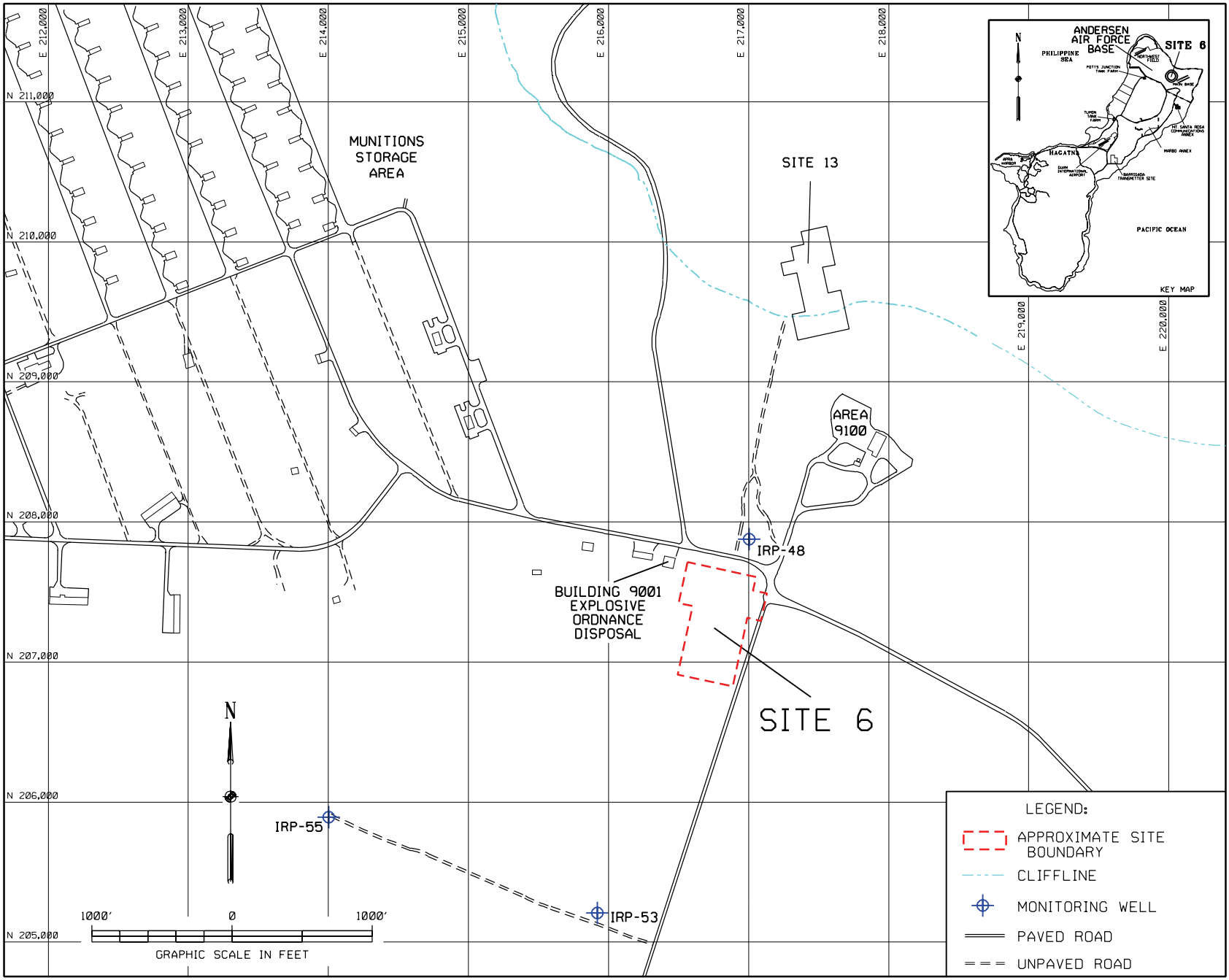


Figure 1-3. Location Map of Site 6 on Andersen Air Force Base, Guam.

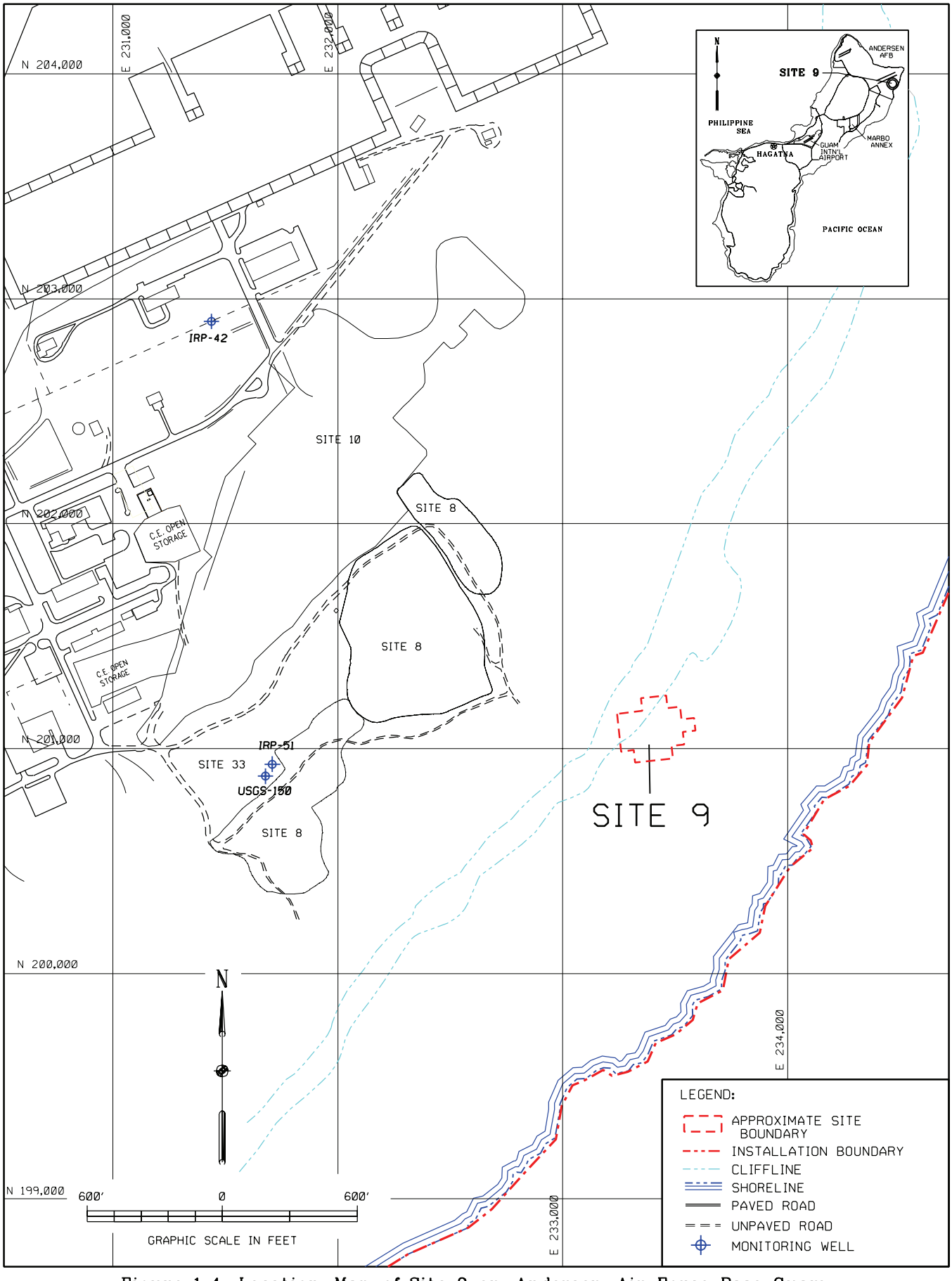
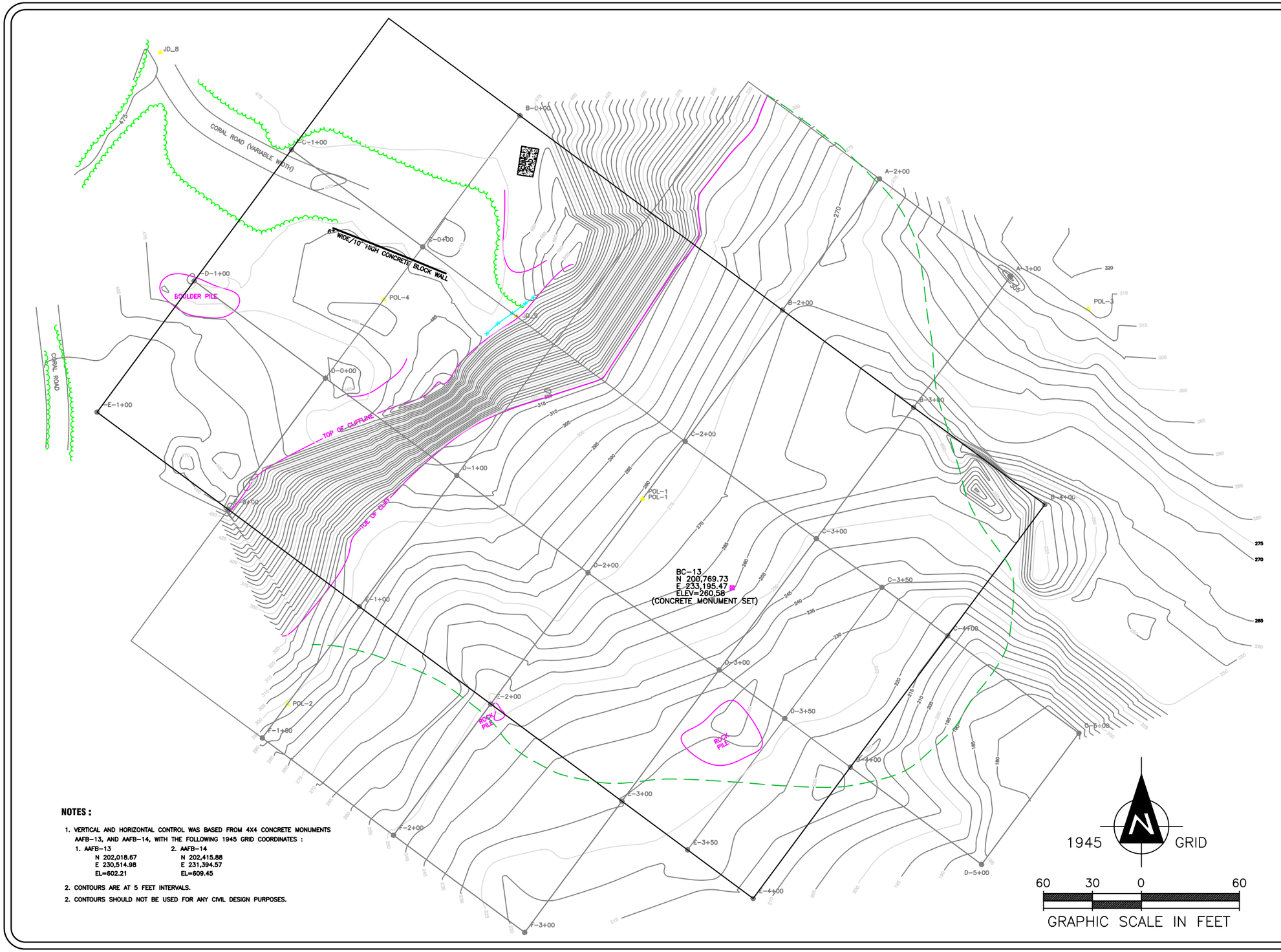
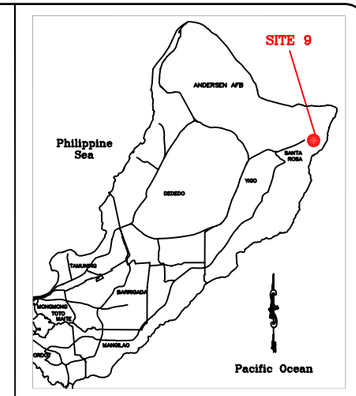


Figure 1-4. Location Map of Site 9 on Andersen Air Force Base, Guam.





SYMBOLS/LEGEND :

- EDGE OF VEGETATION
- A-0+00 GEOPHYSICAL SURVEY POINT
- SURVEY CONTROL POINT
- 500 CONTOUR LINE
- BOUNDARY LINE
- CLIFF LINE
- TRENCH LINE
- ESTIMATED EXTENT OF IMPACTED FILL MATERIAL

NOTES :

1. VERTICAL AND HORIZONTAL CONTROL WAS BASED FROM 4X4 CONCRETE MONUMENTS AAFB-13, AND AAFB-14, WITH THE FOLLOWING 1945 GRID COORDINATES :

1. AAFB-13	2. AAFB-14
N 202,018.67	N 202,415.88
E 230,514.98	E 231,394.57
EL=602.21	EL=609.45

2. CONTOURS ARE AT 5 FEET INTERVALS.
2. CONTOURS SHOULD NOT BE USED FOR ANY CIVIL DESIGN PURPOSES.

Figure 1-5.
Site Map, Site 9,
Andersen AFB, Guam.

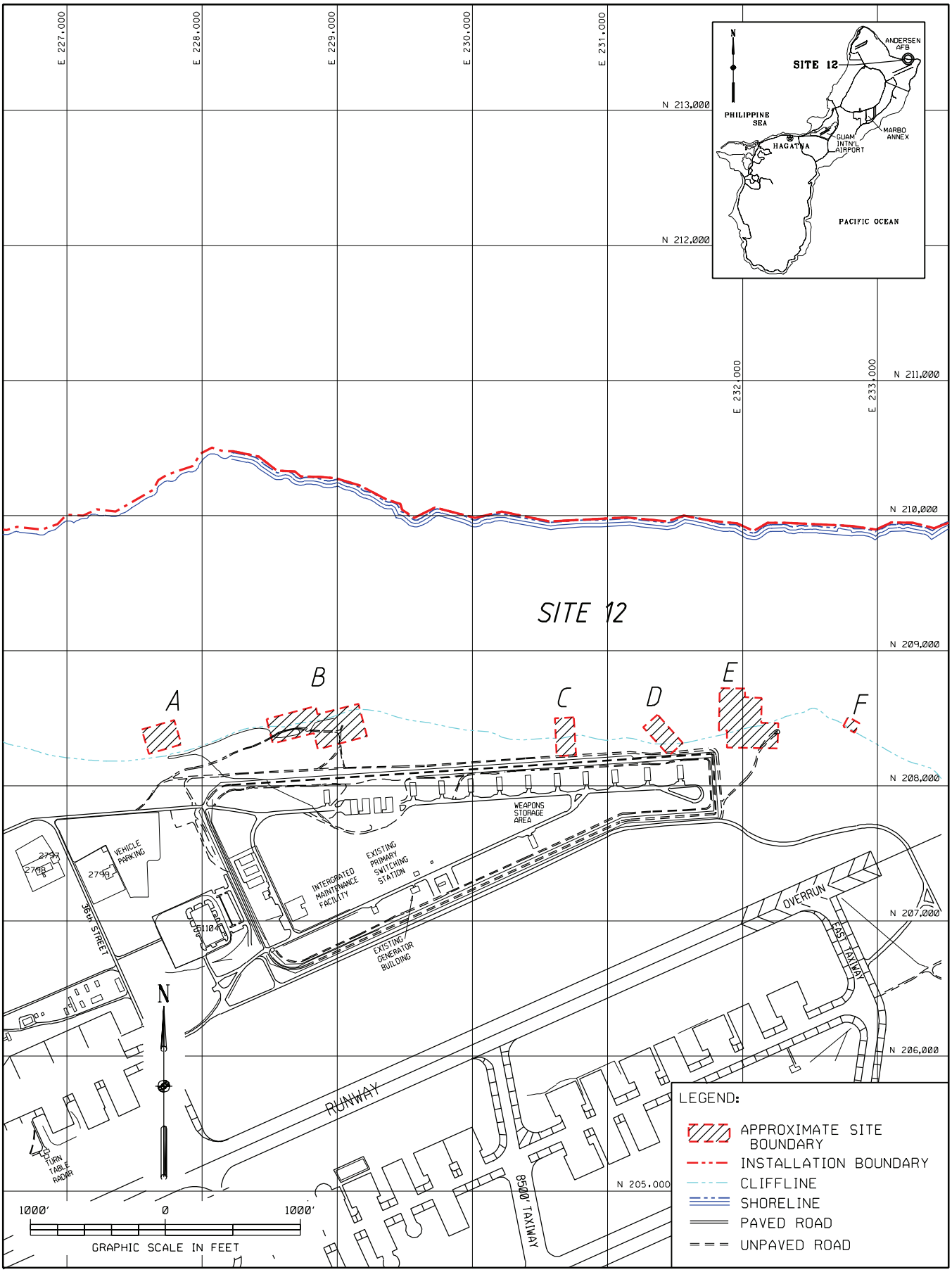


Figure 1-6. Location Map of Site 12 on Andersen Air Force Base, Guam.

2. DECISION SUMMARY FOR SITE 6

This decision summary for Site 6 presents an overview of the site description, environmental characteristics, history, public involvement, nature and extent of contamination, associated human health and ecological risks, remedial alternatives, and rationale for selecting the preferred remedial actions in light of the statutory requirements. A detailed RI/FS was completed in June 2006 (EA Engineering Science and Technology, Inc. [EA], 2006).

This decision summary was prepared for Site 6, which is located in the Main Base OU of Andersen AFB, Guam. The following brief description of the location and setting of Guam and Andersen AFB are provided in this chapter and are not repeated in Chapters 3 or 4 (Decision Summaries for Sites 9 and 12, respectively). Guam is the largest of the Mariana Islands and is located in the western Pacific Ocean between 13°15′ and 13°39′ north latitude and 144°37′ and 144°57′ east longitude, approximately halfway between Japan and New Guinea (Figure 1-1). The island has an area of nearly 209 square miles and is approximately 30 miles long and 4 to 8 miles wide. Andersen AFB is located in the northern half of the island, on a broad undulating limestone plateau overlying a volcanic core. It is bounded on the east, north, and west by cliffs rising approximately 500 feet above mean sea level (msl).

Andersen AFB consists of several parcels of land in the northern half of the island (Figure 1-2). The main portion of Base property consists of the Main Base and Northwest Field, and together they are approximately 8 miles wide, 2 to 4 miles long, and 24.5 square miles in area. The Main Base is the center of active operations, and Northwest Field has been generally inactive since the mid-1950s. Northwest Field, a 2,130-acre property located in the northernmost portion of Guam, is bounded by the Rota Channel to the north, the Philippine Sea to the west, and the Main Base to the east (Figure 1-2).

Site 6 is situated in the western portion of the Main Base, and covers an area of approximately 8 acres (Figure 1-2). It is located adjacent to EOD Building 9001, is approximately 1,000 feet to the southwest of Area 9100 and is bordered on the east by a paved road (Figure 1-3). Site 6 is open, grassy, and relatively flat with elevations ranging from 470 to 482 feet above msl.

Funding for the cleanup of Site 6 is provided under the USAF Environmental Restoration Account. Although the USAF is the lead agency under the CERCLA, the USEPA and Guam EPA are support agencies for the cleanup activities. Site 6 is included in the National Superfund electronic database under CERCLIS identification number GU6571999519.

2.1 History of Site 6

Based on historical records research and interviews, Site 6 was used as a trench-and-fill operation for burial of asphaltic waste material and waste liquids from 1946 to 1949 (Environmental Science and Engineering [ESE], 1985). Prior to the 2002 field investigation, Site 6 was evaluated in three environmental investigations as part of the Main Base OU as follows:

- *IRP Phase I Records Search* (ESE, 1985)

- *Resource Conservation and Recovery Act Facility Assessment (RFA) Report* (Science Applications International Corporation [SAIC], 1986)

- *IRP Phase II Confirmation/Quantification, Stage I* (Battelle Memorial Institute, Columbus [Battelle], 1989)

Site 6 was included in the IRP Phase I Records Search, but was not scored according to Hazard Assessment Rating Methodology (HARM) because of "minimal potential for contamination or hazardous leachate formation" (ESE, 1985). Based on the decision process outlined in the IRP Phase I Records Search, Site 6 was not recommended for further environmental investigation (ESE, 1985). Aerial photographs dated 1946, 1959, 1984, and 1993 show the site as cleared. No potential disposal activities were indicated in the photographs. An aerial photograph of the site taken in 1959 distinctly shows cleared areas trending east-west; however, there was no other indication of activity at the site. There were no aerial photographs taken of the site between 1960 and 1983. Revegetation of the site is evident on aerial photographs taken between 1984 and 1993.

According to the 1986 RFA site visit, "up to 20 rusted and leaking drums were visible on the ground surface" (SAIC, 1986). Furthermore, according to the IRP Phase II, Stage 1 Final Report, most of the site was covered with asphalt drums and asphalt debris, and in some areas animal remains were found in depressions located downgradient from deteriorated drums (Battelle, 1989).

During the 1989 IRP Phase II, Stage 1 investigation at Site 6, two surface soil samples were collected from areas coated with the asphaltic materials and one surface soil sample and duplicate sample were collected from background areas. These samples were analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides, and polychlorinated biphenyls (PCBs). Only trace concentrations of SVOCs were detected in samples collected from areas impacted by the asphaltic material (SAIC, 1990). The 1989 IRP Phase II, Stage 1 sampling and analyses were not performed in accordance with the following approved Basewide plans and procedures for Andersen AFB:

- Basewide Health and Safety Plan (HASP) (EA, 1996a)

- Standard Operating Procedures (EA, 1996b)

- Quality Assurance Project Plan (EA, 1999)

- OU5 Sampling and Analysis Plan (SAP) (ICF Technology, Inc. (ICF), 1994a)

- OU6 Work Plan (ICF, 1994b)

As a result, the 1989 IRP Phase II, Stage 1 sample results are not valid for use in the HHRA or ERA under the IRP, and were not presented in the RI/FS.

In November 2000, the empty drums, asphalt-containing drums, asphalt-coated soil, and other debris were excavated and removed from Site 6 (OHM, 2001) and stored at a staging area near

Site 1. Between November 1998 and November 2000, the following removal actions were completed:

- The site was permitted, cleared, grubbed, and the debris was consolidated.
- Approximately 850 drums containing asphalt contaminated with soil and approximately 2,800 cy of loose asphalt-contaminated soil and other debris were removed from Site 6 and transported to a temporary storage area located at Site 35 on Andersen AFB.
- Approximately 2,000 empty drums and metal debris were removed from Site 6 and transported to the Andersen AFB CU for disposal.
- Approximately 5,000 cy of asphalt contaminated with soil and other debris were removed from Site 6 and transported to a temporary storage area located at Site 35 (OHM, 2001).

Confirmation surface soil samples were collected and analyzed after the asphalt and debris were removed (OHM, 2001). Based on the analytical results, the USAF decided to conduct a RI to further evaluate Site 6. The purpose of the RI was to identify and characterize the contaminants of potential concern (COPCs) at the site and evaluate risks to human health and the environment.

2.2 Enforcement Activities

Due to its primary mission in national defense, the USAF has long been engaged in a wide variety of operations that involve the use, storage, and disposal of hazardous materials. On 14 October 1992, Andersen AFB was formally listed on the National Priorities List by the USEPA to investigate abandoned sites that may have been impacted by the use, storage, and disposal of hazardous materials.

The enforcement activities for Andersen AFB were initiated when the USAF entered into a FFA with the USEPA Region 9 and the Guam EPA. The FFA, finalized on 30 March 1993, established procedures for involving federal and territorial regulatory agencies, as well as the public, in the environmental restoration process at Andersen AFB. The FFA was based on applicable environmental laws including the CERCLA, Hazardous and Solid Waste Act of 1982 (HSWA), SARA, and the NCP.

2.3 Community Participation

In August 1992, Andersen AFB conducted 67 interviews with local government officials, residents, and concerned citizens to determine the level of community concern and interest in the environmental investigations. These community interviews provided the basis for the 1993 Community Relations Plan (CRP) (ICF, 1993). The 1993 CRP described activities to keep the nearby communities informed of the progress of the environmental investigations at Andersen AFB sites and provide opportunities for input from residents regarding cleanup plans. In response to the USEPA request, Andersen AFB conducted 27 additional interviews in 1998 and updated the CRP (EA, 1998).

The USAF has promoted community relations and encouraged public involvement in cleanup decisions through the Restoration Advisory Board (RAB), established in 1995. Currently, the RAB is comprised of community members, elected officials, USAF officials, and representatives from regulatory agencies. The RAB meets on a quarterly basis to discuss program progress and to advise the community on the status and plans for the various IRP sites.

In addition to RAB meetings, in 1993 Andersen AFB prepared a brochure to respond to community concerns and inform the public about Andersen AFB's IRP investigations (ICF, 1993). A summary of the history and status of community involvement in the IRP at Andersen AFB is presented in the December 2000 Final Management Action Plan (Andersen AFB, 2001).

In order to provide access to the public, Andersen AFB has provided copies of reports related to Sites 6, 9, and 12 to the AR file and the Information Repository at the following locations:

Nieves M. Flores Memorial Library
254 Martyr Street
Hagatna, Guam 96910
Telephone: (671) 475-4751, 4752, 4753, or 4754
Contact: Christine Scott-Smith

University of Guam
Federal Document Department, RFK Library, UOG Station
Mangilao, Guam 96923
Telephone: (671) 735-2321
Contact: Walfrid C. Benavente

A notice of availability for the reports related to Sites 6, 9, and 12 was published in the Guam *Pacific Daily News*. A notice of this ROD's availability will also be published in the Guam *Pacific Daily News* after it is signed.

On 2 April 2006, the Proposed Plan for Sites 6, 9, and 12 was released to the public for a review and comment, with a public comment period between 30 March and 29 April 2006. A public meeting was held at the Holiday Resort Guam in Tumon on 6 April 2006, where the Proposed Plan was presented and representatives from USEPA Region 9, Guam EPA, and USAF responded to public comments. The results of the public meeting and responses to public comments are presented in Section 5 of this ROD.

2.4 Scope and Role of the Operable Unit or Response Action

Andersen AFB decided to use an OU approach to manage the investigation and remediation of environmental conditions at Andersen AFB. According to the 1993 FFA, the OUs were formed to:

- Expedite the completion of environmental activities
- Evaluate sites with similar locations and potentially similar requirements as a group
- Complete remedial design investigations at sites where closure decisions have been previously reached with the Government of Guam (GovGuam)
- Provide a screening mechanism for evaluating newly or tentatively identified sites for inclusion in the RI/FS

The environmental investigations at Sites 6, 9, and 12 were performed under the Main Base OU. The Main Base OU addresses potential contamination in the surface soil, subsurface soil, and/or groundwater beneath site within the OU. Sites 6, 9, and 12 have been grouped together in this ROD as they constitute an expedited group of IRP sites that require a decision document in order for the USAF justify the necessary cleanup funding. As the lead agency, the USAF will seek funding for implementation of cleanup activities at these sites.

2.5 Site Characteristics

2.5.1 Site 6 Physical Setting

Site 6 is situated in the western portion of the Main Base, and covers an area of approximately 8 acres (Figure 1-2). It is located adjacent to EOD Building 9001, is approximately 1,000 feet to the southwest of Area 9100 and is bordered on the east by a paved road (Figure 1-3). Site 6 is open, grassy, and relatively flat with a gentle upward slope to the northeast with elevations ranging from 470 to 482 feet above msl. The site was cleared of most surface debris during a 2000 removal action (OHM, 2001).

During the RI fieldwork (February-March 2002), a site reconnaissance and detailed site inventory (DSI) were conducted to accurately define the environmental setting and boundaries of the site, including identification of potentially hazardous wastes. In addition to the DSI, an ecological (flora and fauna) survey was performed to identify potential ecological receptors and exposure pathways. Results of the ecological survey are presented in Section 2.7.2.

Currently, Site 6 has two distinct surface covers (Figure 2-1). Most of the site has been reduced to a thin soil cover. These areas comprise most of the central portion of the site and contain little or no debris except for small patches (less than 18 inches in diameter) of asphalt that remained following removal of large areas of asphalt debris, asphalt drums, and drum remnants. Portions of the site perimeter consist of low mounds (1 to 3 feet high) of fill material containing asphaltic debris, drum remnants, steel pipe, and miscellaneous debris. A detailed description of debris identified at Site 6 is presented in the RI/FS (EA, 2006).

Much of the native soil at Site 6 has been disturbed over time or removed during the asphalt removal action (OHM, 2001). The remaining soils are representative of the Guam-Urban land complex. This unit is characteristic of land disturbed by urban development and consists of approximately 55 percent Guam cobbly-clay loam and 45 percent Urban land. This soil is generally dark reddish-brown, and moderately permeable. The remaining, undisturbed soils consist of the Guam cobbly-clay loam series (Young, 1988) that is very shallow and well drained. This soil is composed of dusky-red, gravelly, clay loam. Permeability of this soil is moderately rapid and it has a very low water-holding capacity.

The surface of Site 6 is situated entirely on the detrital facies of the Mariana Limestone. The depth to the groundwater at Site 6 is approximately 480 feet bgs and the aquifer beneath the site occurs in basal conditions. The aquifer beneath Site 6 is highly permeable and porous. There are no monitoring wells at the site; however, IRP-48 is located approximately 200 feet downgradient of Site 6 (Figure 1-3).

The ecological habitat at Site 6 consists primarily of herbaceous plants surrounded by limestone forest. The fire tree (Serianthes nelsonii), ufa-halomtano (Heritiera longipetiolata), and Tabernaemontana rotensis are three endangered tree species that have been identified near, but not on Site 6. The site lies within the designated foraging area of the endangered Mariana crow (Corvus kubaryi) and the Micronesian starling (Aplonis opacus guami). Site 6 is located outside the overlay for the Guam National Wildlife Refuge. A detailed discussion of ecological habitats and receptors is presented in Section 2.7.2 of this document.

2.5.2 Sampling History for Site 6

During the 1987 IRP Phase II, Stage 1 investigation at Site 6, two surface soil samples were collected from areas coated with asphaltic material and one surface soil sample and one duplicate sample were collected from background areas. These samples were analyzed for VOCs, SVOCs, pesticides, and PCBs. However, the sampling and analyses were not performed in accordance with approved Basewide plans and procedures for Andersen AFB, and the results are not valid for use in the HHRA or ERA performed in the RI (EA, 2006).

In November 2000, the empty drums, asphalt-containing drums, asphalt-coated soil, and other debris were excavated and removed from Site 6 (OHM, 2001) and stored at a staging area near Site 1. Following the removal of the asphalt and debris, 21 random confirmation surface soil samples (including two duplicates) were collected from a depth of 6 inches bgs and analyzed for SVOCs, PAHs, and target analyte list (TAL) metals using USEPA Methods SW8270, SW8310, and SW6010/7000 series, respectively (OHM, 2001). When the soil sample analytical data were validated, only a portion of the data was determined to be usable. The PAH data were not usable because the method detection limits exceeded the residential Preliminary Remediation Goals (PRGs) in several samples. Seven of the 21 surface soil samples contained dibenz(a,h)anthracene at concentrations exceeding the residential PRG. Iron, chromium, and aluminum were detected in two surface soil samples at concentrations exceeding the residential PRGs and BTVs (OHM, 2001). Based on the dibenz(a,h)anthracene and metals exceedances, the USAF decided to conduct a RI to further evaluate Site 6. The purpose of the RI was to identify and characterize the COPCs at the site and evaluate risks to human health and the environment.

During the RI, surface and subsurface soil samples were collected at Site 6. Twenty surface soil samples and two field duplicate samples were collected from 20 locations to characterize the extent of contamination and to evaluate the risks to human health and the environment (Figure 2-2). Discrete (grab) surface soil samples were collected at biased and random locations. The biased samples were typically collected in areas associated with debris or fill material. The surface soil samples were analyzed for the following parameters:

- SVOCs, USEPA Method SW8270C
- PAHs, USEPA Method SW8310
- Andersen TAL metals, USEPA Method SW6010B/SW7000 series

Surface soil samples were not analyzed for VOCs because geologic and climatic conditions on Guam induce volatilization and infiltration, thereby limiting the potential presence of VOCs in surface soil samples.

Seven subsurface soil samples and one field duplicate sample were collected from seven locations so that buried waste materials could be characterized and the potential risks to human health and the environment could be evaluated (Figure 2-3). Subsurface soil samples were collected from the bottom of test pit excavations at depths ranging from 2.75 to 4.0 feet bgs. Subsurface soil samples were analyzed for the following parameters:

- VOCs, USEPA Method SW8260B
- SVOCs, USEPA Method SW8270C
- PAHs, USEPA Method SW8310
- Andersen TAL metals, USEPA Method SW6010B/SW7000 series

The surface and subsurface soil analytical results were compared to residential PRGs that were developed by USEPA Region 9 to establish screening criteria for potentially contaminated sites (USEPA, 2000a; 2004a). As compared to industrial PRGs, the residential PRGs are more conservative regarding the future use of a property. According to the Andersen AFB Base Planner (Alba, 1997), there are no plans to develop the land for residential or commercial use in the future.

Because some metal concentrations in soils occur naturally at high concentrations in Guam, BTVs were established (EA, 2002a). For nine metals (aluminum, barium, beryllium, chromium, cobalt, manganese, nickel, thallium, and vanadium) their BTV exceeds the residential PRG. For these metals, the maximum observed concentration was compared to the BTV rather than the residential PRG.

If the maximum detected concentration of an analyte exceeded the residential PRG (or the BTV for aluminum, barium, beryllium, chromium, cobalt, manganese, nickel, thallium, and vanadium) that analyte was then retained as a COPC. Subsequent to determining the COPCs for Site 6, human health and ecological risk assessments were conducted to establish the COCs, the remedial action objectives (RAOs), and the RGs, as presented in Sections 2.7 and 2.8 of this ROD.

Groundwater samples have been collected from monitoring well IRP-48 on a semiannual basis for 21 rounds since October 1996. Groundwater samples collected from IRP-48 were analyzed for VOCs, SVOCs, PAHs, pesticides, PCBs, cyanide, and metals. The location of IRP-48 is shown on Figure 1-3.

2.5.3 Conceptual Site Model for Site 6

Site 6 is situated on the western portion of the Main Base and covers an area of approximately 8 acres (Figures 1-2 and 1-3). Site 6 is inactive, but is accessible from paved roads to the MSA and a gated road to the Base Landfill. The site is open, grassy, and relatively flat with a gentle upward slope to the northeast. The perimeter of the site is bordered by limestone forest. The nearest residential housing area is the village of Yigo, located approximately 1.3 miles south of the Main Base boundary.

Based on historical records research and interviews, Site 6 was used as a trench-and-fill operation for burial of asphaltic waste material and waste liquids from 1946 to 1949. Based on the *1994 Work Plan for OU5* (ICF, 1994a), Site 6 was estimated to contain approximately 700 drums. From 1998 to 2000, the vast majority of drums, asphalt debris, and asphalt-contaminated soil were removed from the surface at Site 6. Approximately 2,000 empty drums and 7,850 cy of asphalt debris, including drums containing asphalt and asphalt-contaminated soil, were removed from the site (OHM, 2001). After the removal action, 20 surface soil samples and two duplicate soil samples were collected and analyzed for SVOCs, PAHs, and TAL metals.

Potential receptors at the site include occasional users/trespassers. This includes hunters or trespassers who may walk through the area, as well as maintenance workers who may work at the site on a limited basis. There is limited hunting of deer and wild pigs in this area of Andersen AFB. Therefore, adults and children who consume deer and pig meat are also considered receptors at the site. However, risks associated with ingestion of deer and wild pig meat have been addressed on a Basewide basis and are presented in a separate report (EA, 1995). Due to the proximity to the MSA and Base Landfill Complex there are no plans to develop this site for residential use in the future. However, as a conservative assumption, and to serve as a baseline, risks to potential future residents are evaluated for Site 6.

Media of concern identified at the site are surface soil, subsurface soil, and air exposures that could result from dispersion of surface and subsurface soil into air. Groundwater is not considered a medium of concern as it is found at a depth of approximately 480 feet bgs at the site. Groundwater samples have been collected from monitoring well IRP-48 on a semiannual basis since October 1996, and have been analyzed for VOCs, SVOCs, PAHs, pesticides, PCBs, cyanide, and metals. In the groundwater sample collected on 28 April 1997, antimony and chromium were detected at concentrations (8.3 milligrams per kilogram [mg/kg] and 599 micrograms per liter [μg/L]) that exceeded their respective maximum contaminant level (MCLs) (6 μg/L and 100 μg/L). However these concentrations were attributed to corrosion of the dedicated, stainless-steel sampling pumps. Since then pumps have been removed, and sampling has been performed with portable pumps. In the 13 subsequent groundwater sampling

events, the target analytes were either non-detect or detected at concentrations below their respective MCL.

The media of concern identified at the site are surface soil, subsurface soil, and air exposures that could result from dispersion of surface and subsurface soil into air. The exposure pathways that are considered for the unlikely future resident adult and child scenario are incidental ingestion of and dermal exposures to surface soil. It is assumed that residents could be exposed to subsurface soil, which could be disturbed during digging or excavation activities and brought to the surface. Therefore, as a conservative measure, residents were also evaluated for incidental ingestion of, dermal contact with, and inhalation of subsurface soil particles. The exposure pathways that were considered for current and future occasional users/trespassers were incidental ingestion of, dermal contact with, and inhalation of airborne particulates of surface soil. The conceptual site model (CSM) for the Site 6 HHRA is presented in Figure 2-4. An exposure pathway analysis is presented in Table 2-1.

2.5.4 Suspected Contamination Sources at Site 6

Based on the DSI, Site 6 has two distinct surface covers (Figure 2-1). Most of the site has been reduced to a thin soil cover. These areas comprise most of the central portion of the site and contain little or no debris except for patches (less than 18 inches in diameter) of asphalt that remained following removal of the pooled areas of asphalt debris, asphalt drums, and drum remnants.

2.5.5 Site 6 COPCs

Twenty surface soil samples and two field duplicate samples were collected in March 2002 (Figure 2-2). Based on the analytical results, aluminum, cadmium, chromium, thallium, benzo(a)pyrene, and dibenz(a,h)anthracene exceeded their respective residential PRGs and BTVs, and were identified as surface soil COPCs (Figure 2-2).

Seven subsurface soil samples and one field duplicate sample were collected in March 2002 (Figure 2-3). Based on the analytical results, aluminum, antimony, and chromium exceeded their respective residential PRGs and BTVs, and were identified as subsurface soil COPCs (Figure 2-3). There were no air samples collected at Site 6, and air concentrations were modeled from both surface and subsurface soil concentrations.

2.6 Current and Potential Future Site and Resource Uses

Andersen AFB future land reuse plans do not include future residential reuse of Site 6 due to its proximity to the MSA and Base Landfill Complex. Therefore, residential exposures are highly unlikely to occur in the future at the site. Due to occasional access to the site for limited commercial use, occasional users/trespassers are identified as potential receptors.

2.7 Summary of Site Risks

A HHRA and an ERA were performed for Site 6 to evaluate whether the COPCs identified in surface and subsurface soil pose potential unacceptable risks to human health or the

environment. The HHRA and ERA identified the COPCs, exposure concentrations, exposure duration, and exposure pathways and estimated the risks to human health and the environment if no action were taken. COPCs that were determined to pose unacceptable risks to human health or the environment were designated as COCs. As a comprehensive HHRA and ERA for Site 6 are presented in RI/FS (EA, 2006), according to USEPA Guidance (USEPA, 1999a), the HHRA and ERA are presented in terms of COCs, only.

2.7.1 Baseline HHRA for Site 6

The baseline HHRA estimates what risks the site poses if no action were taken. It provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action. This section of the ROD summarizes the results of the baseline HHRA for this site. The HHRA methodology is detailed in Appendix D.1 of the RI/FS (EA, 2006) and, in general, involves a four-step process: (1) hazard identification, (2) toxicity assessment, (3) exposure assessment, and (4) risk characterization.

2.7.1.1 Identification of COCs for HHRA at Site 6

The range of detected concentrations (maximum and minimum) and the frequency of detection for each COC identified in surface and subsurface soils at Site 6 are included in Tables 2-2 and 2-3.

The exposure point concentration (EPC) for each COC is a statistically derived concentration based on the soil sample results that is used to calculate the risk associated with each COC. The EPCs for COCs in surface and subsurface soils for Site 6 are included in Tables 2-2 and 2-3.

For the reasonable maximum exposure (RME) scenario, the EPC for each COC is estimated using the arithmetic mean and the upper 95th percentile upper confidence limit of the mean (95UCLM). The 95UCLM represents a high value for an EPC so there is 95 percent confidence that all other values will be below the 95UCLM value. The 95UCLM is used as the EPC in the exposure assessment for the RME assumptions. However, if the 95UCLM is greater than the maximum detected concentration, the maximum detected concentration value is used as the EPC and is listed in the table instead of the 95UCLM value. The arithmetic mean concentration is used as the central tendency (CT) EPC value using average exposure assumptions.

2.7.1.2 Exposure Assessment for HHRA at Site 6

An exposure assessment was conducted to estimate the magnitude of actual and/or potential human exposures. In the exposure assessment, average and maximum estimates of potential exposure were developed in accordance with USEPA guidance for both current and potential future land-use assumptions. Current maximum exposure estimates were used to determine whether a potential health hazard exists based on current conditions. Future maximum potential exposure estimates were used to provide an understanding of potential future exposures and health hazards and include a qualitative estimate of the likelihood of such exposures occurring.

Due to limited access to the site, occasional users/trespassers were identified as potential receptor populations. Current and future land use also includes recreational hunters. However, risks associated with ingestion of wild pig and deer meat have been addressed on a site-wide basis in another document (EA, 1995). Andersen AFB future land reuse plans do not include future residential reuse of Site 6 due to its proximity to the MSA. Therefore, it is not expected that residential exposures are likely. However future onsite resident adults and children were evaluated as potential receptors, as a conservative measure.

Media of concern include surface soil, subsurface soil, and air as environmental transport media for the release of chemicals present at Site 6. Groundwater is not considered as a medium of concern. Groundwater is deep beneath the site (approximately 480 feet bgs) and is not consumed by on-site receptors. The freshwater lens is relatively thin beneath the site, and becomes even thinner and more brackish as it approaches the nearby Pacific Ocean. The thinness of the lens downgradient of the site and the unsuitability for developing the land preclude it from being used as a source of potable water.

The following human exposure pathways, shown on Figure 2-4 (CSM), were evaluated at Site 6:

- Incidental ingestion of surface soil during residential activities (i.e., gardening)
- Incidental ingestion of surface soil during trespassing activities
- Dermal contact with surface soil during residential activities (i.e., gardening)
- Dermal contact with surface soil during trespassing activities
- Incidental ingestion of subsurface soil during residential activities (i.e., gardening)
- Dermal contact with subsurface soil during residential activities (i.e., gardening)
- Inhalation of suspended surface soil particles during residential activities (i.e., gardening)
- Inhalation of suspended surface soil particles during trespassing activities
- Inhalation of suspended subsurface soil particles during residential activities (i.e., gardening)

Air samples were not collected at Site 6; therefore, it was necessary to model concentrations of COPCs in suspended surface soil. The exposure modeling for this pathway was performed for potential receptors: resident adults and children and occasional users/trespassers. It should be noted that air modeling was only carried out for fugitive dust (suspended surface soil) emissions from the site, not for VOC emissions, as VOCs were not identified as COCs at the site.

The final step in this exposure assessment was to estimate COC intakes for each of the pathways considered in the assessment. In this exposure assessment, two different measures of intake are provided, depending on the nature of the effect being evaluated. When evaluating longer-term exposures to chemicals that produce adverse non-carcinogenic effects, intakes are averaged over the period of exposure (i.e., the averaging time) (USEPA, 1989a). This measure of intake is referred to as the average daily intake (ADI) and is a less-than-lifetime exposure. For chemicals that produce carcinogenic effects, intakes are averaged over an entire lifetime and are referred to as the lifetime average daily intake (LADI) (USEPA, 1989a).

The exposure factor values (exposure duration, exposure time, incidental ingestion rates of contaminated soil, inhalation rates of contaminated dust, and dermal exposure assumptions for resident adults, resident children, occasional users [workers], and trespassers under RME and CT scenarios) used in estimating intakes are presented in Appendix D.1 of the RI/FS (EA, 2006).

2.7.1.3 Toxicity Assessment for HHRA at Site 6

The toxicity assessment considers the types of potential adverse health affects associated with exposures to COCs. The toxicity assessment relies on existing toxicity information developed based on dose-response for specific COCs. Using this dose-response relationship, specific toxicity values were derived by USEPA that can be used to estimate the incidence of potentially adverse effects occurring in humans at different exposure levels. The USEPA-derived toxicity values for COCs were called reference doses (RfDs) for non-carcinogens and slope factors (SFs) for potential carcinogens.

The toxicity values used for COCs at Site 6 were presented in Appendix D.1 of the RI/FS (EA, 2006). The USEPA Integrated Risk Information System (IRIS) database was used for RfDs of non-carcinogenic COCs. If RfDs for COCs were not available from IRIS, the USEPA health effects assessment summary tables (HEAST) were used as a secondary data source. If RfDs for COCs were not available from IRIS or HEAST for one route of exposure but existed for another route, the existing value was examined for technical applicability to the alternate route and subsequently used, if appropriate.

Unlike non-carcinogens, carcinogens are generally assumed to have no threshold, that is, there is presumed to be no level of exposure below which carcinogenic effects will not manifest themselves. This “non-threshold” concept supports the idea that there are small, finite probabilities of inducing a carcinogenic response associated with every level of exposure to a potential carcinogen. The weight-of-evidence classification system assigns a letter or alphanumeric (A through E) to each potential carcinogen that reflects an assessment of its potential to be a human carcinogen:

A = a known human carcinogen
B1 = a probable human carcinogen, based on sufficient animal data and limited human data
B2 = a probable human carcinogen based on sufficient animal data and inadequate or no human data
C = a possible human carcinogen
D = not classifiable as to human carcinogenicity
E = evidence of noncarcinogenicity for humans

Only compounds that have a weight-of-evidence classification of C or above are considered to have carcinogenic potential in this risk assessment.

2.7.1.4 HHRA Characterization for Site 6

Carcinogenic risk was estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to a potential carcinogen at the site. The numerical

estimate of excess lifetime cancer risk was calculated by multiplying the LADI by the risk per unit dose (the slope factor), as shown in the following equation:

$$Risk = LADI \times SF$$

where: Risk = A unitless probability (e.g., 2×10^{-5}) of an individual's developing cancer
LADI = Lifetime average daily intake (milligrams per kilogram per day [mg/kg/day])
SF = Cancer slope factor $(mg/kg/day)^{-1}$

Because the SF is the statistical 95th percent upper confidence limit (UCL) on the dose-response slope, this method provides a conservative, upper-bound estimate of risk.

Cancer risks were estimated for current and future occasional users and for potential future residents. These risks are probabilities that usually are expressed in scientific notation (e.g., 1×10^{-6}). An excess lifetime cancer risk of 1×10^{-6} indicates that an individual experiencing the reasonable maximum exposure estimate has a 1 in 1,000,000 chance of developing cancer as a result of site-related exposure. This is referred to as an "excess lifetime cancer risk" because it would be in addition to the risks of cancer individuals face from other causes such as smoking or exposure to too much sun. The chance of an individual's developing cancer from all other causes has been estimated to be as high as one in three. USEPA's generally acceptable risk range for site-related exposures is 10^{-4} to 10^{-6}.

The potential human health risks associated with exposures to non-carcinogenic COCs at Site 6 were estimated by comparing ADIs with established RfDs, as per USEPA guidance (USEPA, 1989a) derived for a similar exposure period. An RfD represents a level that an individual may be exposed to that is not expected to cause any deleterious effect. The ratio of exposure to toxicity is called a hazard quotient (HQ). An HQ<1 indicates that a receptor's dose of a single contaminant is less than the RfD, and that toxic non-carcinogenic effects from that chemical are unlikely. The Hazard Index (HI) is generated by adding the HQs for all chemical(s) of concern that affect the same target organ (e.g., liver) or that act through the same mechanism of action within a medium or across all media to which a given individual may reasonably be exposed. An HI<1 indicates that, based on the sum of all HQ's from different contaminants and exposure routes, toxic non-carcinogenic effects from all contaminants are unlikely. An HI >1 indicates that site-related exposures may present a risk to human health.

The HQ is calculated as follows:

$$HQ = \frac{ADI}{RfD}$$

where: HQ = Hazard quotient; ratio of average daily intake level to acceptable daily intake level (unitless)
ADI = Estimated average daily intake (mg/kg/day)
RfD = Reference dose (mg/kg/day)

ADI and RfD are expressed in the same units and represent the same exposure period (i.e., chronic, subchronic, or short-term).

2.7.1.4.1 HHRA Results for Surface Soil Exposures at Site 6

The detailed exposure and risk calculations are presented in Appendix D.1 of the RI/FS (EA, 2006). The results of the scenarios for which unacceptable health risks were calculated from exposure to COC in surface soil at Site 6 follow.

The non-cancer HI exceeded 1.0 for the future resident child scenario only. The cancer and non-cancer risk assessment results for future resident children exposed to surface soil under the RME scenario are presented in Table 2-4. Exposure to COCs in surface soil and ambient air among potential future resident children resulted in a HI that exceeded USEPA's risk target of 1.0. Under RME conditions the HI was 6.6. The COCs with a cumulative HI exceeding 1.0 for resident children were aluminum (HI = 2.7) and chromium (HI = 3.7).

There were no unacceptable risks associated with exposures to surface soil at Site 6 that exceeded USEPA's risk range of 10-6 to 10-4 for future residents, although chromium had cancer risks that exceeded 10-6 (2.2 x 10-5).

2.7.1.4.2 HHRA Results for Subsurface Soil Exposures at Site 6

The detail exposure and risk calculations are presented in Appendix D.1 of the RI/FS (EA, 2006). The results of the scenarios for which unacceptable health risks were calculated from exposure to COC in subsurface soil at Site 6 follow.

Unacceptable non-cancer risks were calculated for the future resident child scenario exposed to COCs in subsurface soil. The cancer and non-cancer risk assessment results for future resident children exposed to subsurface soil under the RME scenario at Site 6 are presented in Table 2-5. Exposures to COCs in subsurface soil and ambient air among potential future resident children resulted in an estimated HI of 13 under RME conditions. Aluminum (HI = 2.5), antimony (HI = 3.0), and chromium (HI = 6.8) had HIs exceeding 1.0 under RME conditions.

There were no unacceptable risks associated with exposures to subsurface soil at Site 6 that exceeded USEPA's risk range of 10^{-6} to 10^{-4} for future residents, although chromium had cancer risks that exceeded 10^{-6} (4.0×10^{-5}).

2.7.1.4.3 Basis for Action Statement

Based on the identified unacceptable human health risks under a future residential scenario, as summarized in Sections 2.7.1.4.1 and 2.7.1.4.2, the response action selected in this ROD is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

2.7.1.5 HHRA Uncertainties for Site 6

The different types of uncertainty involved in the HHRA process are discussed in detail in the RI/FS (EA, 2006), and are presented briefly in the following sections.

2.7.1.5.1 Sampling and Analysis Uncertainties

The sampling plan can have a significant impact on the results obtained in calculating human health risks at a site. To the extent that samples are collected in areas that are expected to be contaminated (biased sampling), the EPC used in calculating risk exposures and risks is likely to overestimate the actual concentration encountered at the site from random exposure across the site. Sampling bias generally results in an overestimate of exposures and risks at a site. The soil sampling at Site 6 incorporated a combination of random and biased samples. As the majority of soil samples collected at Site 6 were biased toward suspected contamination, the measured concentrations and calculated health risks would tend to be overestimated.

2.7.1.5.2 Chemical Fate and Transport Modeling Uncertainties

The models used to estimate chemical concentrations associated with particulates in air at Site 6 are consistent with those recommended by USEPA (1996). However, due to uncertainties in modeling methodologies, USEPA-recommended models are likely to overestimate actual concentrations at the site. Thus, use of models is likely to overestimate health risks at Site 6.

2.7.1.5.3 Uncertainties of Toxicity Assessment

There are numerous uncertainties associated with the Toxicity Assessment. These are generally due to the unavailability of data to thoroughly calculate the toxicity of COPCs.

Uncertainties Associated with Non-Carcinogenic Effects

Interspecies Extrapolation

The majority of toxicological information comes from experiments with laboratory animals. Experimental animal data have been relied on by regulatory agencies to assess the hazards of human chemical exposures. Interspecies differences in chemical absorption, metabolism, excretion, and toxic response are not well understood; therefore, conservative assumptions are applied to animal data when extrapolating to humans. These probably result in an overestimation of toxicity.

Intraspecies Extrapolation

Differences in individual human susceptibilities to the effects of chemical exposures may be caused by such variables as genetic factors (e.g., glucose-6-phosphate dehydrogenase deficiency), lifestyle (e.g., cigarette smoking and alcohol consumption), age, hormonal status (e.g., pregnancy), and disease. To take into account the diversity of human populations and their differing susceptibilities to chemically induced injury or disease, a safety factor is used. USEPA uses a factor between 1 and 10. This uncertainty may lead overestimates of human health effects.

Exposure Routes

When experimental data available on one route of administration are different from the actual route of exposure that is of interest, route-to-route extrapolation must be performed before the risk can be assessed. Several criteria must be satisfied before route-to-route extrapolation can be undertaken. The most critical assumption is that a chemical injures the same organ(s) regardless of route, even though the injury can vary in degree. Another assumption is that the behavior of a substance in the body is similar by all routes of contact. This may not be the case when, for example, materials absorbed via the gastrointestinal tract pass through the liver prior to reaching the systemic circulation, whereas by inhalation the same chemical will reach other organs before the liver. However, these extrapolations are made when data are limited, and may result in overestimates of human toxicity.

Uncertainties Associated with Carcinogenic Effects

Interspecies Extrapolation

The majority of toxicological information for carcinogenic assessments comes from experiments with laboratory animals. There is uncertainty about whether animal carcinogens are also carcinogenic in humans. While many chemical substances are carcinogenic in one or more animal species, only a very small number of chemical substances are known to be human carcinogens. The fact that some chemicals are carcinogenic in some animal species but not in others raises the possibility that all chemicals that are non-carcinogenic to animals are carcinogenic to humans. Regulatory agencies assume that humans are as sensitive to carcinogens as the most sensitive animal species. This is designed to prevent underestimation of risk, and has the potential to overestimate carcinogenic risk.

High-Dose to Low-Dose Extrapolation

Typical cancer bioassays provide limited low-dose data on responses in experimental animals for chemicals being assessed for carcinogenic or chronic effects. Because dosing methods do not reflect how animals are actually intake a chemical, a dose-response assessment normally requires extrapolation from high to low doses using mathematical modeling. A central problem with the low-dose extrapolation models is that they may fit experimental data equally well, but they may not all be plausible biologically. The dose-response curves derived from different models diverge substantially in the dose range of interest (National Research Council, 1983). Therefore, low-dose extrapolation is more than a curve-fitting process, and considerations of biological plausibility of the models must be taken into account before choosing the best model for a particular set of data.

2.7.1.5.4 Uncertainties Analysis of Exposure Assessment

An analysis of uncertainties is an important aspect of the exposure assessment. It provides the risk assessor and reviewer with information relevant to the individual uncertainties associated with exposure factor assumptions and their potential impact on the final assessment.

Current Receptors

Under current use conditions at Site 6, the only potential receptors are occasional users/trespassers. The results of this HHRA indicate that there are no unacceptable risks to

occasional user/trespassers. There are no current residential exposures; therefore, under current use of the site, there are no unacceptable risks posed to human health.

There is a very low likelihood that Site 6 will be developed for residential use in the future. Therefore, under expected future use of the site, there are no concerns for adverse human health effects at the site.

The USAF has evaluated risks to potential future residents at the site, although there are no plans for residential development. It was only under these most conservative assumptions that any risks were identified that exceeded USEPA's risk targets. This is an unlikely future-use scenario and is considered to present the possibility of adverse health effects at the site only in the unlikely future event that residential development takes place.

Exposure Factors

Soil Ingestion Rate

Soil ingestion rates for children are based on studies performed by Binder et al. (1986) and Clausing et al. (1987). Both were short-term studies, and as they were not based on average long-term exposures, they represent an overestimate of exposure. More recent published data have shown that average soil ingestion rates for 2-year-olds is less than 100 milligrams per day (Calabrese et al., 1989; Davis et al., 1990). Furthermore, USEPA soil ingestion rates for children ages 1 to 6 years are based on ingestion rates for children at age 18 months and are applied through age 6 years (USEPA, 1989b). This is very unlikely because children over 2 years old do not ingest at the same rate as an 18-month-old. Additionally, a conservative estimate was used for the fraction ingested value of 1.0, which assumes that all soil ingested (for residential exposures) is ingested at the residence. This assumes that no activities take place elsewhere. Taken together, these suggest that intakes for this pathway are overestimated.

Exposure Duration

USEPA assumes residential exposure duration for adults is 30 years, which represents the USEPA-derived 90th percentile upper limit for time spent at one residence. The average (50th percentile) time spent at one residence is 7 years. These values are recommended in the Superfund Guidance Manual (USEPA, 1989a). Soil ingestion for children age 1 to 6 years is assumed to continue for the entire 6-year time frame.

Exposure Frequency

Although the assumption was made that occasional users/trespassers on the island of Guam will be exposed to subsurface soils containing COCs for 40 days per year for 30 years, this is very unlikely. It does not seem feasible that occasional users/trespassers would be exposed to this extent. Therefore, it is highly likely that the RME risk estimates presented in this report significantly overestimate the potential human health risks.

2.7.1.5.5 Uncertainties in Risk Characterization

Uncertainties in the risk characterization can stem from the inherent uncertainties in the data evaluation, the exposure assessment process, including any modeling of EPCs in secondary media from primary media, and the toxicity assessment process. The individual uncertainties in these respective processes were addressed in previous sections.

2.7.2 Baseline ERA for Site 6

The purpose of the ERA was to determine the likelihood that adverse ecological effects may occur as a result of exposure to COCs. In addition to the DSI, an ecological (flora and fauna) survey was conducted at Site 6. The site has been highly modified by asphalt-drum removal operations in 1998 and 1999, and therefore is predominantly open grassland (approximately 77 percent by area) with a perimeter of mixed herbaceous/shrubs/forest (23 percent by area).

Both of the major habitat types are described below, including wildlife observed within each habitat type.

Grassland Habitat

Grassland habitat predominates the site, covering approximately 77 percent of the site (Figure 2-5). Cell No. B-600 was investigated as a representative sample cell of the grassland habitat. A mixture of grasses dominated the habitat. The dominant grasses at the site are *Poaceae* species and large crabgrass *(Digitaria sanguinalis)*. Additional vines identified at the site were *Mikania scandens* and the wild passion flower (*Passiflora suberosa*). Four herbs were identified in the habitat including *Conyza canadensis*, false verbena (*Sida* sp.), beggar's tick *(Bidens pilosa)*, and *Stachytarpheta* species.

Signs of wildlife in the herbaceous habitat included game trails, scat, and actual sightings that indicated Sambar deer (*Cervus mariannus*), feral pigs (*Sus scrofa*), and feral dogs (*Canis familiaris*) migrate across the site. Two bird species were observed in this habitat, the black drongo (*Dicrurus macrocerus*) and Philippine turtle-dove (*Streptopeia bitorquata*). Numerous spiders and insects were found including beetles, flies, mosquitoes, fleas, grasshoppers, crickets, praying mantis, ants, wasps, bees, black citrus swallowtail (*Papilio polytes*), and blue-banded king crow butterfly (*Euploea leucostictos*). Two reptile species were observed in this habitat, the curious skink (*Carlia fusca*) and the monitor lizard (*Varanus indicus*e). One amphibian, the marine toad (*Bufo marinus*), was also identified in this habitat.

Herbaceous Habitat

Mixed herbaceous habitat was observed on a small portion of the site (Figure 2-5). Cell No. B-000 was investigated as a representative sample cell of the mixed herbaceous habitat. A mixture of grasses, vines, herbs (0 to 3 feet tall), and trees (3 to 10 feet tall) dominated the habitat. The dominant grasses at the site were large crabgrass *(Digitaria sanguinalis)* and *Poaceae* species, morning glory (*Convolvulaceae* sp.) dominated vines in this habitat. The dominant herb was *Bidens pilosa* and the dominant fern *Pteris tripartita*. The shrub limeberry (*Triphasia trifolia)* was observed in the 3- to 10-foot strata. The trees dominating the 3- to

10-foot strata were cycad (*Cycas circinalis*) and inkberry (*Cestrum species*). Vines found in this habitat included the morning glory (*Convolvulaceae* sp.), *Mikania scandens*, and the wild passion flower (*Passiflora suberosa*). Several herbs were identified in the habitat including eupatorium *(Chromolaena odorata)*, beggar's tick *(Bidens pilosa)*, *Conyza Canadensis*, and *Stachytarpheta* sp.

Signs of wildlife in the herbaceous habitat included game trails, scat, and actual sightings that indicated Sambar deer (*Cervus mariannus*), feral pigs (*Sus scrofa*), and feral dogs (*Canis familiaris*) migrate across the site. Birds observed in this habitat included black drongo (*Dicrurus macrocerus*) and Philippine turtle-dove (*Streptopeia bitorquata*). Numerous spiders and insects were found, including beetles, flies, mosquitoes, fleas, grasshoppers, crickets, praying mantis, ants, wasps, bees, black citrus swallowtail (*Papilio polytes*), and blue banded king crow butterfly (*Euploea leucostictos*). Several reptiles, including the curious skink (*Carlia fusca*), blue-tailed skink (*Emoia caeruleocauda*), and the monitor lizard *(Varanus indicus)* were observed at the site. One amphibian, the marine toad (*Bufo marinus*), was also identified in this habitat.

Based on flora and fauna observed at Site 6, the CSM for the ERA is presented in Figure 2-6, based on simple direct contact and food-web models. The secondary source of COC exposure is surface soil. This exposure may occur through direct contact with or ingestion of surface soil, or by ingestion of plant or animal tissue that has been exposed to surface soil. Exposure pathways and routes include:

- Direct Contact with Surface Soil—This exposure route is important for uptake of COCs by plants and for soil invertebrates. Most vertebrates, when foraging, may have the potential to be exposed to COCs via dermal contact. However, the dermal exposure pathway is not believed to be important for birds, mammals, or reptiles because of the lack of contact with exposed soils. Many factors limit direct contact with exposed soils, including the extensive ground cover by vegetation, the arboreal nature of most native species, and the protection from dermal contact by scales, feathers, or hair (USEPA, 2000b). Any incidental surface contamination of scales, feathers, or hair that is subsequently ingested during grooming is accounted for in the incidental soil ingestion pathway.
- Ingestion of Food (i.e., plants and biota that have taken up constituents from soil)—Terrestrial herbivores and predators that forage in the terrestrial habitats may ingest plants or animal prey that have bioaccumulated COCs from surface soils.
- Incidental Ingestion of Surface Soils—Herbivores and predators that forage in the terrestrial habitats may incidentally ingest some surface soil with their food or during other activities such as grooming.

On the basis of this evaluation, there are complete exposure pathways to surface soil in ecological habitats potentially impacted by releases of COCs. From this environmental medium, some COCs could bioconcentrate in plants and prey animals that may be eaten by other consumers. There is a potential for COC releases by infiltration to the subsurface soils and to groundwater; however, there are no complete pathways for ecological receptors to subsurface

soil or groundwater. Groundwater at Site 6 is hundreds of feet below the surface; thus, there is no potential for contact with ecological receptors. Ecological receptors are exposed to soils within the root zone, which typically is no more than 18 inches below the surface. There is minimal subsurface soil at Site 6 before encountering the limestone bedrock. Consequently, subsurface soil exposure was not considered a viable exposure pathway to ecological receptors (Figure 2-6).

The selection of assessment endpoints must be based on the fundamental knowledge of the local ecology. Assessment endpoints typically relate to an effect on a population or community. Survival of Mariana fruit bats is an example of a population level assessment endpoint. Community level assessment endpoints could include the primary productivity of the limestone forest habitat. Examples of endpoints representing guilds of species are useful in that they convey information beyond the indicator species identified in the endpoint itself. An assessment endpoint involving a community index may provide more information about a site than an analysis of one species. Consequently, it is important to note that confirmation of the deleterious effects at the community level is an inherent confirmation that population level effects are occurring (Hartwell, 1997).

Based on the ecological survey at Site 6 the following ecological receptors were considered for the ERA:

- Soil-invertebrate communities (i.e., earthworm) and plant communities
- Native terrestrial birds represented by the Mariana crow and the yellow bittern

For the purposes of this ERA, it is assumed that no future actions are expected at Site 6 that would change the potential use of the area by ecological receptors. The ERA methodology involves a four-step process: (1) identification of potential COCs, (2) exposure assessment, (3) toxicity assessment, and (4) risk characterization.

2.7.2.1 Identification of COCs for ERA at Site 6

To identify COCs for the ERA at Site 6, the maximum detected concentration for each chemical in surface soil was compared to the higher of (1) conservative toxicologically based screening criteria or (2) background threshold concentrations for the Base for inorganic constituents (ICF, 1997). A constituent was excluded as a COC if the maximum detected concentration at Site 6 was lower than the screening value, or the constituent was an essential nutrient.

The results of COC screening are shown in Table 2-6. The screening values were based on conservative threshold of ecological risk as recommended by the Dutch National Institute of Public Health and Environmental Protection (Dutch, 1994, 1995, and 1997).

2.7.2.2 Exposure Assessment for ERA at Site 6

Exposure refers to the degree of contact between ecological receptors at a site and the COCs. Based on the CSM described in Section 2.7.2, it is assumed that ecological receptors at Site 6 are exposed to COCs in surface soil either through direct contact, via dietary food web, or both.

The exposure concentrations were estimated statistically to present the most appropriate representative concentration of COCs at Site 6. The data for each COC were tested for normality or lognormality using the Shapiro-Wilks W-test (Shapiro and Wilks, 1965). If the data fit neither or both the normal and lognormal distribution according to the Shapiro-Wilks test, a lognormal distribution was assumed consistent with USEPA guidance (USEPA, 1992). For data fitting a normal distribution, the arithmetic mean was considered to be the most appropriate representative concentration. If the data fit a lognormal distribution, or a lognormal distribution was assumed because the data fit neither type of distribution, the lognormal mean of the constituent data was used as the representative concentration consistent with USEPA guidance.

The following assumptions are made for arriving at each COC exposure concentration:

- COCs are assumed to be 100 percent bioavailable. That is, whether by direct contact or via food-web ingestion, all of the COCs are available for absorption and expression of toxic effects, which is highly unlikely considering the soil chemistry at the site.
- The area use factor for the Mariana crow, yellow bittern, and Mariana fruit bat receptors is assumed to be 1.0. This means that 100 percent of the Mariana crow, yellow bittern, and Mariana fruit bat food comes from Site 6.

2.7.2.3 Toxicity Assessment for ERA at Site 6

Toxicity assessment is based on studies that determine the lowest concentrations of contaminants that may cause adverse effects on ecological receptors. In this ERA, toxicity assessments were completed for soil-invertebrate communities (earthworm), plant communities, native terrestrial birds represented by the Mariana crow and the yellow bittern, and Mariana fruit bat relative to COCs in surface soils at Site 6.

Earthworms

Many of the earthworm toxicity reference values (TRVs) are from Lowest Observed Adverse Effects Level (LOAEL) chronic effects data based on laboratory studies of earthworms (ICF, 1998). In the absence of sufficient data, No Observed Adverse Effects Level (NOAEL) data were used for chronic effects to derive earthworm TRVs.

Plants

Risks to plants, as with invertebrates, are expressed relative to concentrations observed in soil. Plant toxicity data were based on growth effects from Ecological Soil Screening Levels.

Native Terrestrial Birds

Food-web risks for avian species are expressed relative to a dose of chemical (milligrams of Chemical per kilogram of body weight per day [mg/kg-bw/day]) taken up by the organism from food and soil. USEPA (1997a) guidance specifies that a screening ecotoxicity value should be

"equivalent to a documented or best conservatively estimated chronic NOAEL." Literature-reported wildlife NOAEL and LOAEL TRVs were used as TRVs for food-web risks.

2.7.2.4 ERA Characterization for Site 6

The ERA was characterized based on calculation of a HQ or an Ecological Quotient (EQ):

Ecological Quotient = Representative Concentration / TRV

Hazard Quotient = Representative Dose / Toxicity Reference Value

If the representative soil concentration is less than the TRV, then the HQ or EQ will be less than 1.0. In this circumstance, no adverse ecological risk is expected for the exposed ecological receptors. If the representative soil concentration is greater than the TRV, then the HQ or EQ will be greater than 1.0, and adverse ecological risk is expected for the exposed ecological receptors. A summary of the ERA results for Site 6 is presented in the following sections of this ROD.

2.7.2.4.1 ERA Results for Site 6

Six inorganic COCs were identified at Site 6 (aluminum, beryllium, cadmium, chromium, copper, and thallium). Table 2-7 shows assessment and measurement endpoints identified for the ecological receptors (plants, soil invertebrates, Mariana crow, and yellow bittern) in this ERA. These endpoints have been revisited in Table 2-8, along with the results of this Tier I ERA.

With the exception of beryllium, acceptable risks were found for earthworms, representative of soil invertebrates, for those COCs for which TRVs could be identified (Table 2-9). Beryllium had an EQ of 1.8 based on a study cited in ICF (1998), which found a mortality NOAEL for *Lumbricus terrestris* at 2 mg/kg. Considering the low magnitude of the beryllium EQ and the uncertain TRV, soil invertebrates at Site 6 may not be at adverse risk from beryllium. Appropriate earthworm TRVs could not be found in the scientific literature for aluminum or thallium; therefore, risks from these chemicals cannot be quantified or dismissed.

Acceptable risks to terrestrial plants were found for beryllium, cadmium, and copper (Table 2-9). The plant EQ of 31 for chromium may be overestimated because the plant chromium TRV was of low quality. In addition, comparison of the 734 mg/kg representative site concentration to background levels at Andersen AFB (1,250 mg/kg), and the absence of visual plant stress at the site other than stress from heavy machinery on the site, support a conclusion that chromium is not responsible for plant stress at the site. The plant EQ of 2,600 for aluminum is likely very overestimated. This is because the plant TRV upon which risk is based was performed at a pH much lower than that ever to be expected in the weathered limestone found at Andersen AFB, and studies have shown that as long as pH is above 5.5, aluminum is not bioavailable. Finally, the thallium plant EQ of 1.06 is based on a very weak TRV, with no known toxic endpoints from a secondary citation.

Acceptable risks were found for the avian receptors of concern (ROCs) (Mariana crow and yellow bittern) for cadmium and copper. Aluminum NOAEL risks were greater than 1.0 (1.6 and 2.4 for the Mariana crow and yellow bittern, respectively); however, these risks are low, and the exposure concentration is less than the Andersen AFB BTV for aluminum. Chromium NOAEL risks to the Mariana crow and yellow bittern were 1.6 and 1.03, respectively. Site representative concentrations in soil (which drive the dose to the birds) are appreciably lower than Andersen AFB reference concentrations. Thus, chromium at Site 6 is effectively the same as background. Because of the low value for these NOAEL HQs, and the comparison of site chromium concentrations with Andersen AFB reference chromium concentrations, it is not expected that chromium is responsible for elevated risk to the avian receptors. No avian TRVs were found for beryllium or thallium; therefore, avian risks from these COPCs are not quantifiable.

In summary, acceptable risks have been found for the ecological receptors once the conservative assumptions built into the ERA are accounted for (Table 2-8).

2.7.2.4.2 ERA Uncertainties for Site 6

Ecological risk characterization includes analysis of uncertainty (USEPA, 1997a). Uncertainty is distinguished from variability, and arises from lack of knowledge about factors associated with the study. Sources of uncertainty include the process of selecting COCs, assumptions made in establishing the CSM, the adequacy of ecological characterization of the site, estimates of toxicity to receptors, and selection of model parameters. There are a number of factors that contribute to uncertainty in the ecological risk characterization for Site 6.

2.7.2.4.2.1 Uncertainties for Non-Random Sampling

While ecological receptors are likely to be found anywhere about the 8-acre Site 6, environmental media at known or suspected to be contaminated are typically sampled in biased manner. That is, sampling points are chosen to best characterize known or suspected areas of contamination. Peripheral and nearby areas are under-sampled, if at all, and thus the average exposure of ecological receptors is biased high and exposure concentrations used in evaluating risks are conservative.

2.7.2.4.2.2 Uncertainties for COC Selection

COCs for the Site 6 ERA were selected by comparison of maximum concentrations for all measured analytes with conservative, toxicologically based concentrations expected to represent no adverse effect levels. In addition, because the geology of Andersen AFB is unique (represented by highly weathered limestone), reference BTVs of metals were also used to identify COCs. The use of conservative toxicity values relative to maximum concentrations represents a very conservative screening process. Because plants and animals on Andersen AFB have acclimated to high metal concentrations such as aluminum, iron, or chromium, the use of representative background concentrations represents a more realistic COC selection mechanism.

2.7.2.4.2.3 Uncertainties for Receptor of Concern Selection

Selection of appropriate ROCs for Site 6 was performed using different criteria than are typically used. Because of the concern for the extirpation of native animals and plants on the island, any species that were introduced to the island and are thus not native species were not considered to be ROCs. Alternatively, native species found at the site were identified as ROCs. The native blue-tailed skink, while observed on the site, was not selected as an ROC due to the lack of appropriate toxicological values. It is expected that in the event of acceptable risk being found for identified ROCs, the insectivorous blue-tailed skink would also have acceptable risk; however, this is an assumption with unknown uncertainty.

2.7.2.4.2.4 Uncertainties for Exposure Pathway

Inhalation and dermal exposure to terrestrial receptors were not quantified because doses from these pathways are very small relative to food and incidental soil ingestion (USEPA, 2000d). While this may underestimate the total dose to the ROC, the underestimate would be in the fraction of a percent of total dose, and is thus not of importance. In addition, ingestion of surface water was not considered in this risk assessment. There are very few, if any, natural surface water bodies at Andersen AFB because the ground is very porous, and any water that falls on the surface is rapidly infiltrated into the ground. The estimated depth to groundwater in the vicinity of Site 6 is approximately 480 feet bgs, and is thus not accessible to ecological receptors. The ecological receptors on Guam have adapted to this characteristic by obtaining most of their water from the food that they consume, which accounts for the large number of fruigivorous animals on Guam.

2.7.2.4.2.5 Uncertainties for Exposure Assumptions

A number of assumptions were made to estimate doses of metals to the terrestrial ROCs. Some of these assumptions were conservative, adding to the potential overestimate of risk, while some exposure assumptions have an unknown effect on the uncertainty of this risk assessment.

Because there is little information available for the bird receptors, certain food-web model components are uncertain. For example, the assignment of feeding fractions for the yellow bittern (100 percent reptile) and the 2 percent incidental soil ingestion are based on best professional judgment in the absence of species- and site-specific data. Similarly, the use of the available tissue concentration data for monitor lizard and papaya as a surrogate for the various food items eaten by the ROC adds uncertainty. These food items were collected or hunted at Andersen AFB, but not at Site 6. It has been assumed that concentrations of these food items at Site 6 are the same as those found at the Base. How this assumption relates to uncertainty is not known, as risks may be either over- or underestimated.

COCs were assumed to be 100 percent bioavailable, though this assumption is highly unlikely based on soil chemistry. Elements are common constituents of soil and crustal materials. In the solid soil matrix, most of these elements are not bioavailable, and are thus not taken up into organisms exposed to these soils. The environmental behavior (and thus the bioavailability) of metals in soils is complex and not well understood. The solubility and availability of these

metals is dependent on a number of factors including soil Eh, pH, and availability of ligands (chemical constituents capable of bonding with metal ions) (Bodek et al., 1988).

A conservative assumption made for the Mariana crow and the yellow bittern was that the foraging range for them was 100 percent at Site 6 with respect to incidental soil exposure, and over the entire Andersen AFB for tissue concentrations. The assumption of 100 percent soil exposure from the site is very conservative, as these receptors have a wide foraging range.

Exposure and subsequent risks to earthworms and plants were represented by mean values instead of upper level exposures such as the maximum concentration or upper confidence limit of the mean (UCLM). This was done because ecological risk (as long as the receptor is not a threatened and endangered species) is based on the population level rather than individual level risks as is performed in a human health risk assessment. Thus, while some individuals may be impacted by a COC in an ERA, risks are acceptable as long as the population of receptors is not impacted. Consequently, the use of mean concentrations rather than upper limit estimates is more representative of population exposure than individual exposure.

2.7.2.4.2.6 Uncertainties for TRVs

Toxicological data used in the risk characterization represent significant uncertainty. Because there are no known data on the effects of chemical constituents on the Mariana crow and yellow bittern, toxicological data for surrogate species were used, and this adds uncertainty. This uncertainty is to some extent controlled by choosing the lowest available screening values, consistent with USEPA (1997a) guidance to "be consistently conservative in selecting literature values…."

In several instances, TRVs were not available for various ROCs. This included earthworms (aluminum and thallium), and avian receptors (beryllium and thallium). Given the absence of appropriate TRVs, it is not possible to eliminate the potential risk from these COC. However, the finding of acceptable risk levels for other ROCs indicates that these receptors may also not be at risk.

2.7.2.4.2.7 Uncertainties for Cumulative Hazard Indices

While not evaluated for this ERA, it is known that two or more chemicals can interact with each other, resulting in skewed toxicity. These interactions can be additive (risks from the two chemicals should be summed), synergistic (the presence of the second chemical increases the effect of the first chemical), or antagonistic (the presence of the second chemical reduces the effect of the first chemical). The presence of multiple contaminants in soils results in an infinite variety of combinations and permutations of these interactions. No real guidance exists for this type of assessment within the ERA process (USEPA, 1997a; 1998a), and the state-of-the-science does not suggest that cumulative HIs be calculated. However, this is mentioned as a source of uncertainty within this risk assessment.

2.7.2.4.2.8 Uncertainties for Population Level Effects

The goal of an ERA is to protect the populations of organisms living on or near the site of concern. When the potential or observed presence of threatened and endangered species is established, such as the Mariana crow at Site 6, these receptors deserve a special level of protection, protecting each individual organism. However, for most organisms, the protection of the population remains the goal. Toxic endpoints used for plants tend to be individual, such as reduced weight or shoot length. Toxic endpoints for earthworms, mammals, and birds are those that could have an impact on the population, such as reproduction.

2.8 Remedial Action Objectives

RAOs are medium-specific and/or site-specific remediation goals for protecting the human health and the environment. Based on HHRA results at Site 6, aluminum and chromium were determined to be surface soil COCs, and aluminum, antimony, and chromium were determined to be subsurface soil COCs. Under the RME exposure scenario, future resident children would be under health risk from the non-carcinogenic effects of some COCs in surface and subsurface soils. Under the RME exposure scenario, future resident adults would be under health risk from the non-carcinogenic effects of some COCs in subsurface soils. Chromium was the only COC for which the cancer risk exceeded 10^{-6} for future residents (adults and children); however, it was within the "acceptable risk range" of 10^{-6} to 10^{-4}. Table 2-11 identifies RGs for Site 6. Table 2-11 and Figures 2-7 and 2-8 present the spatial distribution of COC-impacted soils at Site 6.

Because of the potential for dermal, ingestion, and inhalation exposures to the COC-impacted surface and subsurface soils, there would be a potential adverse effect on site residents who may come into prolonged contact with soil at Site 6. The adverse health effects may include cancer or damage to blood (such as from exposure to antimony), central nervous system (such as from exposure to aluminum), or lung (such as from exposure to chromium). Due to the proximity to the MSA and Base Landfill Complex there are no plans to develop this site for residential use in the future. Under current use conditions at Site 6, the only potential current receptors are occasional users/trespassers. However, as a conservative assumption, risks to potential future residents were evaluated. The results of this HHRA indicate that there are no unacceptable risks to the occasional user/trespasser exposed to the site. Non-cancer risks for occasional users/trespassers are below USEPA's risk target of 1.0. Cancer risks for occasional users/trespassers are less than USEPA's "acceptable risk range" of 10^{-6} to10^{-4}. Under current use of the site, there are no unacceptable risks posed to human health.

Based on ERA results, acceptable risks have been found for ecological receptors once the conservative assumptions built into the screening ERA are accounted for.

Based on the results of the HHRA and ERA, the following RAO was developed for Site 6:

- Prevent future residential exposure to aluminum and chromium in surface soil and aluminum, antimony, and chromium in subsurface soil at concentrations greater than the respective BTVs.

The above RAO addresses the unacceptable risks identified from the HHRA and ERA at Site 6. Although not determined to pose unacceptable risks in the HHRA or ERA, some debris at Site 6 has been identified as a potential physical hazard. Accordingly, approximately 5 cy of asphalt, drums containing asphalt, and drum remnants are recommended for removal from Site 6.

Risk-based RGs were developed for COPCs at Site 6 that are protective of human health for specific exposure scenarios established for the site. RGs are calculated by deriving the COC concentration in a given medium that corresponds to a cumulative HI for a specific target organ of 1.0, and a cumulative cancer risk equal to a risk level of 10^{-6}, 10^{-5}, and 10^{-4}. RGs have been established for Site 6 based on the HHRA results, as follows:

- A RG of 173,500 mg/kg was established for aluminum in surface and subsurface soils based on the BTV.
- A RG of 1,080 mg/kg was established for chromium in surface and subsurface soils based on the BTV
- A RG of 63 mg/kg was established for antimony in subsurface soil based on the BTV.

Summary of Risk-Based Remedial Goals (RGs) for Surface and Subsurface Soils at Site 6 for Resident Adults and Children

COC	RME EPC (mg/kg)	Calculated Risk for all Pathways	RG for HI = 1.0 (mg/kg)	RG for 10-6 (mg/kg)	RG for 10-5 (mg/kg)	RG for 10-4 (mg/kg)	2004 Residential PRG (mg/kg)	BTV (mg/kg)	Maximum Value (mg/kg)
Surface Soil—Non-Cancer Risks									
Aluminum	153,000	2.7	56,667	NA			76,000	**173,500***	207,000
Chromium	860	3.7	232				210	**1,080***	1,270
Surface Soil—Cancer Risks									
Chromium	860	2.20E-05	NA	39	391	3,909	210	**1,080***	1,270
Subsurface Soil—Non-Cancer Risks									
Aluminum	198,000	3.4	58,235	NA			76,000	**173,500***	215,000
Antimony	95	3	32				31.3	**63***	95
Chromium	1,590	6.8	234				210	**1,080***	1,590
Subsurface Soil—Cancer Risks									
Chromium	1,590	4.00E-05	NA	39.8	397.5	3,975	210	**1,080***	1,590

*BTV exceeds RG; therefore, BTV is used as cleanup goal.

The RGs were used to estimate the area and volume of COCs that are to be addressed by the remedial alternatives and the Selected Remedy. The RGs presented in Table 2-10 represent

COC concentrations below which there are no unacceptable risks to either human health or the environment.

Site 6 is located downgradient of aquifer recharge zones and will not impact current or future groundwater production wells within the recharge zones. The freshwater lens is relatively thin beneath the site, and becomes even thinner and more brackish as it approaches the nearby Pacific Ocean. Based on analytical results from groundwater samples that have been collected downgradient from Site 6 (IRP-48) for the past ten years, the groundwater quality has not been negatively impacted by the presence of COCs at Site 6.

2.9 Description of Alternatives

Using USEPA guidelines (40 Code of Federal Regulations [CFR] 300.430(e)(7)) for screening remediation technologies, 33 remedial technologies for soil were considered at Site 6. Many of these were eliminated from further consideration because they were not feasible for the physical and chemical properties of the Site 6 COCs and/or the unique environmental setting of Site 6. For instance, the COCs at Site 6 are metals. Most biological treatment technologies (e.g., bioventing, enhanced bioremediation, composting, and landfarming) are ineffective in reducing metals concentrations to levels that would not pose a risk to human health or the environment. Similarly, treatment technologies such as vapor extraction and solar denitrification are not designed to treat metals and, therefore, are not feasible at Site 6. The remaining remedial technologies that were potentially feasible for the mitigation of Site 6 risks were screened according to their effectiveness, implementability, and, to a lesser extent, cost. Remedial technologies retained from the screening process were grouped into remedial alternatives that were further screened based on their effectiveness, implementability, and cost. Based on the remedial technology and alternative screenings, the following three remedial alternatives were retained for detailed analysis at Site 6:

- No Action
- Excavation and Offsite Disposal (Removal)
- Institutional Controls

Each of these three remedial alternatives is summarized below. A more complete, detailed presentation of each alternative is presented in Chapter 2 of the FS (EA, 2006). A summary of the comparative analysis of these alternatives and a further description of the Selected Remedy for Site 6 are presented in Sections 2.10 and 2.12, respectively, of this ROD.

2.9.1 *No Action* Alternative

The *No Action* alternative represents a true no action scenario, as no control or active treatment of the site soil is performed. COC-impacted soil, other debris, and the identified human health risks, therefore, would remain at the site.

There are no costs associated with this alternative.

2.9.2 *Removal* Alternative

The site has already been cleared of surface debris with the year 2000 removal action and there are no unacceptable risks to occasional users/trespassers at the site (OHM, 2001). To supplement the completed removal work, the *Removal* alternative would include the following additional components to achieve the RAO for Site 6:

- Excavation and Offsite Disposal of Soil – As derived from the BTV-based RGs, volumes of COC-impacted surface and subsurface soils were estimated to be 1,570 and 530 banked cubic yards (bcy), respectively. These estimated volumes were based on Best Professional Judgment and experience gained from completed and ongoing removal action projects at Andersen AFB. The estimated volume of surface soil for removal is based on a 1-foot-thick cover of aluminum- and chromium-impacted surface soil samples that extends over an area of approximately 42,230 square feet (Figure 2-7). The estimated volume of subsurface soil for removal is calculated by considering a 4-foot thick by 30-foot diameter centered around antimony-, aluminum-, and chromium-impacted subsurface soil samples (Figure 2-8). Following excavation, confirmatory samples would be collected and analyzed for the target COCs prior to backfilling and site restoration. Excavation may be expanded laterally or vertically in areas where COC concentrations in confirmatory samples exceed the RGs. Prior to transporting the COC-impacted soil offsite disposal, the excavated soil will be analyzed for waste characteristics. If necessary, based upon the waste characterization results, the soil may be treated (e.g., stabilization) in order to meet disposal requirements. The excavated soil would then be transported to the Andersen AFB CU for disposal. Upon completion the excavations would be backfilled with clean fill and then compacted and graded.

- Debris Removal – The USAF also would remove approximately 5 cy of asphalt, drums containing asphalt, and drum remnants from Site 6.

The *Removal* alternative costs (including removal of surface debris) are estimated at $336,500 (Table 2-12). Following completion of the *Removal* alternative, the site would be rendered suitable for unrestricted use and unlimited exposure; therefore, the site could be closed under CERCLA and no 5-year reviews would be required. There are no long-term costs ($0) associated with the *Removal* alternative.

2.9.3 *Institutional Controls* Alternative

The site has already been cleared of surface debris with the year 2000 removal action and no risk exists for the expected occasional users/trespassers at the site (OHM, 2001). To supplement the completed removal work, the *Institutional Controls* alternative includes the following additional components to achieve the RAO for Site 6:

- Land Use Controls (LUCs) – The USAF will implement LUCs through amendments to the BCP to ensure the continued protection of human health and the environment. The full scope of the LUCs will be presented in a Land Use Control Management Plan (LUCMP) to be developed by the USAF in coordination with the USEPA and Guam EPA

subsequent to approval of the ROD. Conceptually, the LUCMP will include (1) a prohibition on the redevelopment of Site 6 (particularly for residential use) without prior approvals from the USAF, the USEPA, and the Guam EPA; (2) limitations and controls on any future excavation activities at the site (e.g., worker requirements, soil management, waste disposal); and (3) a requirement that any intrusive activities be first approved by the Andersen AFB Civil Engineer Squadron. The LUCMP will also include additional provisions such as (1) requirements for periodic (e.g., annual) inspections of the site to ensure compliance with the LUCs; (2) specification of periodic (e.g., annual) LUC-compliance reporting requirements; (3) protocols for property lease or transfer (note: currently, there are no plans for property lease or transfer); and (4) protocols for notification and correction of any LUC non-compliant events. The LUCs will remain in effect for as long as the site conditions are not suitable for unrestricted use and unlimited exposure. A detailed discussion of the actions the USAF will be required to perform to ensure proper implementation of LUCs at Site 6 is provided in Table A-1 (Appendix A).

- Debris Removal – The USAF will remove approximately 5 cy of asphalt, drums containing asphalt, and drum remnants from Site 6. The debris includes asphalt material, which if not removed, is a potential continued source of PAH contamination. Removal of this debris will be similar to the previous debris removal completed at the site in 2000 (OHM, 2001).

- Five-year reviews – Following successful implementation of the above actions, the site will be suitable for continued use as open space, but will not be suitable for unrestricted use and unlimited exposures (e.g., residential). Therefore, the USAF, in conjunction with the USEPA and Guam EPA, will conduct 5-year reviews to ensure that the *Institutional Controls* alternative is effective in the future protection of human health and the environment. The reviews may focus on the site conditions, the current and planned future site use, the results of any nearby monitoring programs (e.g., the Basewide Long-term Groundwater Monitoring Program), and the LUC-compliance reports. The 5-year reviews will be conducted until the site was deemed to be suitable for unrestricted use.

Following implementation of the *Institutional Controls* alternative, the site would be rendered suitable for continued use by Andersen AFB. The *Institutional Controls* alternative would control exposures to resident children and adults by prohibiting development of the land for residential use. Due to its close proximity to the Base Landfill, the CU, and the MSA, there is no likelihood that Site 6 would be developed for future residential use; rather, the potential future use of the site would be for an industrial application.

For some CERCLA sites, an *Institutional Controls* alternative would include the installation of a fence around the impacted area to reduce access. However, as the COCs at Site 6 do not pose a potential threat to occasional users/trespassers, the *Institutional Controls* alternative for Site 6 does not require fencing off the area. As a conservative measure, signs will be posted to inform occasional users/trespassers not to disturb the subsurface soil. Under the *Institutional Controls* alternative, the BCP would have to be amended to prevent any facility development at the site. The public would be informed by publication of fact sheets and/or brochures.

The *Institutional Controls* alternative costs are estimated at a present worth of $115,700 (Table 2-13). This includes $21,500 in capital costs (including the surface debris/drum removal) and $94,200 in long-term costs.

2.10 Comparative Analysis of Alternatives

Evaluation criteria for comparison of cleanup alternatives are based on CERCLA statutory requirements, earlier program initiatives promulgated in the 20 November 1985 NCP, and site-specific experience gained in the Superfund program. A total of nine criteria are developed for comparing the merits of each cleanup alternative as follows:

- Overall Protection of Human Health and the Environment
- Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)
- Short-Term Effectiveness
- Long-Term Effectiveness and Permanence
- Reduction of Toxicity, Mobility, or Volume Through Treatment
- Implementability
- Cost
- Territorial (Guam) Acceptance
- Community Acceptance

The first two criteria are threshold factors that must be met by each alternative. The next five criteria are the primary balancing factors upon which the comparison of remedial alternatives is based. The last two criteria are modifying factors and are applied to ensure that the final cleanup alternative would meet public acceptance. The final step is a cost analysis for a few feasible cleanup alternatives before presenting the final cleanup alternative for public review and comment.

The above-mentioned nine criteria will be presented each in the following sections and a comparison of the three alternatives will be made in decreasing order from the most to least advantageous alternative.

2.10.1 Overall Protection of Human Health and the Environment

This threshold criterion provides an overall assessment of human health and environmental protection based on how specific site remedial alternatives would achieve protection over time, how site risks associated with each COC would be reduced, and how each COC source would be eliminated, reduced, or controlled.

The *Removal* alternative (COC-impacted soil and designated surface debris would be removed from the site) adequately meets the criteria for overall protection of human health and the environment both short-term and long-term from risks posed by COCs. By excavating and removing the COC-impacted soil and the solid waste, the source would be removed and the

exposure pathways identified in the risk assessment, direct dermal contact, incidental ingestion of soil, and inhalation of soil particulates, would be controlled. Upon completion of the remedial action, no restrictions on site exposure or future land use would be required.

The *Institutional Controls* alternative would be protective of human health and the environment as it would eliminate exposure to residential receptors by preventing residential development on or adjacent to the site. This alternative would not remove or reduce the volume of soil exceeding RG.

The *No Action* alternative would not adequately meet the criteria for overall protection of human health and the environment, both short term and long term, from risks posed by COCs to future residents. This alternative would not remove or reduce the volume of soil exceeding RGs. Since it does not meet the most important of the criteria, it will not be fully evaluated on the other eight criteria.

2.10.2 Compliance with ARARs

This threshold criterion evaluates a remedial alternative's compliance with the federal and territorial (Guam) ARARs as defined in CERCLA Section 121. The applicable ARARs are those legally enforceable federal and territorial (Guam) requirements that specifically address hazardous substances, pollutants, removal actions, locations, or other circumstances found at the impacted areas. The ARARs and To Be Considered (TBC) documents for the site are presented in Tables 2-14 and 2-15).

The *Institutional Controls* alternative meets each of its respective ARARs.

The *Removal* alternative meets each of its respective ARARs.

The No Action alternative would not comply with chemical-specific TBCs because COC concentrations above PRGs would not be mitigated.

2.10.3 Short-Term Effectiveness

This balancing criterion addresses the impact of the remedial action during the construction and start-up phase as well as the effectiveness for achieving RAOs. Factors evaluated include protection of workers during the remedial actions, environmental impacts resulting from the implementation of the remedial action, and the time required to implement the proposed remedial alternative at the site.

The *Institutional Controls* alternative requires minimal work to implement and would be effective over the short term. During removal of the small volume of surface debris (approximately 5 cy of asphalt, drums containing asphalt, and drum remnants), removal contractor workers may have slight exposure to COCs from incidental inhalation or ingestion of dust particles during excavation activities. Workers will wear appropriate protective clothing (disposable chemical resistant gloves, safety glasses, and possibly dust particulates filter masks) to prevent exposure. Dust suppression techniques would be applied, as conditions require. The

Contractor shall also comply with federal and territorial requirements for any task involving the transportation of hazardous wastes and/or contaminated materials to off-site treatment, storage and/or disposal facilities. This includes 40 CFR 260, 49 CFR 172, 173, 178, 179 and other applicable federal and territorial transportation regulations.

The *Removal* alternative would have lower short-term effectiveness due to the greater disturbance of contaminated soils. Removal contractor workers may have slight exposure to COCs from incidental inhalation or ingestion of dust particles during excavation activities. Workers will wear appropriate protective clothing (disposable chemical resistant gloves, safety glasses, and possibly dust particulates filter masks) to prevent exposure. Dust suppression techniques would be applied, as conditions require. The Contractor shall also comply with federal and territorial requirements for any task involving the transportation of hazardous wastes and/or contaminated materials to off-site treatment, storage and/or disposal facilities. This includes 40 CFR 260, 49 CFR 172, 173, 178, 179 and other applicable federal and territorial transportation regulations.

RAOs would be achieved quickly under both the *Institutional Controls* alternative and the *Removal* alternative. Although active remediation is not required, the *No Action* alternative would not be effective in the short-term because RAOs would not be achieved.

2.10.4 Long-Term Effectiveness and Permanence

This balancing criterion addresses the effectiveness of each remedial alternative over the life of the remedial action. It also assesses the results of the remedial action in terms of the risk remaining after the response objectives have been met. Particularly, the effectiveness of the controls is applied to manage the risk posed by the residual COCs in the impacted areas at the site (i.e., the risk to future residents).

Once the COC-impacted soils and the small volume of surface debris are excavated and removed under the *Removal* alternative, the site will not pose a risk to human receptors. Therefore, this alternative, would provide a high degree of long-term effectiveness in mitigating human health risks.

The *Institutional Controls* alternative would not reduce the volume of COCs or treat the COCs. Therefore, there are residual risks to potential future residents from leaving untreated COC-impacted areas at the site. As long as the USAF prevents residential development in the area, exposure pathways will not be complete and the risks will be effectively mitigated. Due to its close proximity to the Base Landfill Complex and the MSA, there is no likelihood that Site 6 would be developed for future residential use; rather, the potential future use of the site would be an industrial application. As a conservative measure, signs will be posted to inform occasional users/trespassers not to disturb the subsurface soil. Work conducted at the site would require a clearance permit that must be approved by the Andersen AFB Civil Engineer Squadron.

The *No Action* alternative would not be effective for addressing human receptor risk of exposure to COCs. There would be no controls for this alternative to manage the risks posed by the COCs in soil.

2.10.5 Reduction of Toxicity, Mobility, or Volume Through Treatment

This balancing criterion assesses how each alternative would reduce the principal threats of the total mass of COCs, to provide irreversible reduction in COC mobility, and/or to reduce the total volume of impacted media. Factors of this criterion that are evaluated include the treatment process, the amount of COCs destroyed or treated, the degree of reduction in toxicity, mobility, or volume expected, and the type and quantity of untreated COC residuals.

The *Removal* alternative eliminates the source of COCs and a small volume of surface debris from the site. This alternative eliminates potential risks to human health, but will not reduce the mobility, toxicity, or volume of COCs. Under the *Removal* alternative, the COCs are simply relocated from one location to another. Before transporting any COC-impacted soil to the CU, the COC-impacted soils would be characterized using Toxicity Characteristic Leaching Procedure (TCLP) analyses. The COC-impacted soils that are classified as hazardous based on TCLP analyses would be sent off-island to a licensed off-island hazardous waste disposal facility. Otherwise, the COC-impacted soils that are classified as non-hazardous waste based on TCLP analyses would be transported to the CU.

The *Institutional Controls* alternative would not reduce the toxicity, mobility, or volume of waste through treatment. Although this alternative would include the removal of a small volume of surface debris and drums containing asphalt, this alternative, however, would not remove or reduce the volume of soil exceeding RGs.

The *No Action* alternative would not reduce the toxicity, mobility, or volume of soil exceeding RGs. No treatment, removal, or cover would be proposed using this alternative.

2.10.6 Implementability

This balancing criterion assesses the technical and administrative feasibility of implementing a remedial action and the availability of various services and materials required during implementation. Factors of technical feasibility include construction and operational difficulties, reliability of technology, ease of undertaking additional remedial actions, and the ability to monitor the effectiveness of the remedy.

The *No Action* alternative can be an acceptable remedial alternative under the appropriate site conditions. The administrative feasibility to implement the *No Action* alternative is relatively simple, as there would be no direct capital costs associated with the alternative. However, the *No Action* alternative is not implementable at Site 6 because it does not meet the threshold criteria.

The *Institutional Controls* alternative is a proven and accepted remedial alternative under the appropriate site conditions. The administrative feasibility of implementing the alternative would be relatively simple, as there would be very little coordination of resources and materials, except for the installation of sings associated with the alternative. Periodic site review would be necessary to determine if the alternative is effective and to evaluate future remedial technologies that may be applicable for the site.

The *Removal* alternative is a proven and effective technology for Resource Conservation and Recovery Act (RCRA) and CERCLA sites. The technology is feasible to implement. The volumes of COCs and surface debris that require removal have been estimated in this report for purposes of comparison. It is possible that the quantity of soil that needs to be removed may expand as the work effort gets underway and confirmatory samples are collected. The exact volumes will directly impact the cost of cleanup. Some excavated soil would have to be stockpiled onsite and covered pending analytical results. Multiple mobilizations may be required to transport any soil determined to be hazardous off-island for disposal. Excavation and transportation equipment are readily available on the island. Off-island hazardous waste shipping is available; however, also expensive.

2.10.7 Territorial (Guam) Acceptance

This modifying criterion accounts for the technical and administrative issues concerning the territory of Guam regarding each of the remedial alternatives. This factor includes the remedial actions that the territory would support, oppose, or would be concerned about. The Territorial Acceptance was evaluated based on comments received from the Guam EPA's representatives during Remedial Project Managers Meetings (RPMs) regarding IRP sites at Andersen AFB.

The *Institutional control* alternative would be accepted by the Territory (Guam).

The *Removal* cleanup alternative would be accepted by the Territory (Guam).

The *No Action* cleanup alternative would not be accepted by the Territory (Guam) as it does not mitigate the identified risks.

2.10.8 Community Acceptance

This modifying criterion accounts for the issues and concerns the property owner and the public may have regarding each of the remedial actions. The factors included the remedial actions that the property owner or the community would support, oppose, or would be concerned about. Community Acceptance was evaluated based on comments received at the Public Meeting to present the Proposed Plan for Sites 6, 9, and 12, held on 6 April 2006. Also the public was asked for written comments during the Public Comment Period (30 March 2006-29 April 2006).

The *Institutional Controls* alternative would be accepted by the community.

The *Removal* cleanup alternative would be accepted by the community.

The *No Action* cleanup alternative would not be accepted by the community as it does not mitigate the identified risks.

2.10.9 Cost

This balancing criterion assesses the projected cost for the final list of alternatives at the conclusion of the cleanup alternatives screening process. Present worth analysis allows remedial actions to be compared on the basis of a single cost representing an amount that, if invested in the base year and disbursed as needed, would be sufficient to cover costs associated with the remedial action over its planned life. When applicable, a required operating performance period of 30 years will be used in calculating the present worth of the remedial alternatives. The remedial costs included capital costs and annual O&M costs. Capital costs consist of both direct and indirect costs. Direct costs include expenditures for the equipment, labor, and materials necessary to install removal actions. Indirect costs include expenditures for engineering, financial, and other services required when installing a remedial alternative at a site. Annual O&M costs include auxiliary monitoring, materials, and energy required to install remedial actions, disposal of residue, purchased services, administrative costs, insurance, taxes, license costs, maintenance reserve and contingency funds, rehabilitation costs, and costs for periodic site reviews.

There would be no direct capital costs associated with the *No Action* alternative.

The present worth costs associated with implementing the *Institutional Controls* alternative are estimated at $115,700 (Table 2-13).

The *Removal* alternative requires minimal administrative effort and total costs (including the surface debris), protective of residential users, are estimated at $336,500 (Table 2-12).

2.11 Principal Threat Posed by Waste

According to USEPA guidelines, treatment alternatives must be used to address the principal threats posed by any site whenever practicable. In general, the term "principal threat wastes" includes:

- Liquid source material, such as waste contained in drums, lagoons or tanks, and free product in the subsurface containing COCs
- Mobile source material, such as surface soil or subsurface soil containing high concentrations of COCs that are mobile due to wind entrainment, volatilization, surface runoff, or subsurface transport
- Highly-toxic source materials, such as buried drums containing non-liquid wastes, buried tanks containing non-liquid wastes, or soils containing significant concentrations of highly toxic materials (USEPA, 1999a)

Wastes that are generally considered as "non-principal threat" include:

- Non-mobile contaminated source material of low to moderate toxicity, such as surface soil containing COCs that generally are relatively immobile in air and groundwater in the specific environmental setting

- Low toxicity source materials, such as surface soil and subsurface soil with concentrations of COCs not greatly above reference dose levels or that present an excess cancer risk near acceptable risk range (USEPA, 1999a)

The COC-impacted surface and subsurface soils at Site 6 are a non-principal threat because:

- The major COCs are metals that are relatively immobile in the alkaline conditions of the limestone formations at Site 6.
- The site is not currently a residential area.

Due to the proximity to the Base Landfill, the CU, and the MSA there are no plans to develop this site for residential use in the future. The potential future use of the site would be for an industrial application. However, as a conservative assumption and to serve as a baseline, risks to potential future residents are evaluated for Site 6. Under current use conditions at Site 6, the only potential current receptors are occasional users/trespassers. The results of this HHRA indicate that there are no unacceptable risks to the occasional user/trespasser at the site. Nevertheless, the human health risks associated with COC-impacted soils, in conjunction with the physical risks posed by the surface debris, justify a remedial action to protect human health. No unacceptable ecological risks were identified. As such, the *Institutional Controls* alternative was selected.

2.12 Selected Remedy

The USAF and USEPA Region 9 co-selected the *Institutional Controls* alternative in conjunction with concurrence from the Guam EPA and affected property owners.

2.12.1 Summary of the Rationale for the Selected Remedy

The major rationale for selecting the *Institutional Controls* as a remedial alternative for Site 6 is that the USAF, USEPA Region 9, and the Guam EPA, have agreed that the *Institutional Controls* alternative would control exposures to resident children and adults by prohibiting development of the land for residential use. Due to the proximity to the Base Landfill Complex, the CU, and the MSA there are no plans to develop this site for residential use in the future. The potential future use of the site would be for an industrial application. No fencing is required around Site 6 as there are no unacceptable risks to occasional users/trespassers.

As presented in Section 2.10 of this ROD, the *Institutional Controls* alternative has advantages over the *Removal* alternative and the *No Action* alternative. The *Institutional Controls* alternative:

- Will meet RAOs, but at a cost less than that estimated for the *Removal* alternative.
- Will be protective of human health and the environment, but at a cost less than that estimated for the *Removal* alternative.
- Removes the small volume of surface debris from the site.

2.12.2 Detailed Description of the Selected Remedy

A detailed description of the actions the USAF will be required to perform to ensure proper implementation of institutional controls and LUCs at Site 6, in accordance with this ROD, is provided in Table A-1 (Appendix A). Table A-1 provides a summary of: (1) site risks relevant to the selected remedy, (2) a description of the property including current and anticipated future property ownership, land use, and restrictions, (3) a description of onsite structures, (4) a description of LUC objectives, (5) a list of applicable engineering and institutional controls and other specific measures that are required to implement LUCs consistent with the selected remedy, (6) monitoring and reporting requirements, and (7) specific corrective actions to address non-compliant LUC events. The components necessary for implementation of the *Institutional Controls* alternative are provided in the following bullets.

- Phase 1—Site Preparation, mobilization, and surveying
- Phase 2—Surface grubbing of approximately 5 cy of drum remnants, drums containing asphalt, and surface asphalt debris to the CU
- Phase 3—Development of LUCMP and implementation of LUCs
- Phase 4—Periodic reviews (LUCs inspections and 5-year reviews)

2.12.3 Summary of the Estimated Remedy Costs

A summary of the *Institutional Controls* alternative cost estimate is presented in Table 2-13. Implementation of the *Institutional Controls* alternative is estimated to cost approximately $115,700 (30-year present worth). This is an engineering cost estimate that is expected to be within +50 percent to –30 percent of the actual project cost. The cost information presented in Table 2-13 is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. Major changes may be documented in the form of a memorandum in the AR, in an Explanation of Significant Difference (ESD), or a ROD amendment.

2.12.4 Expected Outcome of the Selected Remedy

The expected outcome of the Selected Remedy is the continued use of the property by Andersen AFB as an undeveloped parcel. Under the *Institutional Controls* alternative, the BCP will be amended to prevent any residential development at the site. Periodic reviews would be conducted to ensure the long-term protection of human health and the environment.

2.13 Statutory Determination

According to USEPA guidelines (USEPA, 1999b), the lead agency must select remedies that are protective of human health and the environment, comply with ARARs, are cost effective, and utilize permanent solutions and alternative treatment or resource recovery technologies to the maximum extent practicable. Additionally, a preference is given for remedies that permanently and significantly reduce the volume, toxicity, or mobility of hazardous waste materials.

The Selected Remedy (*Institutional Controls*) is protective of human health and the environment, complies with Federal and Territory of Guam requirements that are applicable or relevant and appropriate to the remedial action, and is cost-effective.

Because the *Institutional Controls* alternative will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that do not allow for unlimited use and unrestricted exposure, a five-year review will be required for this remedial action.

2.13.1 Protection of Human Health and the Environment

The *Institutional Controls* alternativ*e* will be protective of human health and the environment as it will eliminate exposure to residential receptors by preventing residential development on or adjacent to the site. Due to its close proximity to the CU and the MSA, there is no likelihood that Site 6 would be developed for future residential use. The potential future use of the site would be for an industrial application. At some CERCLA sites, institutional controls would include the installation of a fence around the impacted area to reduce access. However, because the COCs at Site 6 do not pose a potential threat to occasional users/trespassers, the *Institutional Controls* alternative does not require fencing off the area. As a conservative measure, signs will be posted to inform occasional users/trespassers not to disturb the subsurface soil. Work conducted at the site would require a clearance permit that must be approved by the Andersen AFB Civil Engineer Squadron. This alternative will not remove or reduce the volume of soil exceeding the RGs.

2.13.2 Compliance with ARARs

The *Institutional Controls* alternative meets each of its respective ARARs (Tables 2-14 and 2-15).

2.13.3 Cost Effectiveness

According to USEPA guidelines (USEPA, 1999b), a remedy is cost effective if the cost is proportional to its overall effectiveness in protecting human health and the environment.

The *Institutional Controls* alternative will be protective of human health and the environment, but at a cost less than that estimated for the *Removal* alternative (Tables 2-13 and 2-12, respectively).

2.13.4 Utilization of Permanent Solution

The *Institutional Controls* alternative is not a permanent solution for the site because it would not reduce the volume of COCs or treat the COCs. Therefore, there are residual risks to potential future residents from leaving untreated COC-impacted soil areas exceeding RGs at the site.

2.13.5 Preference for Treatment as a Principal Element

The *Institutional Controls* alternative does not treat site COCs; however, the associated risks are mitigated through LUCs. Additionally, the small volume (approximately 5 cy) of surface debris to be removed from the site will simply be relocated to the CU; however, that volume is not significant compared to the CU capacity.

2.13.6 Five-Year Review Requirement

A five-year review of this ROD will be necessary because residual COCs will be left at Site 6 after implementing the *Institutional Controls* alternative, per 42 United States Code [USC]§9621(c) and 40 CFR§300.430(f)(5)(iii)(C).

2.14 Documentation of Significant Changes

On 29 March 2006, the Proposed Plan for the Sites 6, 9, and 12 was released to the public for review and comments, with a Public Comment Period extending from 30 March to 29 April 2006. A public meeting was held in the Holiday Resort in Tumon on 6 April 2006 to present the Proposed Plan to the public.

The same *Institutional Controls* alternative that is presented in this ROD was also presented in Proposed Plan and the public meeting as the preferred alternative. The USAF, USEPA Region 9, Guam EPA, and affected property owners have agreed that *Institutional Controls* is an acceptable alternative to address Site 6. Therefore, there are no significant changes in this ROD to the remedy as originally identified in the March 2006 Proposed Plan.

TABLE 2-1. POTENTIAL RECEPTORS AND EXPOSURE PATHWAYS FOR HHRA AT SITE 6, ANDERSEN AFB, GUAM.

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type Of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current	Groundwater	Groundwater	Tap Water	Commercial Worker	Adult	Ingestion	Onsite	None	No workers currently at site.
	Surface Soil	Surface Soil	Site 6	Trespasser/Occasional User	Adult	Ingestion	Onsite	Quant	Trespasser may visit the area.
						Dermal	Onsite	Quant	Trespasser may visit the area.
				Commercial Worker	Adult	Ingestion	Onsite	None	No workers are present at site.
						Dermal	Onsite	None	No workers are present at site.
		Air	Site 6	Trespasser/Occasional User	Adult	Inhalation	Onsite	Quant	Trespasser may visit the area.
				Commercial Worker	Adult	Inhalation	Onsite	None	No workers are present at site.
		Animal tissue	Wild Deer Meat	Hunter	Adult	Ingestion	Onsite	Quant	Risks are evaluated on a facility-wide basis.
					Child	Ingestion	Onsite	Quant	Risks are evaluated on a facility-wide basis.
		Animal tissue	Wild Pig Meat	Hunter	Adult	Ingestion	Onsite	Quant	Risks are evaluated on a facility-wide basis.
					Child	Ingestion	Onsite	Quant	Risks are evaluated on a facility-wide basis.
	Subsurface Soil	Subsurface Soil	Site 6	Utility Worker	Adult	Ingestion	Onsite	None	No utilities are present at site.
						Dermal	Onsite	None	No utilities are present at site.
		Air	Site 6	Utility Worker	Adult	Inhalation	Onsite	None	No utilities are present at site.
	Sediment	Sediment	Site 6	Trespasser/Occasional User	Adult	Ingestion	Onsite	None	No sediment found at site.
	Surface Water	Surface Water	Site 6	Trespasser/Occasional User	Adult	Dermal	Onsite	None	No surface water found at site.
Future	Groundwater	Groundwater	Tap Water	Resident	Adult	Ingestion	Onsite	None	Groundwater is evaluated under a separate program.
					Child	Ingestion	Onsite	None	Groundwater is evaluated under a separate program.
	Surface Soil	Surface Soil	Site 6	Resident	Adult	Ingestion	Onsite	Quant	Future use of site assumes residential exposures.
						Dermal	Onsite	Quant	Future use of site assumes residential exposures.
					Child	Ingestion	Onsite	Quant	Future use of site assumes residential exposures.
						Dermal	Onsite	Quant	Future use of site assumes residential exposures.
		Air	Site 6	Resident	Adult	Inhalation	Onsite	Quant	Future use of site assumes residential exposures.
					Child	Inhalation	Onsite	Quant	Future use of site assumes residential exposures.
	Subsurface Soil	Subsurface Soil	Site 6	Resident	Adult	Ingestion	Onsite	Quant	Future use of site assumes residential exposures.
						Dermal	Onsite	Quant	Future use of site assumes residential exposures.
					Child	Ingestion	Onsite	Quant	Future use of site assumes residential exposures.
						Dermal	Onsite	Quant	Future use of site assumes residential exposures.
				Construction Worker	Adult	Ingestion	Onsite	None	Residents are evaluated as future worst case scenario.
						Dermal	Onsite	None	Residents are evaluated as future worst case scenario.
		Air	Site 6	Resident	Adult	Inhalation	Onsite	Quant	Future use of site assumes residential exposures.
					Child	Inhalation	Onsite	Quant	Future use of site assumes residential exposures.
				Construction Worker	Adult	Inhalation	Onsite	None	Residents are evaluated as future worst case scenario.
	Sediment	Sediment	Site 6	Resident	Adult	Ingestion	Onsite	None	No sediment found at site.
	Surface Water	Surface Water	Site 6	Resident	Child	Ingestion	Onsite	None	No surface water found at site.

TABLE 2-2. SUMMARY OF CONTAMINANTS OF CONCERN AND MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATIONS FOR SURFACE SOIL, SITE 6, ANDERSEN AFB, GUAM.

Scenario Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil

Exposure Point	COC	Concentration Detected		Units	BTV	Residential PRG	Industrial PRG	Frequency of Detection	EPC	Statistical Measure
		Min	Max							
Site 6	Aluminum	42,700	207,000	ppm	**173,500**	76,000	100,000	20/20	153,477	95% UCL-N
	Chromium	234	1,270	ppm	**1,080**	210	450	20/20	859	95% UCL-N

Key
Bold/Shaded: Higher of BTV & Industrial PRG (USEPA, 2004)
BTV: Background Threshold Value
COC: Contaminant of concern
EPC: Exposure point concentration
ppm: Parts per million
PRG: USEPA Region 9 Preliminary Remediation Goal
USEPA: U.S. Environmental Protection Agency
95% UCL-N: 95% Upper Confidence Limit of Normal Data (95% UCL-N)

The table presents the COCs and EPC for each of the COCs detected in surface soil (i.e., the concentration that will be used to estimate the exposure and risk from each COC in the surface soil). The table includes the range of concentrations detected for each COC, as well as the frequency of detection (i.e., the number of times the chemical was detected in the samples collected at the surface site), the EPC, and how the EPC was derived. The table indicates that both aluminum and chromium were equally detected COCs in surface soil at the site. The 95%UCL on the arithmetic mean was used as the EPC for aluminum and chromium.

TABLE 2-3. SUMMARY OF CONTAMINANTS OF CONCERN AND MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATIONS FOR SUBSURFACE SOIL, SITE 6, ANDERSEN AFB, GUAM.

Scenario Timeframe: Current/Future
Medium: Subsurface Soil
Exposure Medium: Subsurface Soil

Exposure Point	COC	Concentration Detected		Units	BTV	Residential PRG	Industrial PRG	Frequency of Detection	EPC	Statistical Measure
		Min	Max							
Site 6	Aluminum	5,690	215,000	ppm	**173,500**	76,000	100,000	7/7	197,844	95% UCL-N
	Antimony	0.5	95.3	ppm	63	31	**410**	5/7	95.3	Max[1]
	Chromium	39.7	1,590	ppm	**1,080**	210	450	7/7	1590	Max[1]

Key
Bold/Shaded: Higher of BTV & Industrial PRG (USEPA, 2004)
BTV: Background Threshold Value
COC: Contaminant of concern
EPC: Exposure point concentration
MAX: Maximum concentration
ppm: Parts per million
PRG: USEPA Region 9 Preliminary Remediation Goal
USEPA: U.S. Environmental Protection Agency
95% UCL-N: 95% Upper Confidence Limit of Normal Data (95% UCL-N)
1: Shapiro-Wilk W-Test indicates data are log-normally distributed.

The table presents the COCs and EPC for each of the COCs detected in subsurface soil (i.e., the concentration that will be used to estimate the exposure and risk from each COC in the subsurface soil). The table includes the range of concentrations detected for each COC, as well as the frequency of detection (i.e., the number of times the chemical was detected in the samples collected at the site), the EPC, and how the EPC was derived. The 95%UCL on the arithmetic mean was used as the EPC for aluminum and chromium. However, due to the log-normally distributed sample data available for antimony and chromium, the maximum concentration was used as the default EPC.

TABLE 2-4. SUMMARY OF SURFACE SOIL HHRA RESULTS FOR FUTURE RESIDENT CHILDREN UNDER REASONABLE MAXIMUM EXPOSURE, SITE 6, ANDERSEN AFB, GUAM.

Scenario Timeframe: Current/Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk[1]				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Site 6	ALUMINUM	--	--	--	--	ALUMINUM	CNS	2.0E+00	--	--	2.0E+00
			CADMIUM	--	--	--	--	CADMIUM	kidney	7.4E-02	--	4.1E-03	7.81E-02
			CHROMIUM	--	--	--	--	CHROMIUM		3.7E+00	--	--	3.7E+00
			THALLIUM	--	--	--	--	THALLIUM		2.0E-01	--	--	2.0E-01
			BENZO[A]PYRENE	9.1E-07	--	--	9.1E-07	BENZO[A]PYRENE		--	--	--	--
			DIBENZ[A,H]ANTHRACENE	6.4E-07	--	--	6.4E-07	DIBENZ[A,H]ANTHRACENE		--	--	--	--
			(Total)	1.55E-06	--	--	1.55E-06	(Total)		5.97E+00	--	4.1E-03	5.98E+00
	Air	Site 6	ALUMINUM	--	--	--	--	ALUMINUM		--	6.6E-01	--	6.6E-01
			CADMIUM	--	2.2E-08	--	2.2E-08	CADMIUM		--	--	--	--
			CHROMIUM	--	2.2E-05	--	2.2E-05	CHROMIUM		--	--	--	--
			THALLIUM	--	--	--	--	THALLIUM		--	--	--	--
			BENZO[A]PYRENE	--	3.5E-10	--	3.5E-10	BENZO[A]PYRENE		--	--	--	--
			DIBENZ[A,H]ANTHRACENE	--	2.4E-10	--	2.4E-10	DIBENZ[A,H]ANTHRACENE		--	--	--	--
			(Total)	--	2.20E-05	--	2.20E-05	(Total)		--	6.6E-01	--	6.6E-01
						Total Risk Across Medium	2.36E-05					Total Hazard Index Across All Media and All Exposure Routes	6.64E+00

(1) Carcinogenic risks are combined for Resident Adults and Children.
CNS = Central Nervous System
HI = Hazard Index

Total CNS HI = 2.0E+00
Total kidney HI = 7.81E-02

The carcinogenic portion of this table provides risk estimates for the significant routes of exposure. These risk estimates are based on a reasonable maximum exposure and were developed by taking into account various conservative assumptions about the frequency and duration of a child's exposure to soil and groundwater, as well as the toxicity of the COCs. The combined total risk from direct exposure to contaminated soil at this site to a current/future adult and children resident is estimated to be 2.36E-05. This risk level indicates that if no clean-up action is taken, an individual would have an increased probability of 2.4 in 100,000 of developing cancer as a result of site-related exposure to the COCs.

The non-carcinogenic portion of this table provides hazard quotients (HQs) for each route of exposure and the hazard index (sum of hazard quotients) for all routes of exposure. The Risk Assessment Guidance (RAGS) for Superfund states that, generally, a hazard index (HI) greater than 1 indicates the potential for adverse noncancer effects. The estimated HI of 6.6 indicates that the potential for adverse noncancer effects could occur from exposure to contaminated soil containing aluminum and chromium.

TABLE 2-5. SUMMARY OF SUBSURFACE SOIL HHRA RESULTS FOR FUTURE RESIDENT CHILDREN UNDER REASONABLE MAXIMUM EXPOSURE, SITE 6, ANDERSEN AFB, GUAM.

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk[1]				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Subsurface Soil	Subsurface Soil	Site 6	ALUMINUM	--	--	--	--	ALUMINUM	CNS	2.5E+00	--	--	2.5E+00
			ANTIMONY	--	--	--	--	ANTIMONY	blood	3.0E+00	--	--	3.0E+00
			CHROMIUM	--	--	--	--	CHROMIUM		6.8E+00	--	--	6.8E+00
			(Total)	--	--	--	--	(Total)		1.23E+01			1.23E+01
	Air	Site 6	ALUMINUM	--	--	--	--	ALUMINUM		--	8.5E-01	--	8.5E-01
			ANTIMONY	--	--	--	--	ANTIMONY		--	--	--	--
			CHROMIUM	--	4.0E-05	--	4.0E-05	CHROMIUM		--	--	--	--
			(Total)	--	4.0E-05	--	4.0E-05	(Total)			8.5E-01		8.5E-01
						Total Risk Across Medium	4.0E-05					Total Hazard Index Across All Media and All Exposure Routes	1.32E+01

(1) Carcinogenic risks are combined for Resident Adults and Children.

CNS = Central Nervous System

HI = Hazard Index

Total CNS HI = 2.5E+00

Total blood HI = 3.0E+00

The carcinogenic portion of this table provides risk estimates for the significant routes of exposure. These risk estimates are based on a reasonable maximum exposure and were developed by taking into account various conservative assumptions about the frequency and duration of a child's exposure to soil and groundwater, as well as the toxicity of the COCs. The combined total risk from direct exposure to contaminated soil at this site to a current/future adult and children resident is estimated to be 4.0E-05. This risk level indicates that if no clean-up action is taken, an individual would have an increased probability of 4 in 100,000 of developing cancer as a result of site-related exposure to the COCs.

The non-carcinogenic portion of this table provides hazard quotients (HQs) for each route of exposure and the hazard index (sum of hazard quotients) for all routes of exposure. The Risk Assessment Guidance (RAGS) for Superfund states that, generally, a hazard index (HI) greater than 1 indicates the potential for adverse noncancer effects. The estimated HI of 13 indicates that the potential for adverse noncancer effects could occur from exposure to contaminated soil containing aluminum, antimony,and chromium.

TABLE 2-6. ECOLOGICAL CONTAMINANTS OF CONCERN AT SITE 6, ANDERSEN AFB, GUAM.

Analyte	Ecological Screening Value (mg/kg)	Range of Detections	Frequency of Detection	Samples Greater Than Screen	Outliers That Exceed Bulk of Samples	COC	Rationale For Selection
INORGANICS							
Aluminum	173500	42700 - 207000	20/20	6/20	No	Yes	ASL
Antimony	63	0.5 - 7.4	20/20	0/20		No	BSL
Arsenic	62	3.9 - 26.4	20/20	0/20		No	BSL
Barium	335	5.7 - 30.3	20/20	0/20		No	BSL
Beryllium	3.4	1 - 5.6	20/20	11/20	No	Yes	ASL
Cadmium	6.5	1.6 - 8	20/20	6/20	No	Yes	ASL
Calcium	N/A	4470 - 258000	20/20	0/20		No	NUT
Chromium	1080	234 - 1270	20/20	3/20	No	Yes	ASL
Cobalt	29	3.2 - 23.2	20/20	0/20		No	BSL
Copper	72	4.5 - 281	20/20	1/20	Yes	Yes	ASL
Iron	N/A	26300 - 134000	20/20	0/20		No	NUT
Lead	166	21.2 - 112	20/20	0/20		No	BSL
Magnesium	N/A	815 - 1750	20/20	0/20		No	NUT
Manganese	5500	656 - 5250	20/20	0/20		No	BSL
Mercury (Inorganic)	2.2	0.06 - 0.34	19/20	0/20		No	BSL
Nickel	243	20.8 - 165	20/20	0/20		No	BSL
Potassium	N/A	64.8 - 144	7/20	0/20		No	NUT
Sodium	N/A	49.1 - 85.2	7/20	0/20		No	NUT
Thallium	1.4	0.29 - 1.8	20/20	4/20	No	Yes	ASL
Vanadium	206	30.1 - 129	20/20	0/20		No	BSL
Zinc	130	6.5 - 62.4	20/20	0/20		No	BSL
POLYCYCLIC AROMATIC HYDROCARBONS (PAHs)							
Anthracene	21	0.00041 - 0.00041	1/20	0/20		No	BSL
Benz[a]anthracene	21	0.00081 - 0.2417	12/20	0/20		No	BSL
Benzo[a]pyrene	21	0.00081 - 0.2097	18/20	0/20		No	BSL
Benzo[b]fluoranthene	21	0.0073 - 0.2647	8/20	0/20		No	BSL
Benzo[g,h,i]perylene	21	0.207 - 0.207	1/20	0/20		No	BSL
Benzo[k]fluoranthene	21	0.00105 - 0.1493	18/20	0/20		No	BSL
Chrysene	21	0.00034 - 0.3426	16/20	0/20		No	BSL
Dibenz[a,h]anthracene	21	0.00125 - 0.1304	15/20	0/20		No	BSL
Fluoranthene	21	0.00132 - 0.5622	7/20	0/20		No	BSL
Indeno[1,2,3-cd]pyrene	21	0.0082 - 0.0117	2/20	0/20		No	BSL
Phenanthrene	21	0.244 - 0.244	1/20	0/20		No	BSL
Pyrene	21	0.00122 - 0.5915	17/20	0/20		No	BSL
Total PAH	21	0.6756 - 3.2931	20/20	0/20		No	BSL
SEMIVOLATILE ORGANIC COMPOUNDS (SVOCs)							
Dibutylphthalate	30	0.148 - 0.148	1/20	0/20		No	BSL
Total Phthalates	30	0.148 - 0.148	1/20	0/20		No	BSL

ASL = Above screening level
BSL = Below screening level
COC = Contaminant of concern
mg/kg = milligrams per kilogram
NUT = nutrient

TABLE 2-7. ECOLOGICAL RISK ASSESSMENT ENDPOINTS FOR SITE 6, ANDERSEN AFB, GUAM.

Assessment Endpoint	Null Hypothesis	Measurement Endpoint	Specifics of Assessment
Ecological health of terrestrial invertebrate communities	Soils are not exhibiting a detrimental effect on invertebrate population survival and growth.	Evaluation of soil chemistry with respect to soil invertebrate toxicity values	• Comparison of soil concentrations to soil invertebrate toxicity values.
Ecological health of terrestrial plant communities	Soils are not exhibiting a detrimental effect on population plant survival and growth.	Evaluation of soil chemistry with respect to vegetation toxicity values	• Comparison of soil concentrations to vegetation toxicity values.
Long-term health and reproductive capacity of omnivorous avian species (Mariana crow)	Ingestion of COPC in prey does not have a negative impact on growth, survival, and reproductive success of the species.	Evaluation of dose in prey based on surface soil, fruit, and reptile data in dietary exposure models	• The risk associated with the calculated dose will be evaluated by comparison to Toxicity Reference Values (TRVs). • Fruit and reptile dose approximated using measured concentrations and other appropriate exposure assumptions.
Long-term health and reproductive capacity of carnivorous avian species (yellow bittern)	Ingestion of COPC in prey does not have a negative impact on growth, survival, and reproductive success of the species.	Evaluation of dose in prey based on surface soil and reptile data in dietary exposure models	• The risk associated with the calculated dose will be evaluated by comparison to TRVs. • Reptile dose approximated using measured concentrations and other appropriate exposure assumptions.

COPC = Contaminant of Potential Concern

TABLE 2-8. SUMMARY OF ERA RESULTS FOR SITE 6, ANDERSEN AFB, GUAM.

Assessment Endpoint	Measurement Endpoint	Result
Ecological health of terrestrial invertebrate communities	Evaluation of soil chemistry with respect to soil invertebrate toxicity values	• EQ is less than 1.0 for cadmium, chromium and copper indicating acceptable invertebrate risk levels from these COPCs. • The EQ for beryllium was 1.8, and is based on an uncertain mortality NOAEL. Due to the small magnitude of the EQ, it is not expected that soil invertebrates are at risk from beryllium • There were no appropriate screening values for aluminum or thallium. Risk to soil invertebrates from these chemicals cannot be quantified, nor can they be dismissed.
Ecological health of terrestrial plant communities	Evaluation of soil chemistry with respect to plant toxicity values	• EQ for beryllium, cadmium and copper were less than 1.0, indicating acceptable plant risk levels from these COPC. • A high EQ of 2,600 was found for aluminum; however, this was based on a toxicity test run at a low pH. Studies have shown that the toxicity of aluminum is highly dependent upon soil pH, and the weathered limestone soils of Andersen AFB ameliorate potential aluminum toxicity to plants. • An EQ of 31 was found for chromium. The plant toxicity value for chromium is of low quality. The Site 6 exposure concentration was smaller than that representative of background, and there was an absence of visual plant stress at the site. Consequently the plant EQ of 31 for chromium may be overestimated. • No primary toxicological references were found for thallium. The plant TRV for thallium that resulted in a EQ of 1.06 was based on a secondary citation with no known toxic effects. Consequently the TRV is of very low quality, and it is not expected to cause plant stress.

TABLE 2-8. SUMMARY OF ERA RESULTS FOR SITE 6, ANDERSEN AFB, GUAM.

Assessment Endpoint	Measurement Endpoint	Result
Long-term health and reproductive capacity of omnivorous avian species (Mariana Crow)	Evaluation of dose in prey based on surface soil, fruit, and reptile data in dietary exposure models	• NOAEL HQ for cadmium and copper were less than 1.0 indicating that the Mariana crow risks from these COPC are acceptable, and no further evaluation is necessary. • The NOAEL HQ was greater than 1.0 for aluminum exposure to the Mariana crow (1.4). However, the exposure concentration used to estimate this risk was smaller than representative Andersen AFB soil concentrations of aluminum. The soil pH would also ameliorate the bioavailabililty of aluminum to the Mariana crow. • The NOAEL HQ for chromium was greater than 1.0 at 1.03. Because of the conservative assumptions built into the exposure and toxicity assessment, and the LOAEL HQ being less than 1.0, it is not expected that chromium is a potential source of toxicity to the Mariana crow. • No toxicity values were found for beryllium or thallium, therefore, there is the potential for unacceptable risk from these COPC.
Long-term health and reproductive capacity of carnivorous avian species (yellow bittern)	Evaluation of dose in prey based on surface soil and reptile data in dietary exposure models	• NOAEL HQ for cadmium and copper were less than 1.0 indicating that the yellow bittern risks from these COPC are acceptable, and no further evaluation is necessary. • NOAEL risks from aluminum were 2.4. However as for the Mariana crow, the exposure concentration responsible for this HQ was smaller than representative Andersen AFB reference concentrations. In addition, soil pH helps to limit the bioavailability of this element. Potential risks to populations of yellow bittern are acceptable. • NOAEL risks from chromium were slightly greater than 1.0 at 1.6, however Site 6 representative chromium concentrations are smaller than reference concentrations and LOAEL risks are well below 1.0. Consequently risks to the yellow bittern from chromium are acceptable on a population-level. • No toxicity values were found for beryllium or thallium, therefore, there is the potential for unacceptable risk from this COPC.

EQ = Ecological Quotient; NOAEL = No observed adverse effects level; LOAEL = Lowest observed adverse effects level; COPC = Contaminant of potential concern; HQ = Hazard Quotient; TRV = Toxicity reference value

TABLE 2-9. SUMMARY OF ERA RESULTS FOR EARTHWORMS AND PLANTS FOR SITE 6, ANDERSEN AFB, GUAM.

COPC	Representative Soil Concentration (mg/kg)	Toxicity Reference Value (mg/kg)	Ecological Quotient
Earthworms			
INORGANICS			
Aluminum	132,000	No screening value	-----
Beryllium	3.5	2	**1.77**
Cadmium	5.04	110	0.05
Chromium	734	1,250	0.59
Copper	21.8	61	0.36
Thallium	1.06	No screening value	-----
Plants			
INORGANICS			
Aluminum	132,000	50	**2,640**
Beryllium	3.5	10	0.35
Cadmium	5.04	29	0.17
Chromium	734	24	**31**
Copper	21.8	100	0.22
Thallium	1.06	1	**1.06**

mg/kg = milligrams per kilogram

TABLE 2-10. SUMMARY OF CLEANUP STANDARDS FOR RESIDENTIAL USE AT SITE 6, ANDERSEN AFB, GUAM

Future Site Users	Cleanup Matrix	COC	PRG Residential (mg/kg)	PRG Industrial (mg/kg)	BTV (mg/kg)	RG (mg/kg)
Residential Receptors	SURFACE SOIL	Aluminum	76,000	100,000	173,500	**173,500#**
		Chromium	210	450	1,080	**1,080#**
	SUBSURFACE SOIL	Aluminum	76,000	100,000	173,500	**173,500#**
		Antimony	31.3	N/A	63	**63#**
		Chromium	210	450	1,080	**1,080#**

Notes: COC = contaminant of concern; BTV = background threshold value; PRG = 2004 USEPA Region 9 Preliminary Remediation Goal; RG = Remediation Goal; sq ft = square feet; mg/kg = milligrams per kilogram; N/A = not applicable; bcy = bank cubic yard; lcy=loose cubic yard (assuming 30% "fluff" factor) # = RG based on BTV

Surface cleanup volumes are estimated based Best Professional Judgment and experience gained during former removal projects at Andersen AFB for 1-foot-deep excavations.

Subsurface soil cleanup volume is estimated based on a depth 4 feet below ground surface, 30 feet in diameter.

TABLE 2-11. SUMMARY OF CLEANUP VOLUMES FOR RESIDENTIAL USE AT SITE 6, ANDERSEN AFB, GUAM.

Future Site Users	Cleanup Matrix	COC	RG (mg/kg)	Cleanup Sample Locations	Estimated COC Cleanup Area (sq ft)	Estimated COC Cleanup Volume	
						(bcy)	(lcy)
Residential Receptors	SURFACE SOIL	Aluminum	173, 500#	S009, S011, S012, S014, S015, S019	42,230	1,570	2,040
		Chromium	1,080#	S009, S011, S019			
	SUBSURFACE SOIL	Aluminum	173,500#	S018, S020, S022, S025	3,540	530	690
		Antimony	63#	S017			
		Chromium	1,080#	S018, S020, S022, S025			
					Total Cleanup Volume	**2,100**	**2,730**

Notes: COC = contaminant of concern; BTV = background threshold value; PRG = 2004 USEPA Region 9 Preliminary Remediation Goal; RG = Remediation Goal; sq ft = square feet; mg/kg = milligrams per kilogram; N/A = not applicable; bcy = bank cubic yard; lcy=loose cubic yard (assuming 30% "fluff" factor) # = RG based on BTV

Surface cleanup volumes are estimated based Best Professional Judgment and experience gained during former removal projects at Andersen AFB for 1-foot-deep excavations.

Subsurface soil cleanup volume is estimated based on a depth 4 feet below ground surface, 30 feet in diameter.

TABLE 2-12. COST ESTIMATE FOR SOIL REMOVAL PROTECTIVE OF RESIDENTIAL RECEPTORS, SITE 6, ANDERSEN AFB, GUAM.

Item	Reference	Quantity	Unit	Rate ($)	Year 1 Capital Costs ($)	Present Worth ($) at 5% for 30 years (rounded)
Capital Cost. Write Site-specific Work Plan						
Sr Labor Hours	BPJ	24	Hour	$ 135	$ 3,240	
Mid Labor Hours	BPJ	24	Hour	$ 80	$ 1,920	
Jr Labor Hours	BPJ	120	Hour	$ 72	$ 8,640	
Clerical/Editor/Word Processor/CADD Hours	BPJ	120	Hour	$ 60	$ 7,200	
Reproduction, shipping, per diem, travel	BPJ	1	Lump Sum	$ 6,000	$ 6,000	
15% Markup on ODC					$ 900	
4% Guam Tax					$ 1,080	
Subtotal					**$ 28,980**	**$ 29,000**
Capital Cost. Clear, Grub, and Pre-survey						
Sr Labor Hours	BPJ	16	Hour	$ 135	$ 2,160	
Jr Labor Hours	BPJ	40	Hour	$ 72	$ 2,880	
Clerical/Editor/Word Processor/CADD Hours	BPJ	8	Hour	$ 60	$ 480	
Reproduction, shipping, per diem, travel	BPJ	1	Lump Sum	$ 2,000	$ 2,000	
Surveyors and Laborers to Clear	Vendor Quote	2	Week	$ 8,000	$ 12,000	
15% Markup on ODC					$ 2,100	
4% Guam Tax					$ 781	
Subtotal					**$ 21,620**	**$ 21,700**
			Volume	**Weeks**		
Capital Cost. Mob-demob, Remove and Dispose of Soil			**2,730**	**3**		
Sr Labor Hours	BPJ	120	Hour	$ 135	$ 16,200	
Mid Labor Hours	BPJ	80	Hour	$ 80	$ 6,400	
Jr Labor Hours	BPJ	120	Hour	$ 72	$ 8,640	
Clerical/Editor/Word Processor/CADD Hours	BPJ	80	Hour	$ 60	$ 4,800	
Reproduction, shipping, per diem, travel	BPJ	3	Week	$ 3,000	$ 9,000	
Mobilization/Demobilization	Vendor Quote	2	Task	$ 600	$ 1,200	
Trackhoe/Dozer Rental	Vendor Quote	15	Day	$ 800	$ 12,000	
Drag Line with Clam Shell Bucket	Vendor Quote	15	Day	$ 1,650	$ 24,750	
Rolloff Bins	BPJ	12	Each	$ 2,200	$ 26,400	
Laborers	Vendor Quote	0	Hour	$ 15	$ -	
Dump Trucks and Drivers	Vendor Quote	15	Day	$ 450	$ 6,750	
Steam/Water Truck	Vendor Quote	15	Day	$ 1,100	$ 16,500	
Transport/dispose non-haz waste at consolidation unit (98%)	BPJ	2,675	Loose Cubic Yard	$ 10	$ 26,754	
Transport/dispose hazwaste off island (0.2%)	BPJ	5	Loose Cubic Yard	$ 2,000	$ 10,920	
TSP Treated non-hazwaste waste (1.8%)	BPJ	109	Loose Cubic Yard	$ 220	$ 24,024	
Reseeding/revegetation	Vendor Quote	0	Square Feet	$ 0.50	$ -	
Clean Backfill**	Vendor Quote	0	Loose Cubic Yard	$ 26	$ -	
15% Markup on ODC					$ 23,745	
4% Guam Tax					$ 6,332	
Subtotal					**$ 224,415**	**$ 224,500**
Capital Cost. Confirmatory Samples & Closure Report						
Sr Labor Hours	BPJ	24	Hour	$ 135	$ 3,240	
Mid Labor Hours	BPJ	24	Hour	$ 80	$ 1,920	
Jr Labor Hours	BPJ	40	Hour	$ 72	$ 2,880	
Clerical/Editor/Word Processor/CADD Hours	BPJ	40	Hour	$ 60	$ 2,400	
Survey confirmatory samples	Vendor Quote	1	Week	$ 4,500	$ 4,500	
Reproduction, perdiem, etc.	BPJ	1	Lump Sum	$ 6,500	$ 6,500	
Analytical Cost	Vendor Quote	50	Sample	$ 500	$ 25,000	
Sampling & Shipment Cost	BPJ	1	Task	$ 5,000	$ 5,000	
15% Markup on ODC					$ 7,716	
4% Guam Tax					$ 2,058	
Subtotal					**$ 61,214**	**$ 61,300**
				TOTAL Capital Cost		**$ 336,500**
Long Term Costs. IC and 5-Year Review Costs (shared for multiple sites; see Table 2-24)						**$ -**
				TOTAL Long-Term Cost		**$ -**
				TOTAL COST		**$ 336,500**

Notes:
BPJ = Best Professional Judgement; O&M = Operation & Maintenance; ODC = Other Direct Costs (short term); IC = Institutional Control

TABLE 2-13. COST ESTIMATE FOR INSTITUTIONAL CONTROL ALTERNATIVE FOR SITE 6, ANDERSEN AFB, GUAM.

Item	Reference	Quantity	Unit	Rate ($)	Year 1 Capital Costs ($)	Present Worth ($) at 5% for 30 years (rounded)
Capital Cost. Site Clearance and Preparation						
List of Assumptions: Includes technical memorandum, surface grubbing of approximately 5 cubic yards of drum remnants, drum containing asphalt, and surface asphalt debris to the Andersen AFB Consolidation Unit. Unit cost includes Guam tax.						
Labor and Other ODC	**Rates**	**Hours**	**Labor Cost**	**Per Diem and Other ODCs**	**Total Labor and ODCs**	
Geologist-SR	$130	16	$2,080	0	$2,080	
Engineer-SR	$135	16	$2,160	200	$2,360	
Chemist-SR	$120	40	$4,800	500	$5,300	
Geologist-MID	$80	40	$3,200	500	$3,700	
CADD/GIS Operator-MID	$60	16	$960	200	$1,160	
Other ODC Listing					$1,766	
Subcontractor Labor and Other ODC	**Specifications**	**Quantity**	**Unit**	**Cost/Unit**	**Estimated Cost**	
Loader with operator	3-cubic yard	3	Daily	600	$1,800	
Dump truck	10-cubic yard	3	Daily	450	$1,350	
Mob/Demob					$1,200	
Water truck					$500	
Guam Tax					$194	
				TOTAL Capital Cost	**$21,500**	**$21,500**
Long Term Cost. Site Periodic Review (shared costs for IRP Sites with ICs)						
List of Assumptions: Periodic Site Review & Public Education to be coordinated with Five-year ROD Review Events performed at year 5, year 10, year 15, year 20, year 25, and year 30 Cost model assumes Periodic Site Review & Public Education costs shared with multiple IRP sites. Includes fact sheets. Cost model assumes Public Education costs shared with multiple IRP sites.						
Labor and Other ODC	**Rates**	**Hours**	**Labor Cost**	**Per Diem and Other ODCs**	**Total Labor and ODCs**	
Geologist-SR	$130	40	$5,200	$0	$5,200	
Engineer-SR	$135	40	$5,400	$500	$5,900	
Toxicologist-SR	$120	24	$2,880	$300	$3,180	
Geologist-MID	$80	24	$1,920	$300	$2,220	
CADD/GIS Operator-MID	$60	40	$2,400	$500	$2,900	
(ODC)					$5,491	
CADD/GIS Equipment				$600	$600	
Car Rental, airfare, travel & fuel				$500	$500	
Posting Signs and fix the fence (O&M)		1	event	$2,000	$2,000	
Press Release		1	event	$500	$500	
Phone/Communications				$224	$224	
Copies, Postage, FedEx				$300	$300	
Guam Tax on Labor			$504		$504	
14.5% Markup on ODCs				$830	$830	
Guam Tax on ODCs				$33	$33	
			TOTAL Site Periodic Review (shared by multiple sites with ICs)		**$24,891**	**$94,200**
					TOTAL Long-Term Cost	**$94,200**
					TOTAL COST	**$115,700**
Notes: O&M = Operation & Maintenance; ODC = other direct costs; IC = Institutional Control						

TABLE 2-14. SUMMARY OF PERTINENT ARARs AND TBCs FOR SITE 6, ANDERSEN AFB, GUAM.

AUTHORITY	CITATION	ARAR DETERMINATION (note: may not pertain to every remedial alternative)	SYNOPSIS OF REQUIREMENT
Chemical Specific			
Federal			
USEPA Region 9 Preliminary Remediation Goals (PRGs) to screen and establish Remedial Goals (RGs)	USEPA Region 9 PRGs Table (2004)	To Be Considered	Generic RBCs that are intended to assist risk assessors and others in initial screening-level evaluations of environmental measurements.
Risk Assessment Guidance - Cancer Slope Factors and Reference Doses	USEPA Integrated Risk Information System Database and U.S. Department of Energy Risk Assessment Information System	To Be Considered	Used in human health risk assessments (HHRAs) as guidance values to evaluate the potential carcinogenic hazard caused by exposure to COCs.
Territorial (No chemical specific territorial ARARs or TBCs have been identified.)			
Location Specific			
Federal			
Endangered Species Act	16 USC 1531 and 50 CFR 200, 402	Relevant and Appropriate	Promotes actions to conserve endangered species or habitats.
Territorial			
Guam Wellhead Protection Program	Guam EPA (August 1993)	Relevant and Appropriate	Protects groundwater in wells/well fields that supply drinking water.
Historical Objects and Sites	21 Guam Code Annotated, Chapter 76	Relevant and Appropriate	Promotes historic preservation, restoration and presentation of historic sites and objects.

TABLE 2-14. SUMMARY OF PERTINENT ARARs AND TBCs FOR SITE 6, ANDERSEN AFB, GUAM.

AUTHORITY	CITATION	ARAR DETERMINATION (note: may not pertain to every remedial alternative)	SYNOPSIS OF REQUIREMENT
Fish, Game, Forestry & Conservation	5 Guam Code Annotated, Chapter 63	Relevant and Appropriate	Promotes actions to conserve endangered species or habitats.
Action Specific			
Federal			
Resource Conservation and Recovery Act (RCRA) regulations for Identification of Hazardous Waste 40 CFR 261, Transport of Hazardous, and for land disposal restrictions (LDRs) and landfills	40 CFR 261 40 CFR 263	Applicable	These requirements identify the maximum concentrations of contaminants for which a waste would be considered a RCRA characteristic waste due to toxicity. The analytical test specified in Appendix II of 40 CFR 61 is referred to as the Toxic Characteristic Leaching Procedure (TCLP).
RCRA Generator Requirements for Manifesting Waste for Offsite Disposal	40 CFR 262	Applicable	Standards for manifesting, marking, and recording hazardous waste shipments for offsite treatment/disposal.
RCRA - Subpart I, Use and Management of Containers	40 CFR 264, Subpart I	Applicable	Outlines use and management standards applicable to owners and operators of all hazardous waste facilities that store containers of hazardous waste.
RCRA Standards Applicable to Generators of Hazardous Waste	40 CFR 262	Applicable	These regulations establish standards for generators of hazardous waste including labeling, manifesting, and reporting requirements.
EPA Office of Solid Waste and Emergency Response (OSWER)	Publication 9345.3-03 FS (January 1992)	To Be Considered	Management of wastes generated during remedial activities must ensure protection of human health and the environment.

TABLE 2-14. SUMMARY OF PERTINENT ARARs AND TBCs FOR SITE 6, ANDERSEN AFB, GUAM.

AUTHORITY	CITATION	ARAR DETERMINATION (note: may not pertain to every remedial alternative)	SYNOPSIS OF REQUIREMENT
LDR ("Land Ban")	40 CFR 268	Applicable	LDR treatment standards for contaminated soils require that contaminated soils that will be land disposed be treated to reduce concentrations of hazardous constituents by 90 percent or meet hazardous constituent concentrations that are ten times the universal treatment standards.
Clean Air National Ambient Air Quality Standards (NAAQSs)	40 CFR 50	To Be Considered	Promotes guideline air quality standards to protect human health and welfare
Corrective Action Management Unit Regulations	40 CFR 264.552	Relevant and Appropriate	Regulates the management and disposal of RCRA defined hazardous waste as part of corrective response actions and remedial actions
Territorial			
Water Pollution Control Act	10 Guam Code Annotated, Chapter 47	Applicable	Regulates the discharge of pollutants to water resources on Guam.
Solid Waste Management Act	10 Guam Code Annotated, Chapter 51	Applicable	Regulates the management of solid waste and hazardous waste.
Air Pollution Control Act	10 Guam Code Annotated, Chapter 49	Applicable	Prohibits the generation of fugitive dust emissions.

ARAR = Applicable or Relevant and Appropriate Requirements
COC = Contaminant of Concern
LDR = Land Disposal Restrictions
OSWER = Office of Solid Waste and Emergency Response
RBC = Risk-based concentration
RG = Remediation Goal
TCLP = Toxic Characteristic Leaching Procedure
USEPA = United States Environmental Protection Agency
CFR = Code of Federal Regulations
HHRA = human health risk assessment
NAAQC = National Ambient Air Quality Standard
PRG = Preliminary Remediation Goal
RCRA = Resource Conservation and Recovery Act or 1976
TBC = To Be Considered
USC = United States Code

TABLE 2-15. SUMMARY OF ARARs AND TBCs FOR REMEDIAL ALTERNATIVES FOR SITE 6, ANDERSEN AFB, GUAM.

AUTHORITY	REMEDIAL ALTERNATIVE		
	No Action	**Institutional Control**	**Removal**
Chemical Specific			
USEPA Region 9 PRGs to screen and establish RGs	Preliminary cleanup criteria would not be met. No waiver is justified.	Institutional controls (land use controls) will mitigate the identified risk for site soil associated with the future residential scenario.	Removal would mitigate the identified unacceptable risk for the future residential scenario associated with site soil.
Risk Assessment Guidance - Cancer Slope Factors and Reference Doses	Risk Assessment Guidance adequately considered in assessing risk.	Risk Assessment Guidance adequately considered in assessing risk.	Risk Assessment Guidance adequately considered in assessing risk.
Location Specific			
Endangered Species Act	NA	Institutional controls will not impact nearby endangered species or their habitat. Endangered species have not been observed on the site. No unacceptable ecological risks have been identified onsite.	Listed species have not been observed on the site. Removal activities would not impact nearby endangered species or their habitat. The removal plan would be assessed to ensure that there are no adverse impacts to potential roosting, nesting, or foraging habitat of endangered species.
Guam Wellhead Protection Program	NA	NA	Groundwater is not a media of concern. However, all groundwater on the Northern Plateau has been designated as a Sole Source Aquifer. Guam EPA must review any project in this aquifer regardless if a permit is required.

TABLE 2-15. SUMMARY OF ARARs AND TBCs FOR REMEDIAL ALTERNATIVES FOR SITE 6, ANDERSEN AFB, GUAM.

AUTHORITY	REMEDIAL ALTERNATIVE		
	No Action	**Institutional Control**	**Removal**
Historical Objects and Sites	NA	NA	Any remedial actions would be conducted in accordance with the substantive requirements of this regulation.
Fish, Game, Forestry & Conservation	NA	Institutional controls will not impact nearby endangered species or their habitat. Endangered species have not been observed on the site. No unacceptable ecological risks have been identified onsite.	Listed species have not been observed on the site. Removal activities would not be anticipated to impact nearby endangered species or their habitat. The removal plan would be assessed to ensure that there is no adverse impact to potential roosting, nesting, or foraging habitat of endangered species.
Action Specific			
RCRA regulations for Identification of Hazardous Waste 40 CFR 261, Transport of Hazardous Waste 40 FR 263, and for LDRs and landfills	NA	NA	Excavated material would be tested for hazardous waste characteristics (ignitability, reactivity, corrosivity, or TCLP). Any material classified as hazardous waste would be transported for off-island disposal and would be handled, stored, and transported to landfills in accordance with RCRA.
RCRA Generator Requirements for Manifesting Waste for Offsite Disposal	NA	NA	If remedial actions require the offsite disposal of RCRA-defined hazardous waste, then the substantive requirements of these regulations will be followed.

TABLE 2-15. SUMMARY OF ARARs AND TBCs FOR REMEDIAL ALTERNATIVES FOR SITE 6, ANDERSEN AFB, GUAM.

AUTHORITY	REMEDIAL ALTERNATIVE		
	No Action	**Institutional Control**	**Removal**
RCRA - Subpart I, Use and Management of Containers	NA	NA	If remedial actions require storage of hazardous waste in containers, then the substantive requirements of these regulations will be followed.
RCRA Standards Applicable to Generators of Hazardous Waste	NA	NA	Remediation-derived waste may be characterized as hazardous waste. If so, the material will be handled in compliance with the substantive requirements of these standards.
40 CFR 268 Land Disposal Restrictions (LDR) ("Land Ban")	NA	NA	Any soil classified as a hazardous waste which is to be disposed offsite would be treated, as necessary, to meet the established LDR treatment standards.
Corrective Action Management Unit (CAMU) Regulations	NA	NA	No hazardous waste or recently generated waste will be placed at the site. Groundwater in the vicinity of the site will be monitored under a separate program.
Water Pollution Control Act 10 Guam Code Annotated, Chapter 47	NA	Asphalt removal would be conducted in a manner to prevent surface erosion of soil to nearby streams and marine waters.	Removal would be conducted in a manner to prevent surface erosion of soil to nearby streams and marine waters.
Solid Waste Management Act	NA	Any solid waste will be managed in accordance with the substantive requirements of these regulations will be followed.	Any solid waste will be managed in accordance with the substantive requirements of these regulations will be followed.

TABLE 2-15. SUMMARY OF ARARs AND TBCs FOR REMEDIAL ALTERNATIVES FOR SITE 6, ANDERSEN AFB, GUAM.

AUTHORITY	REMEDIAL ALTERNATIVE		
	No Action	**Institutional Control**	**Removal**
Air Pollution Control Act	NA	Asphalt removal would be conducted in a manner to minimize fugitive dust emissions.	Remedial activities would be conducted in a manner to minimize fugitive dust emissions.

ARAR = Applicable or Relevant and Appropriate Requirements
COC = Contaminant of Concern
LDR = Land Disposal Restrictions
OSWER = Office of Solid Waste and Emergency Response
RG = Remediation Goal
TBC = To Be Considered
TCLP = Toxic Characteristic Leaching Procedure
CFR = Code of Federal Regulations
HHRA = human health risk assessment
NAAQC = National Ambient Air Quality Standard
PRG = Preliminary Remediation Goal
RCRA = Resource Conservation and Recovery Act or 1976
USC = United States Code
USEPA = United States Environmental Protection Agency

Figure 2-1. Suspected Sources of Contamination at Site 6, Andersen AFB, Guam.

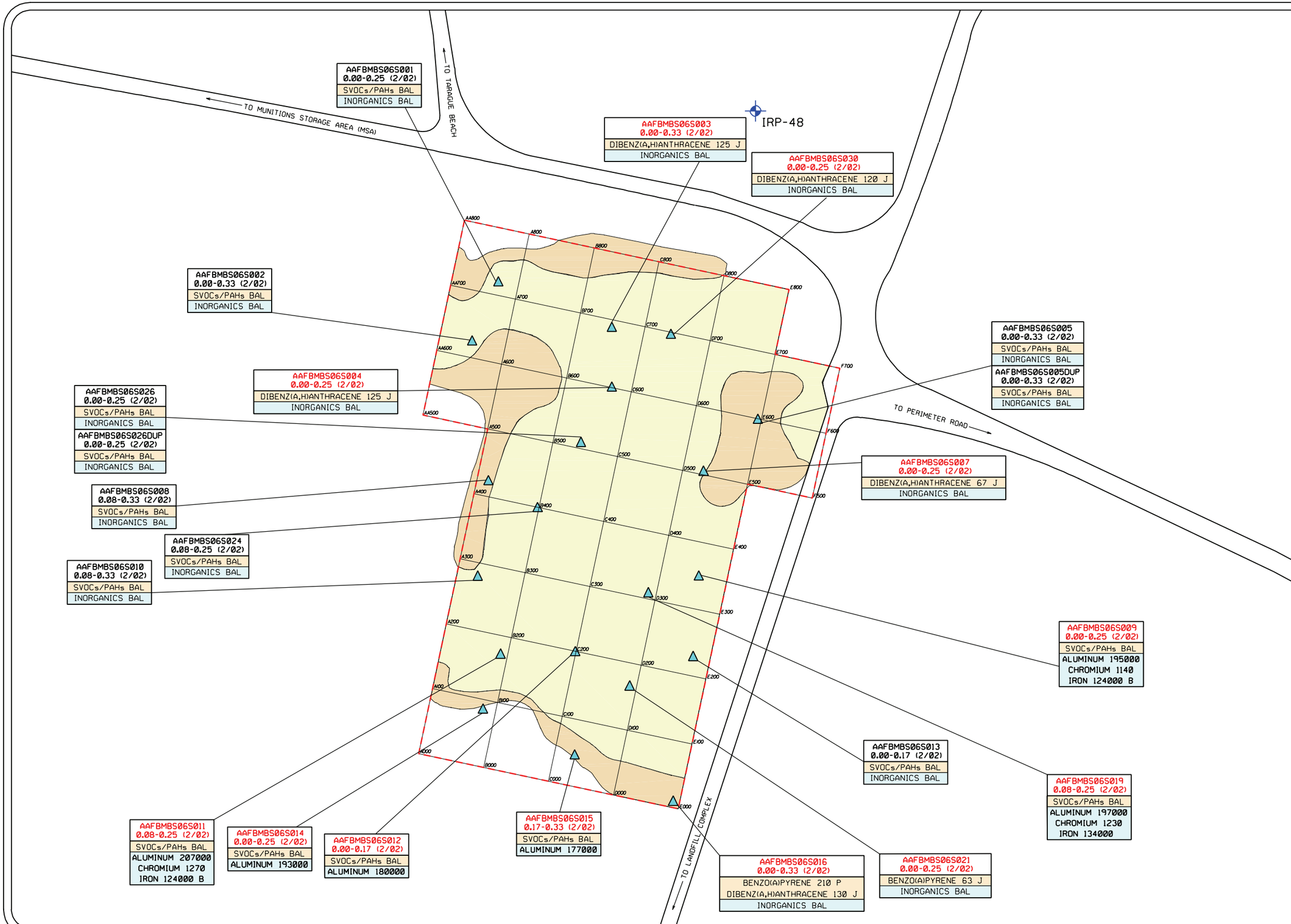


Figure 2-2.
Surface Soil Sample Locations and Results at Site 6, Andersen AFB, Guam.

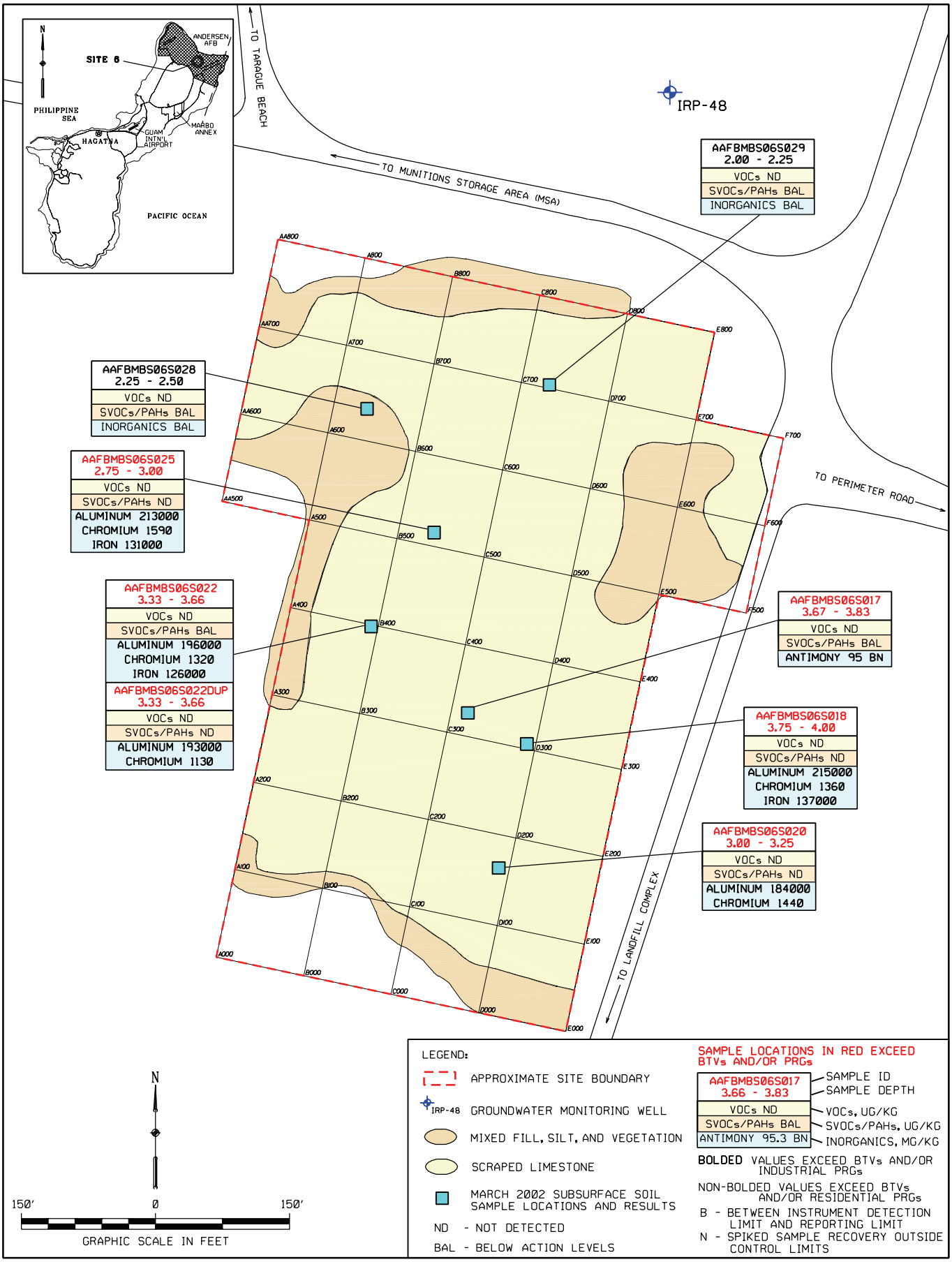
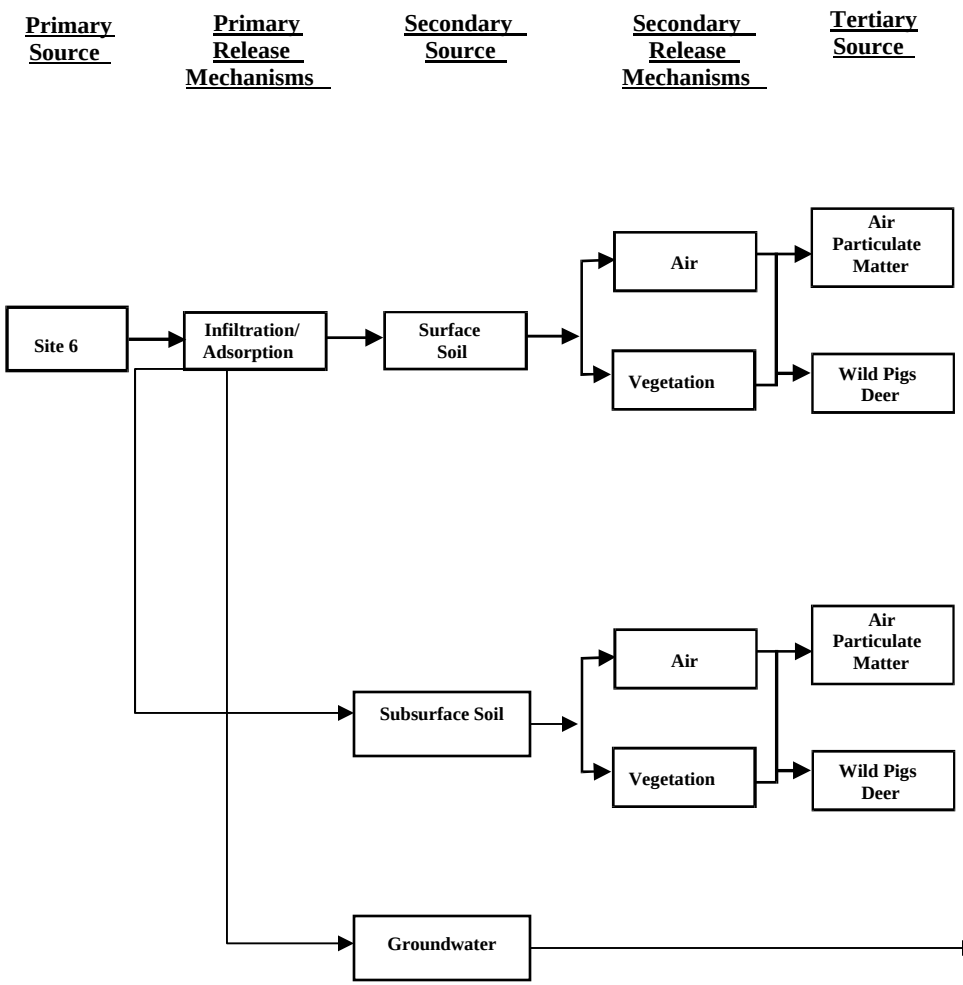


Figure 2-3. Subsurface Soil Sample Locations and Results at Site 6, Andersen AFB, Guam.



Specific Receptors of Concern

Potential Exposure Routes	Occasional Users/Trespassers (Adults, Children)	Future Residents (Adults, Children)	Hunters (Adults, Children)
Soil Ingestion	X	X	
Dermal Contact with Soils	X	X	
Inhalation of Air Particulates	X	X	
Ingestion of Deer, Pig			X

Potential Exposure Routes	Occasional Users/Trespassers (Adults, Children)	Future Residents (Adults, Children)	Hunters (Adults, Children)
Soil Ingestion		X	
Dermal Contact with Soils		X	
Inhalation of Air Particulates		X	
Ingestion of Deer, Pig			

Figure 2-4. Human Health Risk Assessment Conceptual Site Model for Site 6, Andersen AFB, Guam.

Figure 2-5. Ecological Survey Results at Site 6, Andersen AFB, Guam.

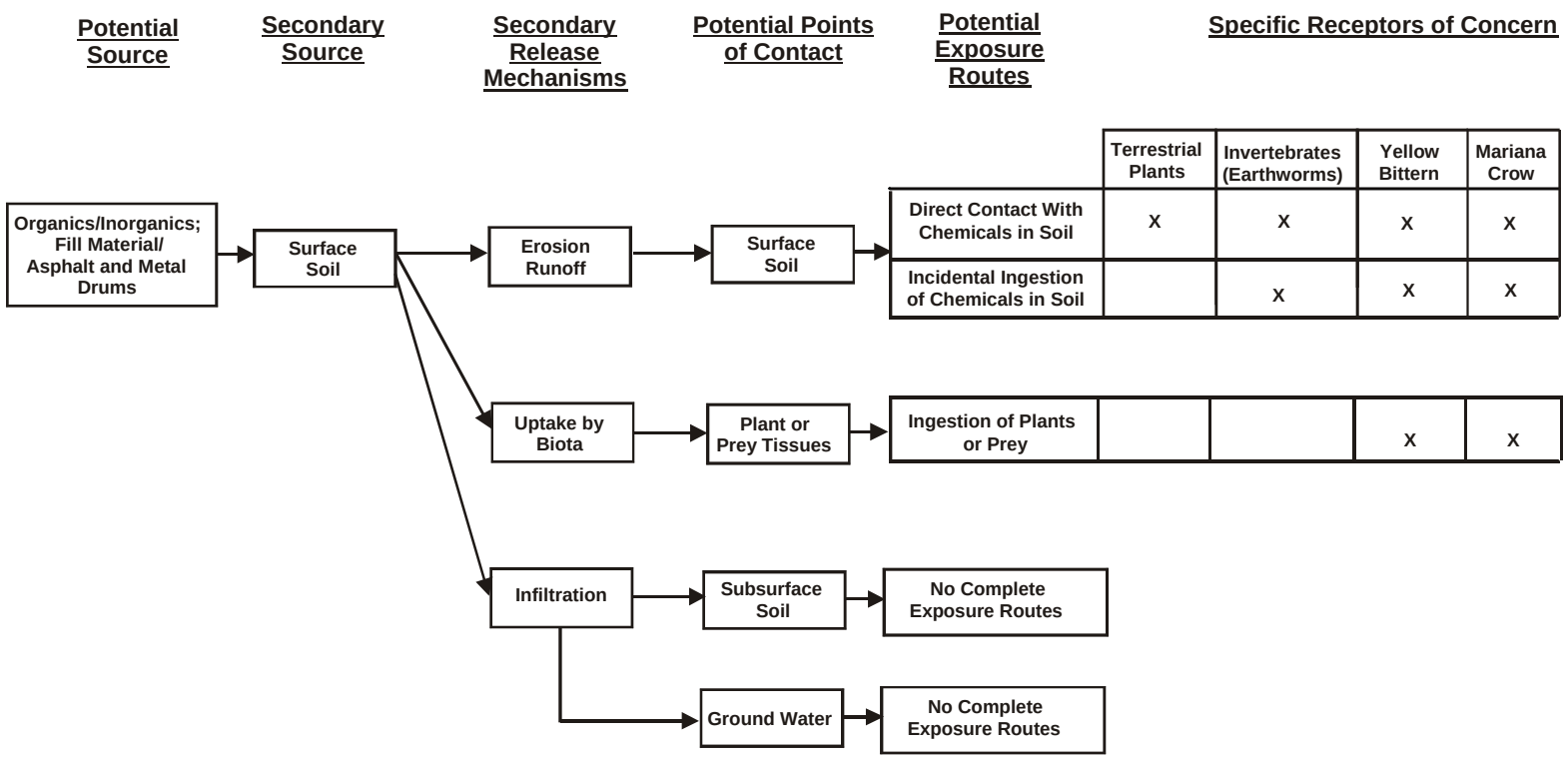


Figure 2-6. Ecological Risk Assessment Conceptual Site Model for Site 6, Andersen AFB, Guam.

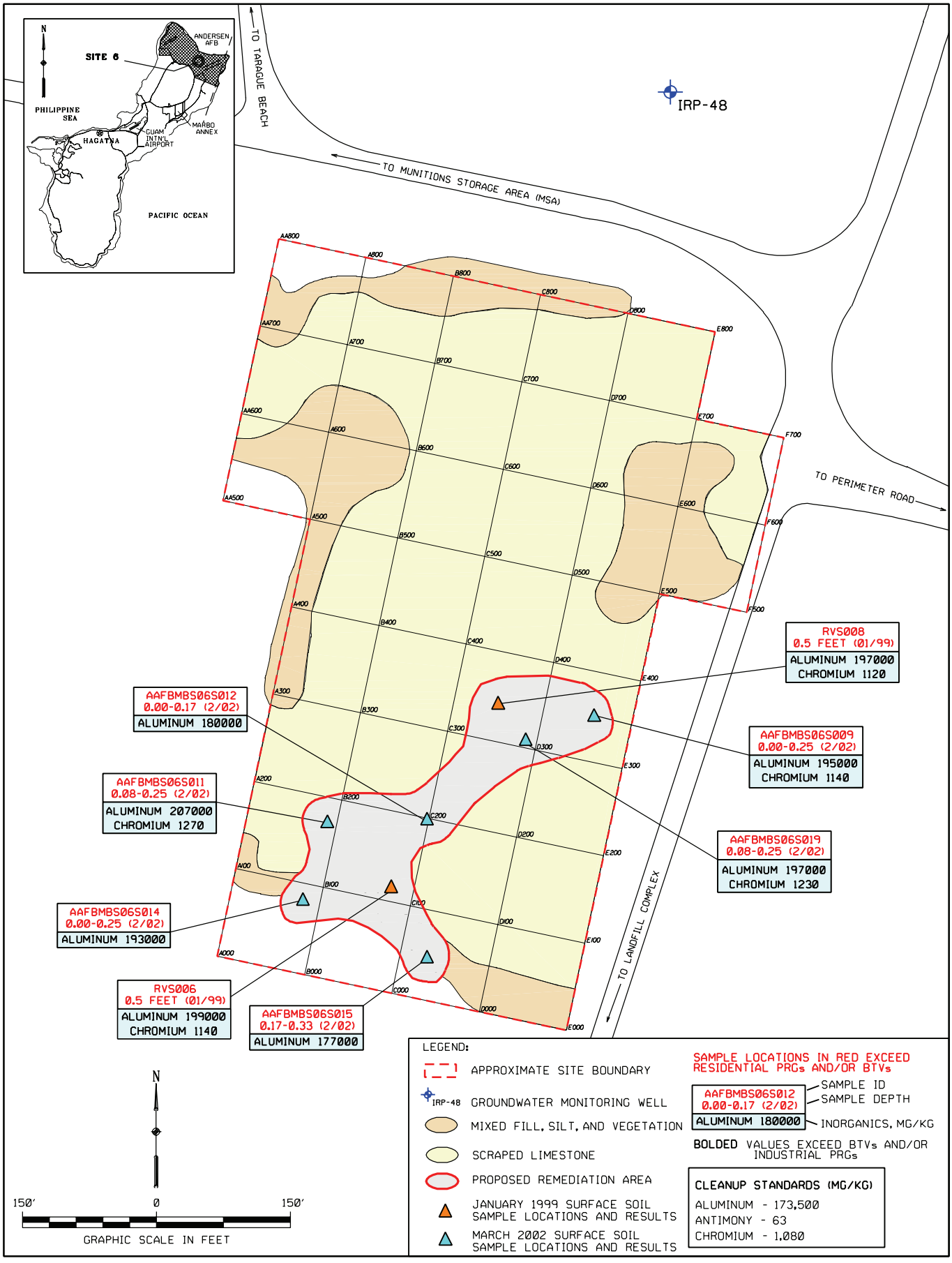


Figure 2-7. Proposed Surface Soil Cleanup Areas at Site 6, Andersen AFB, Guam.

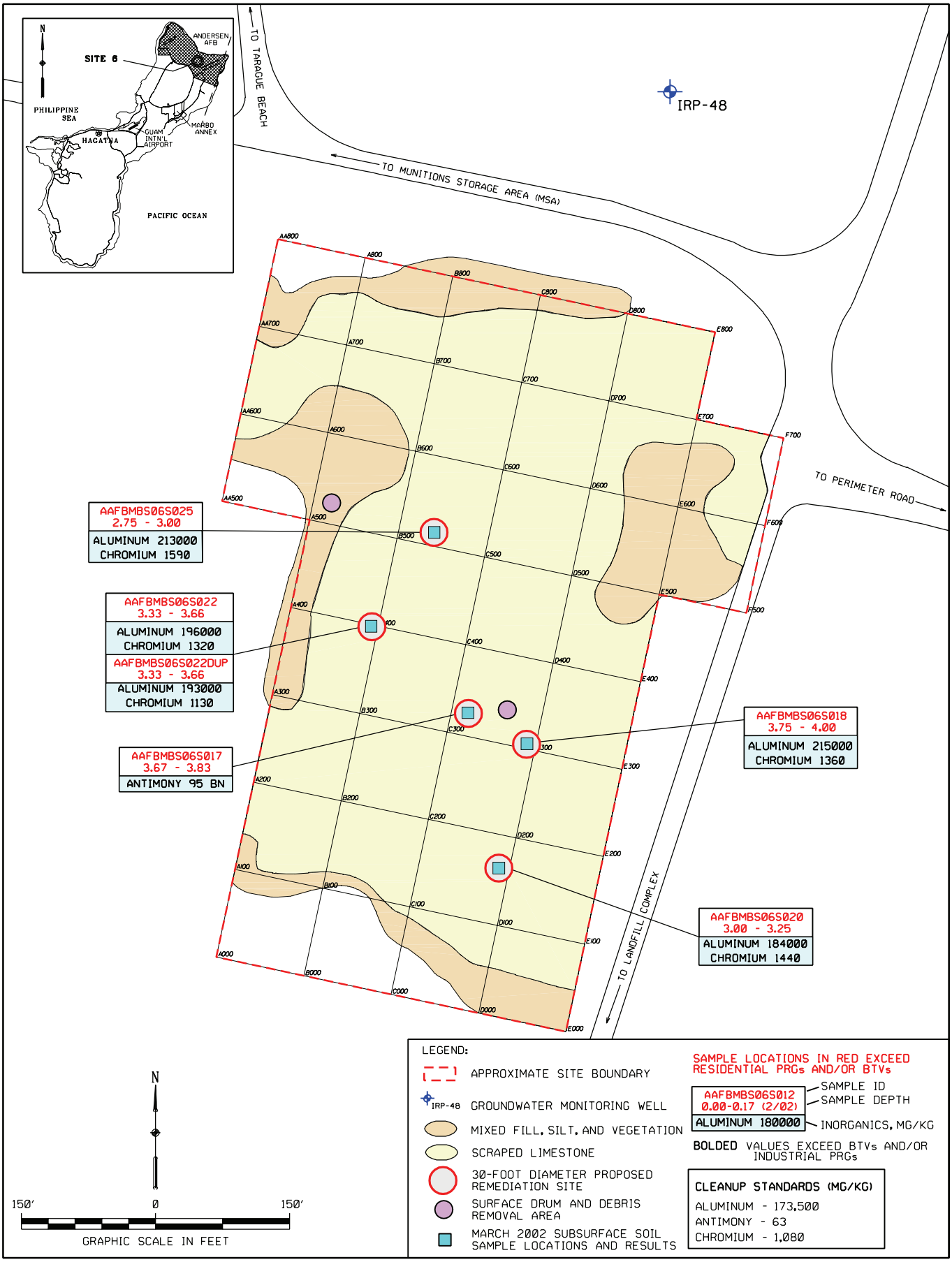


Figure 2-8. Proposed Subsurface Cleanup and Debris Removal Areas at Site 6, Andersen AFB, Guam.

3. DECISION SUMMARY FOR SITE 9

This decision summary for Site 9 presents an overview of the site description, environmental characteristics, history, public involvement, nature and extent of contamination, associated human health and ecological risks, remedial alternatives, and rationale for selecting the preferred remedial actions in light of the statutory requirements. A detailed RI/FS for Site 9 was completed in June 2006 (EA, 2006)

This decision summary was prepared for the Site 9, which is located in the Main Base OU at Andersen AFB, Guam. Site 9 is located along the eastern edge of the Main Base, covers an area of 4.5 acres, and is located approximately 4,000 feet southeast of the eastern end of the South Runway (Figures 1-2 and 1-4). The site consists of three distinct physiographic areas: an upper plateau, a limestone cliffline, and a lower slope (Figure 1-5).

Funding for the cleanup of Site 9 is provided under the USAF Environmental Restoration Account. Although the USAF is the lead agency under CERCLA, the USEPA and Guam EPA are support agencies for cleanup activities. The Site 9 is included in the National Superfund electronic database under CERCLIS identification number GU6571999519.

3.1 History of Site 9

According to the IRP Phase I Final Report, the 1986 RFA Report, and the IRP Phase II, Stage 1 Final Report, Site 9 was used for the disposal of sanitary trash; equipment; waste petroleum, oils, and lubricants (POL); and various unknown waste chemicals between 1951 and 1956. In addition, the 1986 RFA Report indicates that Site 9 was also used as a surface dump (ESE, 1985; SAIC, 1986; Battelle, 1989). During a site visit in 1986, several corroded drums and some construction/demolition debris were visible from the top of the cliffline. The area below the cliffline was not closely examined due to its difficult access and heavy vegetation. During the summer 1992 site visit, various types of surface debris were observed that included drums, metal debris, and construction debris.

Between June 1993 and June 1994, ICF performed the initial records search for Site 9 (ICF, 1996a). Very little written documentation was discovered relating to the use or operation of the site. In addition, none of the former or current base employees interviewed as part of the 1993-94 records search had any recollection of disposal activities at Site 9. ICF noted that according to the 1993–94 records search, a disturbance was observed at the base of the cliffline as early as 1946. The access road to the area above Site 9 is apparent on each of the available aerial photographs of the area, including those taken in 1993. However, none of the information reviewed during the record search identified specific types of waste materials deposited at this location.

During the RI for Site 9, a site reconnaissance and DSI were conducted to accurately define the environmental setting and boundaries of the site, including identification of potentially hazardous wastes. During the DSI, the physical characteristics of the site and areas containing surface debris that may be potential sources of contamination were documented (presented in Section 3.5.4). A summary of the related findings is presented on Figure 3-1.

3.2 Enforcement Activities

Section 2.2 presents information about Enforcement Activities; this information is common to Chapters 2, 3, and 4 (Decision Summaries for Sites 6, 9, and 12, respectively).

3.3 Community Participation

Section 2.3 presents information about Community Participation; this information is common to Chapters 2, 3, and 4 (Decision Summaries for Sites 6, 9, and 12, respectively).

3.4 Scope and Role of the Operable Unit or Response Action

Section 2.4 presents information about the Scope and Role of the OU or Response Action; this information is common to Chapters 2, 3, and 4 (Decision Summaries for Sites 6, 9, and 12, respectively).

3.5 Site Characteristics

3.5.1 Site 9 Physical Setting

Site 9 is located along the eastern edge of the Main Base, covers an area of 4.5 acres, and is located approximately 4,000 feet southeast of the eastern end of the South Runway (Figure 1-4). The site consists of three distinct physiographic areas: an upper plateau, a limestone cliffline, and a lower slope (Figure 1-5). The upper plateau is relatively flat to hummocky, with elevations ranging from 470 to 500 feet above msl. The cliffline is characterized by very steep to vertical cliff face, with elevations ranging from 310 to 470 feet above msl. The lower slope consists of a moderately sloping to uneven area at the base of the cliffline, covered with 6- to 10-foot high benches. The lower slope ranges in elevation from 180 to 310 feet above msl, and extends to approximately 600 feet of the shoreline. A notched feature that was cut into the limestone characterizes the top of the cliffline. This area served as the dumping point for over the cliff disposal. The limestone rises up approximately 20 to 25 feet on each side of the notch, and there is a chain-link fence across the notch limiting access to the cliffline. The site extends approximately 175 feet to the west of the notch, approximately 400 feet to the east of the notch, approximately 500 feet to the north of the notch, and approximately 300 feet to the south of the notch.

The soil present at Site 9 consists of the Ritidian (extremely cobbly clay loam) Rock outcrop complex series. The soil is typically a thin layer, consisting of approximately 0- to 3-feet thick layer scattered over porous limestone bedrock above the top of the cliff face.

Site 9 is located along the cliffline, and is situated predominantly on the reefal facies of the Mariana Limestone. There are no monitoring wells within 0.25-mile of the site. The depth to groundwater at Site 9 is anticipated to vary from approximately 460 feet bgs at the top of the cliffline to approximately 300 feet bgs at the base of the cliffline, and the aquifer beneath the site occurs in basal conditions. The aquifer beneath Site 9 is highly permeable and porous (ICF, 1995). No rivers or streams are present at the site and precipitation, except that portion lost to

evapotranspiration, contributes to the groundwater lens. Based on the site location and topography, the prevailing groundwater flow direction would be to the southeast, toward the Pacific Ocean (Figure 1-4). Site 9 is located downgradient of aquifer recharge zones and will not impact current or future groundwater production wells. The freshwater lens would be relatively thin beneath the site and becomes even thinner and more brackish as it approaches the nearby Pacific Ocean.

Site 9 is comprised of three distinct habitats: Leucaena forest, mixed shrubs, and limestone forest. The portion of the site situated above the cliff is comprised of Leucaena forest. The fill area at the base of the cliff is covered by assorted mixed shrubs. The limestone forest is covered with sparse to heavy undergrowth beneath a canopy of taller, emergent trees that border the portion of the fill area below the cliff. There are several nearby areas within the Main Base, including the cliffline areas, that are proposed as critical habitats for the Mariana crow and the Mariana fruit bat (endangered species). In addition, Hayun-lago (Serianthes nelsonii) and Heritiera longipetiolata are two endangered tree species that have been observed nearby; however, no known endangered or threatened species were observed on the site. There are no nearby wetland communities, and Site 9 is located outside the overlay for the Guam National Wildlife Refuge. Additional information regarding the ecological habitats and receptors is presented in Section 3.7.2 of this document.

3.5.2 Sampling History for Site 9

Prior to the RI, there were no samples collected from Site 9. During the RI, surface and subsurface soil samples were collected. A total of 63 surface soil samples, including eight duplicates and three re-samples, were collected from 52 locations during three separate sampling events. The first set of samples was collected in May 2000. In July 2000, three surface soil sample locations were re-sampled, and analyzed for PAHs, because of a laboratory error in sample handling the original samples. In October 2000, a third sampling event was conducted to further delineate “hot spots” and collect additional confirmation samples. The laboratory analytical results for surface soil samples are summarized in Figure 3-2. Surface soil samples were analyzed for the following parameters:

- SVOCs, USEPA Method SW8270C
- PAHs, USEPA Method SW8310
- Pesticides and PCBs, USEPA Method SW8081A
- Andersen TAL metals, USEPA Method SW6010B
- Cyanide, USEPA Method SW9012

Surface soil samples were not analyzed for VOCs because geologic and climatic conditions on Guam induce volatilization and infiltration, thereby limiting the potential presence of VOCs in surface soil samples.

A total of 19 subsurface soil samples (including one duplicate and one re-sample) were collected during May and October 2000 sampling events. One subsurface soil sample location was

re-sampled for SVOC analysis, in July 2000, because of a laboratory error in handling the original sample. Samples were collected at depths ranging from approximately 1.0 to 3.5 feet bgs. Subsurface samples were collected at locations selected based on the DSI and magnetic survey results. Laboratory analytical results for subsurface soil samples are summarized in Figure 3-3. Subsurface soil samples were analyzed for the following parameters:

- VOCs, USEPA Method SW8260B
- SVOCs, USEPA Method SW8270C
- PAHs, USEPA Method SW8310
- Pesticides and PCBs, USEPA Method SW8081A
- Andersen TAL metals, USEPA Method SW6010B
- Cyanide, USEPA Method SW9012

The surface and subsurface soil analytical results were compared to residential PRGs that were developed by USEPA Region 9 to establish screening criteria for potentially contaminated sites (USEPA, 2000a; 2004a). As compared to industrial PRGs, the residential PRGs are more conservative regarding the future use of a property. No future deed restrictions would be required if residential PRGs are used as screening levels at the site and COC concentrations in soils are below them. Site 9 is located in an area that is highly unlikely to be developed in the future. There is no private property adjacent to the site and no land use downgradient of the site. However, in order to protect against the remote chance of future residential land use contaminant concentrations in soils were compared to residential PRGs and BTVs.

Because some metal concentrations in soils occur naturally at high concentrations in Guam, BTVs were established (EA, 2002c). For nine metals (aluminum, barium, beryllium, chromium, cobalt, manganese, nickel, thallium, and vanadium) their BTV exceeds the residential PRG. For these metals, the maximum observed concentration was compared to the BTV rather than the residential PRG.

If the maximum detected concentration of an analyte exceeded the residential PRG (or the BTV for aluminum, barium, beryllium, chromium, cobalt, manganese, nickel, thallium, and vanadium) that analyte was then retained as a COPC. Subsequent to determining the COPCs for Site 9, human health and ecological risk assessments were conducted to establish the COCs, the RAOs, and the RGs, as presented in Sections 3.7 and 3.8 of this ROD.

There are no groundwater wells located on or downgradient of Site 9, and as such there is no relevant groundwater data available for the site.

3.5.3 Conceptual Site Model for Site 9

Site 9 was not investigated during the IRP Phase II, Stage 1 and Stage 2 field survey, conducted by ICF in 1992. Aerial photos show that the site was actively used in the mid-1940s and 1950s. The records search indicates that the site was used as a dumping area between 1951 and 1956, for a variety of waste streams, including sanitary trash, used equipment, waste POL, UXO, OEW,

and unknown waste chemicals. During a 1993 site visit, drums, metal debris, and construction debris were observed.

Metal and construction debris extends from the flat portion above the cliffline to several hundred feet below the cliffline, where debris was pushed over the cliff. The upper cliffline area and the base of slope are surrounded by limestone forest. The base of the slope is forested and characterized by scattered boulders intermixed with debris. There are no building structures on the property. According to the Base Planner (Alba, 1997), the property is not projected for development. There are no residential areas on or in the vicinity of the site. There are no commercial or industrial areas on or in the vicinity of the site.

Potential receptors at the site include occasional users/trespassers. This includes hunters or trespassers who may walk through the area as well as maintenance workers who may work at the site on a limited basis. There is limited hunting of deer and wild pigs in this area of Andersen AFB. Adults and children who consume deer and pig meat are addressed on a site-wide basis and are presented in a separate report (EA, 1995). There are no plans to develop this site for residential use at anytime in the future, however as a conservative baseline assumption risks to potential future residents are evaluated for Site 9.

Media of concern include surface soil, subsurface soil and air. Groundwater is not considered a medium of concern because it is presumed to occur at depths ranging from 180 to 460 feet bgs. Therefore, the media of concern identified at the site are surface soil, subsurface soil, and air exposures, which could result from dispersion of surface and subsurface soil into air.

The exposure pathways that are considered for future resident adults and children are incidental ingestion of and dermal exposures to surface soil, and inhalation of air emissions from surface soil. Although unlikely, it is assumed that residents could be exposed to subsurface soil, which could be disturbed during digging or excavation activities and brought to the surface. Therefore, as a conservative measure, resident exposure pathways were evaluated for incidental ingestion of, dermal contact with, and inhalation of subsurface soil particles. The exposure pathways, which are considered for current and future occasional users/trespassers, are incidental ingestion of, dermal contact with, and inhalation of airborne particulates of surface soil. The types of exposure pathways to human receptors are shown in the CSM for Site 9 (Figure 3-4). Rationale for selection of exposure pathways is presented in Table 3-1.

3.5.4 Suspected Contamination Sources at Site 9

During the RI for Site 9, a site reconnaissance and DSI were conducted to define the environmental setting and boundaries of the site, including identification of potentially hazardous wastes. During the DSI, the physical characteristics of the site and areas containing surface debris that may be potential sources of contamination were documented. A summary of the related findings is presented on Figure 3-1. Reconnaissance mapping was performed to establish the northern, southern, eastern, and western extent of fill material present at the site. Due to the presence of UXO and OEW, cell A-1+00, which is located below the cliffline, was not surveyed in detail because of personnel safety issues. The DSI was performed over an area covering approximately 4.5 acres, on 19 out of 20 of the grid cells. Due to the presence of the

180-foot vertical cliff within the site, portions of some cells were not inventoried because of safety and access issues.

Concentrated fill material and debris observed at the site are located predominantly below the cliffline in the form of step-like mounds (terraces) that slope away from and extend approximately 400 feet downslope to the southeast. The lateral extent of the fill material and waste debris is directly related to the fall line for material dumped from the notch at the top of the cliffline.

Most surface debris observed at the site is scattered around the central portion of the site, along the base of the cliffline. It is approximately 600 feet from the eastern-most boundary of the landfill at grid point C-5+00 to the shoreline. The elevation drops over a series of terraces that abruptly drops to a 20 to 25 foot high cliffline at the shoreline. Reconnaissance surveys along these plateaus and ridges did not reveal significant solid waste below grid point C-5+00. Scattered miscellaneous debris was observed throughout the site, but predominantly consisted of deteriorated metal, aircraft and motor vehicle equipment parts, and miscellaneous construction debris. Other debris observed included: glass bottles, jars, and glass pieces; scattered sheet metal and metal parts; deteriorated metal drums; tar paper rolls; pipes, cables, and wire; metal mess kits; electrical components; porcelain pieces; small metal containers and gas cylinders; food cans and beverage cans; headlight fixtures; household trash; pulley systems; rubber and plastic pieces; vinyl records; aircraft parts; and concrete slabs.

Physical evidence (55-gallon drums, tar, stressed vegetation, etc.) was found indicating hazardous waste could have been disposed of at the site. The metal containers and 55-gallon drums found at the site were empty and mostly deteriorated.

Several items of UXO/OEW were observed on site, below the cliffline. Types of UXO found included 20-millimeter (mm) cartridges, 50-caliber cartridges, one 4-inch dummy round projectile, one illumination round, and several small bomblets. OEW found on site included 50-caliber shell casings, bomb brackets, and 20-mm shell casings. Locations of the UXO/OEW were documented in the field and are presented in Figure 3-1.

3.5.5 Site 9 COPCs

A total of 63 surface soil samples, including eight duplicates and three re-samples, were collected from 52 locations during three separate sampling events (May, July, and October 2000) to evaluate the risks to human health and the environment posed by the site (Figure 3-2). Based on these analytical results, antimony, barium, cadmium, chromium, copper, cyanide, lead, molybdenum, nickel, zinc, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-c,d)pyrene, DDD, DDT, and bis(2-chloroethyl)ether were identified as COPCs in surface soil at Site 9.

A total of 19 subsurface soil samples (including one duplicate and one re-sample) were collected during May and October 2000 sampling events so that buried waste materials could be evaluated (Figure 3-3). Based on these analytical results, antimony, cadmium, copper, lead, zinc, benzo(a)pyrene, and DDE were identified as COPCs in subsurface soil at Site 9.

3.5.5.1 Comparison of Data From Top and Bottom of Cliffline

A comparison of the analytical data for samples collected at the top and bottom of the cliffline was conducted to ensure that risks were not underestimated by combining data from both areas for the purposes of the risk assessment. For most COPCs, the number of samples collected at the top of the cliff was not adequate to calculate a 95UCLM, and comparisons are made to maximum values. Maximum values at the top of the cliffline exceeded the combined RME EPCs for cadmium, cyanide, molybdenum, and zinc, suggesting the potential to underestimate risks for these four COPCs if exposures were to be limited to the top of the cliffline.

Only one sample was collected from subsurface soil at the top of the cliffline; therefore, a similar comparison was not made for subsurface soil at the top and bottom of the cliff.

3.6 Current and Potential Future Site and Resource Uses

Due to the current and projected future use of the site by occasional users/trespassers, this target group is identified as a potential receptor population. Site 9 and adjacent areas are not currently used for residential purposes due to the rugged topography. Furthermore, future Andersen AFB land reuse plans (BCP) exclude Site 9 and adjacent areas from future residential reuse. Though residential exposures are unlikely to occur at the site in the future, onsite resident adults and children were evaluated as potential receptor populations, as a conservative measure.

3.7 Summary of Site Risks

A HHRA and an ERA were performed for Site 9 to evaluate whether the COPCs identified in surface and subsurface soil pose potential unacceptable risks to human health or the environment. The HHRA and ERA identified the COPCs, exposure concentrations, exposure duration, and exposure pathways and estimated the risks to human health and the environment if no action were taken. COPCs that were determined to pose unacceptable risks to human health or the environment were designated as COCs. As a comprehensive HHRA and ERA for Site 9 are presented in the RI (EA, 2006), according to USEPA Guidance (USEPA, 1999b), the HHRA and ERA in this document are presented in terms of COCs, only.

The OEW/UXO present below the cliffline at Site 9 does pose a potential threat to human health. However, the UXO issue is beyond the scope of the IRP and investigation and cleanup of OEW and UXO at Site 9 is being addressed under the MMRP being conducted at Andersen AFB. Periodic review of Site 9 may be necessary to ensure that engineering or institutional controls remain intact and functional at the site until such a time that OEW/UXO are cleared from the area and no longer pose a potential threat.

3.7.1 Baseline HHRA for Site 9

The baseline HHRA estimates what risks the site poses if no action were taken. It provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action. This section of the ROD summarizes the results of the baseline HHRA for this site. The HHRA methodology is detailed in Appendix D.2 of the RI/FS (Volume III) (EA, 2006) and, in general, involves a four-step process: (1) hazard identification, (2) toxicity assessment, (3) exposure assessment, and (4) risk characterization.

3.7.1.1 Identification of COCs for HHRA at Site 9

The range of detected concentrations (maximum and minimum) and the frequency of detection for each COC identified in surface and subsurface soils at Site 9 are included in Tables 3-2 and 3-3.

The EPC for each COC is a statistically derived concentration based on the soil sample results. The EPC was used to calculate the risk associated with each COC. The EPCs for COCs in surface and subsurface soils for Site 9 are included in Tables 3-2 and 3-3.

For the RME conditions, the EPC for each COC is estimated using the arithmetic mean and the 95UCLM. The 95UCLM represents a high value for an EPC so there is 95 percent confidence that all other values will be below the 95UCLM value. The 95UCLM is used as the EPC in the exposure assessment for the RME assumptions. However, if the 95UCLM is greater than the maximum detected concentration, the maximum detected concentration value is used as the EPC and is listed in the table instead of the 95UCLM value. The arithmetic mean concentration is used as the CT EPC value using average exposure assumptions.

3.7.1.2 Exposure Assessment for HHRA at Site 9

An exposure assessment is conducted to estimate the magnitude of actual and/or potential human exposures. In the exposure assessment, average and maximum estimates of potential exposure are developed in accordance with USEPA guidance for both current and potential future land-use assumptions. Current maximum exposure estimates are used to determine whether a potential health hazard exists based on current conditions. Future maximum potential exposure estimates are used to provide an understanding of potential future exposures and health hazards and include a qualitative estimate of the likelihood of such exposures occurring. Conducting an exposure assessment involves analyzing releases of COCs, identifying potential pathways of exposure, estimating average and maximum potential exposure point concentrations for specific pathways based both on environmental monitoring data and predictive chemical modeling results, and estimating potential chronic daily intakes for specific pathways. The results of this assessment are pathway-specific estimates of intakes for current and potential future exposures to individual COCs.

As stated in Section 3.6, as projected future use of the site includes occasional users/trespassers, this target group is identified as a receptor population. Though residential exposures are unlikely

to occur at the site in the future, at the request of USEPA Region 9, future onsite resident adults and children were evaluated as receptor populations, as a conservative measure.

As illustrated in the CSM (Figure 3-4), COCs detected in the heterogeneous wastes disposed at Site 9 may have adsorbed onto surface and subsurface soil particles. COCs may also have been released into the air as a result of disturbance of impacted soils (e.g., entrainment of soil particles by wind and other climatic factors).

Media of concern include surface soil, subsurface soil and air as environmental transport media for the release of chemicals present at Site 9. Groundwater is not considered an exposure medium of concern for this HHRA because deep groundwater beneath the site is estimated to be between 180 and 460 feet bgs and is not consumed by the potential receptor populations.

The following exposure pathways are considered to be complete for Site 9:

- Incidental ingestion of surface soil during residential activities (i.e., gardening).
- Incidental ingestion of surface soil during trespassing activities.
- Dermal contact with surface soil during residential activities (i.e., gardening).
- Dermal contact with surface soil during trespassing activities.
- Incidental ingestion of subsurface soil during residential activities (i.e. gardening).
- Dermal contact with subsurface soil during residential activities (i.e. gardening).
- Inhalation of suspended surface soil particles during residential activities (i.e., gardening).
- Inhalation of suspended surface soil particles during trespassing activities.
- Inhalation of suspended subsurface soil particles during residential activities (i.e., gardening).

The final step in the exposure assessment is to estimate COC intakes for each of the pathways considered in the assessment. In this exposure assessment, two different measures of intake are provided depending on the nature of the effect being evaluated. When evaluating longer-term exposures to chemicals that produce adverse non-carcinogenic effects, intakes are averaged over the period of exposure (i.e., the averaging time) (USEPA, 1989b). This measure of intake is referred to as the ADI and is a less-than-lifetime exposure. For chemicals that produce carcinogenic effects, intakes are averaged over an entire lifetime and are referred to as the LADI (USEPA, 1989b).

The detailed exposure duration, exposure time, incidental ingestion rates of contaminated soil, inhalation rates of contaminated dust, and dermal exposure assumptions for resident adults, resident children, trespassers, and occasional users (workers) under RME and CT conditions are presented in Appendix D.2 of the RI/FS (EA, 2006).

3.7.1.3 Toxicity Assessment for HHRA at Site 9

The toxicity assessment considers the types of potential adverse health affects associated with exposures to COCs. The toxicity assessment relies on existing toxicity information developed based on dose-response for specific COCs. Using this dose-response relationship, specific toxicity values are derived by USEPA that can be used to estimate the incidence of potentially adverse effects occurring in humans at different exposure levels. The USEPA-derived toxicity values for COCs are called RfDs for non-carcinogens and SFs for potential carcinogens.

The USEPA IRIS database was used for RfDs of non-carcinogenic COCs. If RfDs for COCs were not available from IRIS, the USEPA HEAST were used as a secondary data source. If RfDs for COCs were not available from IRIS or HEAST for one route of exposure but existed for another route, the existing value was examined for technical applicability to the alternate route and subsequently used, if appropriate. The primary non-carcinogenic target organs for antimony and copper are the blood and the gastro-intestinal system.

Unlike non-carcinogens, carcinogens are generally assumed to have no threshold, that is, there is presumed to be no level of exposure below which carcinogenic effects will not manifest themselves. This "non-threshold" concept supports the idea that there are small, finite probabilities of inducing a carcinogenic response associated with every level of exposure to a potential carcinogen. The primary carcinogenic target organs for chromium (total) and benzo(a)pyrene are lung and forestomach. The weight-of-evidence classification system assigns a letter or alphanumeric (A through E) to each potential carcinogen that reflects an assessment of its potential to be a human carcinogen:

A = a known human carcinogen
B1 = a probable human carcinogen, based on sufficient animal data and limited human data
B2 = a probable human carcinogen based on sufficient animal data and inadequate or no human data
C = a possible human carcinogen
D = not classifiable as to human carcinogenicity
E = evidence of noncarcinogenicity for humans

Only compounds that have a weight-of-evidence classification of C or above are considered to have carcinogenic potential in this risk assessment.

Additionally, there are no toxicity values available for lead. According to the USEPA, lead is classified as a B2-probable human carcinogen. However, there is no USEPA value for use as a slope factor in quantifying cancer risks. In the absence of any USEPA-published toxicity values for lead, it is currently not possible to perform a quantitative risk estimate for lead exposures using standard USEPA methodology. The current USEPA guidance sets forth an interim soil cleanup level for total lead at 400 mg/kg (USEPA, 1989b), which is considered "protective for direct contact at residential settings." Infants and young children are the populations most vulnerable to effects from exposure to lead.

3.7.1.4 HHRA Characterization for Site 9

Carcinogenic risk was estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to a potential carcinogen at the site. The numerical estimate of excess lifetime cancer risk was calculated by multiplying the LADI by the risk per unit dose (the slope factor), as shown in the following equation:

$$Risk = LADI \times SF$$

where: Risk = A unitless probability (e.g., 2×10^{-5}) of an individual's developing cancer
LADI = Lifetime average daily intake (mg/kg/day)
SF = Cancer slope factor $(mg/kg/day)^{-1}$

Because the SF is the statistical 95th percent UCL on the dose-response slope, this method provides a conservative, upper-bound estimate of risk.

Cancer risks were estimated for current and future occasional users and for potential future residents. These risks are probabilities that usually are expressed in scientific notation (e.g., 1×10^{-6}). An excess lifetime cancer risk of 1×10^{-6} indicates that an individual experiencing the reasonable maximum exposure estimate has a 1 in 1,000,000 chance of developing cancer as a result of site-related exposure. This is referred to as an "excess lifetime cancer risk" because it would be in addition to the risks of cancer individuals face from other causes such as smoking or exposure to too much sun. The chance of an individual's developing cancer from all other causes has been estimated to be as high as one in three. USEPA's generally acceptable risk range for site-related exposures is 10^{-4} to 10^{-6}.

The potential human health risks associated with exposures to non-carcinogenic COCs at Site 9 were estimated by comparing ADIs with established RfDs, as per USEPA guidance (USEPA, 1989a) derived for a similar exposure period. An RfD represents a level that an individual may be exposed to that is not expected to cause any deleterious effect. The ratio of exposure to toxicity is called a hazard quotient (HQ). An HQ<1 indicates that a receptor's dose of a single contaminant is less than the RfD, and that toxic non-carcinogenic effects from that chemical are unlikely. The HI is generated by adding the HQs for all chemical(s) of concern that affect the same target organ (e.g., liver) or that act through the same mechanism of action within a medium or across all media to which a given individual may reasonably be exposed. An HI<1 indicates that, based on the sum of all HQ's from different contaminants and exposure routes, toxic non-carcinogenic effects from all contaminants are unlikely. An HI >1 indicates that site-related exposures may present a risk to human health.

The HQ is calculated as follows:

$$HQ = \frac{ADI}{RfD}$$

where: HQ = Hazard quotient; ratio of average daily intake level to acceptable daily intake level (unitless)

ADI = Estimated average daily intake (mg/kg/day)
RfD = Reference dose (mg/kg/day)

ADI and RfD are expressed in the same units and represent the same exposure period (i.e., chronic, subchronic, or short-term).

3.7.1.4.1 HHRA Results for Surface Soil Exposures at Site 9

The detailed exposure and risk calculations are presented in Appendix D.2 of the RI/FS (EA, 2006). The results of the scenarios for which unacceptable health risks were calculated from exposure to COC in surface soil at Site 9 follow.

The non-cancer HI exceeded 1.0 for the future resident child scenario only. The cancer and non-cancer risks for resident children exposed to COCs in surface soil under RME conditions are presented in Table 3-4. Exposure to COCs in surface soil and ambient air results in an HI that exceeds USEPA's risk target of 1.0 under RME conditions (6.7). The COCs with HIs exceeding 1.0 under RME conditions were antimony (HI = 3.6) and copper (HI = 1.4).

There were no carcinogenic risks associated with exposures to surface soil at Site 9 that exceed USEPA's risk range of 10^{-6} to 10^{-4} for future residents or occasional users/trespassers, although the COCs for which cancer risks exceeds 10^{-6} (for residents only) were benzo(a)pyrene and chromium.

3.7.1.4.2 HHRA Results for Subsurface Soil Exposures at Site 9

The detail exposure and risk calculations are presented in Appendix D.2 of the RI/FS (EA, 2006). The following are the scenarios for which unacceptable health risks were calculated from exposure to COCs in surface soil at Site 9.

The non-cancer HI exceeded 1.0 for the future resident child scenario only. The cancer and non-cancer risks for potential future resident children exposed to COCs in subsurface soil at Site 9 are presented in Table 3-5. Exposure to COCs in subsurface soil and ambient air at Site 9 resulted in an estimated HI of 4.1 under RME conditions. The COCs with HIs exceeding 1.0 under RME conditions were antimony (HI = 2.3) and copper (HI = 1.5).

Cumulative cancer risks across all pathways were within USEPA's "acceptable risk range" of 10^{-6} to 10^{-4} for future resident adults and children.

3.7.1.4.3 HHRA Results for Lead in Surface and Subsurface Soils at Site 9

Lead was detected in surface soil samples at Site 9 at concentrations greater than the screening level of 400 mg/kg. The mean lead concentration was 1,560 mg/kg. This is above the risk screening level of 400 mg/kg used by USEPA. The maximum measured concentration of lead in surface soils at Site 9 was 13,700 mg/kg.

Based on Lead Version 0.99D (LEAD99D) model outputs, children exposed to lead in surface soil, under the hypothetical residential exposure scenario described previously, are predicted to have a mean blood lead level of:

- 15.1 micrograms pre deciliter (μg/dL), with approximately 78 percent of the exposed children's blood lead levels above the level of concern (10 μg/dL) at Site 9.

Lead was detected in subsurface soil samples at Site 9 at concentrations greater than the screening level of 400 mg/kg. The mean lead concentration was 1,280 mg/kg. This is above the risk screening level of 400 mg/kg used by USEPA. The maximum measured concentration of lead in subsurface soils at Site 9 was 7,510 mg/kg.

Based on LEAD99D model outputs, children exposed to lead in subsurface soil, under the hypothetical residential exposure scenario described in this chapter, are predicted to have a mean blood lead level of:

- 13.2 μg/dL, with approximately 69 percent of the exposed children's blood lead levels above the level of concern (10 μg/dL) at Site 9.

The predicted mean blood lead concentration for resident children hypothetically exposed to surface and subsurface soils at Site 9 exceeded the 10 μg/dL "level of concern" when all data are included in the mean lead concentration at Site 9.

3.7.1.4.4 Basis for Action Statement

Based on the identified unacceptable human health risks under a future residential scenario, as summarized in Sections 3.7.1.4.1 and 3.7.1.4.3, the response action selected in this ROD is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

3.7.1.5 HHRA Uncertainties for Site 9

There are numerous uncertainties involved in the human health risk assessment process. These are discussed briefly in the following sections.

3.7.1.5.1 Sampling and Analysis Uncertainties

The different types of uncertainty involved in the HHRA process are discussed in detail the RI (Volume 1) (EA, 2006), and are discussed briefly in the following sections. The sampling plan can have a significant impact on the results obtained in calculating human health risks at a site. To the extent that samples are collected in areas that are expected to be contaminated (biased sampling), the EPC used in calculating risk exposures and risks is likely to overestimate the actual concentration encountered at the site from random exposure across the site. Sampling bias generally results in an overestimate of exposures and risks at a site. The soil sampling at Site 9 incorporated a combination of random and biased samples. As the majority of soil

samples collected at Site 9 were biased toward suspected contamination, the measured concentrations and calculated health risks would tend to be overestimated.

3.7.1.5.2 Chemical Fate and Transport Modeling Uncertainties

Section 2.7.1.5.2 presents information about Chemical Fate and Transport Modeling Uncertainties; this information is common to Chapters 2, 3, and 4 (Decision Summaries for Sites 6, 9, and 12, respectively).

3.7.1.5.3 Toxicity Assessment Uncertainties

Section 2.7.1.5.3 presents information about Toxicity Assessment Uncertainties; this information is common to Chapters 2, 3, and 4 (Decision Summaries for Sites 6, 9, and 12, respectively).

3.7.1.5.4 Uncertainties Analysis of Exposure Assessment

An analysis of uncertainties is an important aspect of the exposure assessment. It provides the risk assessor and reviewer with information relevant to the individual uncertainties associated with exposure factor assumptions and their potential impact on the final assessment.

Current Receptors

Under current use conditions at Site 9, the only potential receptors are trespassers/occasional users. The results of this HHRA indicate that there are no unacceptable risks to the trespassers/occasional users at the site. There are no current residential exposures; therefore, under current use of the site, there are no unacceptable risks posed to human health.

Site 9 and adjacent areas are not currently used for residential purposes due to the rugged topography; e.g., the steep slope of cliff faces. Furthermore, future Andersen AFB land reuse plans (BCP) exclude future residential reuse for Site 9 and adjacent areas. Therefore, under expected future use of the site, there are no concerns for adverse human health effects at the site.

The USAF has evaluated risks to potential future residents at the site, although there are no plans for residential development. It was only under these most conservative assumptions and for the potential future resident child that any risks were identified that exceeded USEPA's risk targets. This is an unlikely future-use scenario and is considered to present the possibility of adverse health effects at the site only in the unlikely future event that residential development takes place.

Exposure Factors

Section 2.7.1.5.4 presents information about Exposure Factors; this information is common to Chapters 2, 3, and 4 (Decision Summaries for Sites 6, 9, and 12, respectively).

3.7.1.5.5 Uncertainties in Risk Characterization

Section 2.7.1.5.5 presents information about Uncertainties in Risk Characterization; this information is common to Chapters 2, 3, and 4 (Decision Summaries for Sites 6, 9, and 12, respectively)

3.7.2 Baseline ERA for Site 9

The purpose of the ERA was to determine the likelihood that adverse ecological effects may occur as a result of exposure to COCs. In addition to the DSI, an ecological (flora and fauna) survey was conducted at Site 9.

Each of the three major habitat types are described below, including wildlife observed within each habitat type.

Leucaena Forest

The *Leucaena* forest habitat represents approximately 25 percent of the site. *Leucaena* forests, also known as tangantangan forest, are forests of *Leucaena leucocephala* planted by the USAF after World War II for reforestation. A mixture of vines, herbs, shrubs and trees 0 to 3 feet tall, shrubs and small trees (3 to 10 feet tall), and small trees (10 to 30 feet tall) dominate this habitat. Examples of the dominant species include vines such as the climbing hemp vine (*Mikania scandens*) and corkystem passion flower (*Passiflora suberosa*); herbs include the beggar's tick (*Bidens pilosa*) and eupatorium (*Chromolaena ordorata*); shrubs include the limeberry (*Triphasia trifolia*); and trees include the lipstick tree (*Ochrosia mariannensis*) and tangantangan (*Leucaena leucocephala*).

Based on site observations of game trails, scat, skeletal remains, and actual sightings, animals present in this habitat, include Sambar deer (*Cervus mariannus*) and feral pigs (*Sus scrofa*). Bird species observed transiting this habitat were the black drongo (*Dicrurus macrocerus*), yellow bittern (*Ixobrychus sinensis*), and Eurasian tree sparrow (*Passer montanus*).

Mixed Shrub

The mixed shrub habitat represents approximately 25 percent of the site. A mixture of grasses, vines, and herbs (0 to 3 feet tall), shrubs (3 to 10 feet tall), and small trees (3 to 10 feet tall) dominate this habitat. Examples of the dominant species of mixed shrub include grasses (*Poaceae* sp.); vines include jasmine [*Jasminium marianum*] and corkystem passion flower; herbs include beggar's tick, eupatorium (*Chromolaena odorata*), and *Stachytarpheta* sp.; shrubs include limeberry; and small trees include inkberry (*Cestrum* sp.), lipstick tree, and mapunyao (*Agalia mariannensis*).

Based on site observations, game trails, scat, skeletal remains, and actual sightings, animals present in this habitat include Sambar deer and feral pigs. One bird species observed transiting this habitat was the Philippine turtle-dove (*Streptopeia bitorquata*).

Limestone Forest

The limestone forest habitat covers approximately 50 percent of the site. A mixture of vines (0 to 3 feet tall), small trees (3 to 10 feet tall), and larger trees (10 to 30 feet tall) dominate this habitat. Dominant species included vines of balsam pear (*Momoridca charantia*); small trees include the chopak (*Mammea odorata*) and lipstick tree; and larger trees include the fish-kill tree (*Barringtonia asiatica*), banyan (*Ficus prolixa*), chopak, and umumu (*Pisonia grandis*). The Guam Endangered Species List (GESL) plant species *Heritiera longipetiolata* was also observed in the limestone habitat.

Based on site observations of game trails, scat, skeletal remains, and actual sightings, there are animals prevalent across the habitat, including Sambar deer, feral pigs, and feral dogs (*Canis familiaris*). The GESL and United States Endangered Species List-listed Mariana fruit bats were observed in the limestone forest. One bird species observed transiting and nesting in this habitat was the Pacific reef-heron (*Egretta sacra*). Other birds seen transiting were the brown noddy (*Anous stolidus*), Philippine turtledove, and white tern (*Gygis alba*).

Based on flora and fauna of Site 9, the CSM for the ERA at Site 9 is presented in Figure 3-5. As presented in Figure 3-5, the CSM is based on simple direct contact and food-web models. The secondary source of COC exposure is surface soil. This exposure may occur through direct contact with or ingestion of surface soil, or by ingestion of plant or animal tissue that has been exposed to surface soil. Exposure pathways and routes include:

- Direct Contact with Surface Soil—This exposure route is important for uptake of COCs by plants and for soil invertebrates. Most vertebrates, when foraging, may have the potential to be exposed to COCs via dermal contact. However, the dermal exposure pathway is not believed to be important for birds, mammals, or reptiles because of the lack of contact with exposed soils. Many factors limit direct contact with exposed soils including the extensive ground cover by vegetation, the arboreal nature of most native species, and the protection from dermal contact by scales, feathers, or hair (USEPA, 2000c). Any incidental surface contamination of scales, feathers, or hair that is subsequently ingested during grooming is accounted for in the incidental soil ingestion pathway.

- Ingestion of Food (i.e., plants and biota that have taken up constituents from soil)—Terrestrial herbivores and predators that forage in the terrestrial habitats may ingest plants or animal prey that have bioaccumulated COCs from surface soils.

- Incidental Ingestion of Surface Soils—Herbivores and predators that forage in the terrestrial habitats may incidentally ingest some surface soil with their food or during other activities such as grooming.

On the basis of this evaluation, there are complete exposure pathways to surface soil in ecological habitats potentially impacted by releases of COCs. From this environmental medium, some COCs could bioconcentrate in plants and prey animals that may be eaten by other consumers.

The selection of assessment endpoints must be based on the fundamental knowledge of the local ecology. Assessment endpoints typically relate to an effect on a population or community. Survival of Mariana fruit bats is an example of a population level assessment endpoint. Community level assessment endpoints could include the primary productivity of the limestone forest habitat. Examples of endpoints representing guilds of species are useful in that they convey information beyond the indicator species identified in the endpoint itself. An assessment endpoint involving a community index may provide more information about a site than an analysis of one species. Consequently, it is important to note that confirmation of the deleterious effects at the community level is an inherent confirmation that population level effects are occurring (Hartwell, 1997).

Based on the ecological survey at Site 9 the following ecological receptors were considered for the ERA:

- Soil-invertebrate communities (i.e., earthworm) and plant communities
- Native terrestrial birds represented by the Mariana crow and the yellow bittern
- Mariana fruit bat

For the purposes of this ERA, it is assumed that no future actions are expected at Site 9 that would change the potential use of the area by ecological receptors. The ERA methodology involves a four-step process: (1) identification of potential COCs, (2) exposure assessment, (3) toxicity assessment, and (4) risk characterization.

3.7.2.1 Identification of COCs for ERA at Site 9

To identify COCs for the ERA at Site 9, the maximum detected concentration for each chemical in surface soil was compared to the higher of (1) conservative toxicologically based screening criteria or (2) background threshold concentrations for the base for inorganic constituents (ICF, 1998). A constituent was excluded as a COC if the maximum detected concentration at Site 9 was lower than the screening value, or the constituent was an essential nutrient.

The results of COC screening for Site 9 are shown in Table 3-6. The screening values were based on conservative threshold of ecological risk as recommended by the Dutch National Institute of Public Health and Environmental Protection (Dutch, 1994, 1995, and 1997).

3.7.2.2 Exposure Assessment for ERA at Site 9

Exposure refers to the degree of contact between ecological receptors at a site and the COCs. Based on the CSM described in Section 3.7.2 of this ROD, it is assumed that ecological receptors at Site 9 are exposed to COCs in surface soil either through direct contact, via dietary food web, or both.

The exposure concentrations were estimated statistically to present the most appropriate representative concentration of COCs at Site 9. The data for each COC were tested for normality or lognormality using the Shapiro-Wilks W-test (Shapiro and Wilks, 1965). If the data fit neither

or both the normal and lognormal distribution according to the Shapiro-Wilks test, a lognormal distribution was assumed consistent with USEPA guidance (USEPA, 1992b). For data fitting a normal distribution, the arithmetic mean was considered to be the most appropriate representative concentration. If the data fit a lognormal distribution, or a lognormal distribution was assumed because the data fit neither type of distribution, the lognormal mean of the constituent data was used as the representative concentration consistent with USEPA guidance.

The following assumptions are made for arriving at each COC exposure concentration:

- COCs are assumed to be 100 percent bioavailable. That is, whether by direct contact or via food-web ingestion, all of the COCs are available for absorption and expression of toxic effects, which is highly unlikely considering the soil chemistry at the site.

- The area use factor for the Mariana crow, yellow bittern, and Mariana fruit bat receptors is assumed to be 1.0. This means that 100 percent of the Mariana crow, yellow bittern, and Mariana fruit bat food comes from Site 9.

3.7.2.3 Toxicity Assessment for ERA at Site 9

Toxicity assessment is based on studies that determine the lowest concentrations of contaminants that may cause adverse effects on ecological receptors. In this ERA, toxicity assessments were completed for soil-invertebrate communities (earthworm), plant communities, native terrestrial birds represented by the Mariana crow and the yellow bittern, and Mariana fruit bat relative to COCs in surface soils at Site 9.

Earthworms

Many of the earthworm TRVs are from LOAEL chronic effects data based on laboratory studies of earthworms (ICF, 1998). In the absence of sufficient data, NOAEL data were used for chronic effects to derive earthworm TRVs.

Plants

Risks to plants, as with invertebrates, are expressed relative to concentrations observed in soil. Plant toxicity data were based on growth effects from Ecological Soil Screening Levels.

Native Terrestrial Birds and Mariana Fruit Bat

Food-web risks for avian species and the Mariana fruit bat are expressed relative to a dose of chemical (mg/kg-bw/day) taken up by the organism from food and soil. USEPA (1997b) guidance specifies that a screening ecotoxicity value should be “equivalent to a documented or best conservatively estimated chronic NOAEL.” Literature-reported wildlife NOAEL and LOAEL TRVs were used as TRVs for food-web risks.

3.7.2.4 ERA Characterization for Site 9

The ERA was characterized based on calculation of a HQ or an EQ:

Ecological Quotient = Representative Concentration / TRV

Hazard Quotient = Representative Dose / Toxicity Reference Value

If the representative soil concentration is less than the TRV, then the HQ or EQ will be less than 1.0. In this circumstance, no adverse ecological risk is expected for the exposed ecological receptors. If the representative soil concentration is greater than the TRV, then the HQ or EQ will be greater than 1.0, and adverse ecological risk is expected for the exposed ecological receptors. A summary of the ERA results for Site 9 is presented in the following sections of this ROD.

3.7.2.4.1 ERA Results for Site 9

Nine inorganic COCs were identified at Site 9 (antimony, barium, cadmium, chromium, copper, lead, nickel, silver, and zinc). Two pesticide COCs were identified (total DDT and dieldrin). Four SVOCs (2,4-dinitrotoluene, benzoic acid, benzyl alcohol, and bis[2-chloroethyl]ether) and one VOC (methylene chloride) were identified as COC for Site 9. In Table 3-7, assessment and measurement endpoints were identified for this ERA. These endpoints have been revisited in Table 3-8, along with the results of this Tier I ERA.

All but two risks to earthworms were found to be acceptable (Table 3-8). Copper and zinc may be potential risks with hazard quotients above 1.0 (18 and 22, respectively). Organic chemical risks are expected to be low due to low observed VOC and SVOC concentrations.

Acceptable risks to terrestrial plants were found for barium, cadmium, and 2,4-dinitrotoluene (Table 3-8). Some potential risks were identified for plants from antimony, chromium, nickel, and silver; however, the concentrations of these metals at the site were lower than BTVs. Plants may be at risk from copper, lead, and zinc because the plant risk quotients were greater than 1.0 (11, 54, and 14, respectively), and site concentrations of these metals exceeded BTVs. No TRVs were found for most of the organic chemicals; however, concentrations of these chemicals at Site 9 were low and are not expected to cause risk to plants.

Acceptable risks were found for both avian ROCs (Mariana crow and yellow bittern) for all COCs with the exception of lead (Tables 3-9 and 3-10). No TRVs were found for antimony, silver, 2,4-dinitrotoluene, benzoic acid, benzyl alcohol, bis(2-chloroethyl)ether, and methylene chloride for avian ROC. However, antimony and silver concentrations observed at Site 9 were less than their respective BTVs. Both the Mariana crow and yellow bittern may be at small risk from exposures to lead at Site 9.

Risks to the threatened and endangered Mariana fruit bat were found acceptable for most COC at Site 9. A hazard quotient of 1.6 for antimony was found for exposure of the Mariana fruit bat (Table 3-11). Site concentrations of antimony are lower than the BTV.

In summary, lead was found to be a source of potential risk for the Mariana crow, yellow bittern, and terrestrial plants. Copper and zinc may be a source of risk for terrestrial plants and soil

invertebrates. Specific sample locations were identified that may be driving these risks. Sample S-039 revealed notably high lead and zinc concentrations. Remediation of these localized areas may be required to protect ecological receptors.

3.7.2.4.2 ERA Uncertainties for Site 9

Ecological risk characterization includes analysis of uncertainty (USEPA, 1997a). Uncertainty is distinguished from variability, and arises from lack of knowledge about factors associated with the study. Sources of uncertainty include the process of selecting COC, assumptions made in establishing the CSM, the adequacy of ecological characterization of the site, estimates of toxicity to receptors, and selection of model parameters. There are a number of factors that contribute to uncertainty in the ecological risk characterization for Site 9 described above.

3.7.2.4.2.1 Uncertainties for Non-Random Sampling

While ecological receptors are likely to be found anywhere about the 4.5-acre Site 9, environmental media at known or suspected waste sites are typically sampled in a non-random fashion. That is, sampling points are chosen to best characterize known or suspected areas of contamination. Peripheral and nearby areas are under-sampled, if at all, and thus the average exposure of ecological receptors is biased high and exposure concentrations used in the risk assessment are conservative. This is an example of sampling to characterize suspected areas of contamination (USEPA, 1988), even though this area represents a small proportion of the entire Site 9.

3.7.2.4.2.2 Uncertainties for COC Selection

Consistent with USEPA guidance (USEPA, 1997a), COC for the Site 9 ERA were selected by comparison of maximum concentrations for all measured analytes with conservative, toxicologically based concentrations expected to represent no adverse effect levels. In addition, because the geology of Guam is unique (represented by highly weathered limestone), reference BTVs of metals may be used to identify COCs. The use of conservative toxicity values relative to maximum concentrations represents a very conservative screening process. Because plants and animals on Andersen AFB have acclimated to high metal concentrations such as aluminum, lead, or nickel, the use of representative BTVs represents a more realistic COC selection mechanism.

3.7.2.4.2.3 Uncertainties for Receptor of Concern Selection

Selection of appropriate ROCs was performed using different criteria than are typically used. Because of the concern for the extirpation of native animals and plants on the island, any species that were introduced to the island and are thus not native species were not considered to be ROCs. Alternatively, native species found at the site were identified as ROCs. The native blue-tailed skink, while observed on the site, was not selected as an ROC due to the lack of appropriate toxicological values. It is expected that in the event of acceptable risk being found for identified ROC, the insectivorous blue-tailed skink would also have acceptable risk; however, this is an assumption with unknown uncertainty.

3.7.2.4.2.4 Uncertainties for Exposure Pathway

Inhalation and dermal exposure to terrestrial receptors were not quantified because doses from these pathways are very small relative to food and incidental soil ingestion (USEPA, 2000c). While this may underestimate the total dose to the ROC, the underestimate would be in the fraction of a percent of total dose, and is thus not of importance. In addition, ingestion of surface water was not considered in this risk assessment. There are very few, if any, natural surface water bodies at Andersen AFB because the ground is very porous, and any water that falls on the surface is rapidly infiltrated into the ground. Groundwater at the site is deep, from 180 to 460 feet bgs, and is thus not accessible to ecological receptors. The ecological receptors on Guam have adapted to this characteristic by obtaining most of their water from the food that they consume, which accounts for the large number of fruit eaters on Guam.

3.7.2.4.2.5 Uncertainties for Exposure Assumptions

A number of assumptions were made to estimate metal doses to the terrestrial ROC. Some of these assumptions were conservative, adding to the potential overestimate of risk, while some exposure assumptions have an unknown effect on the uncertainty of this risk assessment.

Inhalation and dermal exposure to terrestrial receptors were not quantified because doses from these pathways are very small relative to food and incidental soil ingestion (USEPA, 2000c). While this may underestimate the total dose to the ROC, the underestimate would be in the fraction of a percent of total dose, and is thus not of importance.

Because there is little information available for the bird receptors, certain food-web model components are uncertain. For example, the assignment of feeding fractions for the yellow bittern (100 percent of reptile) and the 2 percent incidental soil ingestion are based on best professional judgment, in the absence of species- and site-specific data. Similarly, the use of the available tissue concentration data for monitor lizard and papaya as a surrogate for the various food items eaten by the ROC adds uncertainty. These food items were collected or hunted at Andersen AFB, but not at Site 9. It has been assumed that concentrations of these food items at Site 9 are the same as those found at the base. How this assumption relates to uncertainty is not known, as risks may be either over- or under-estimated.

COCs were assumed to be 100 percent bioavailable. The assumption that COC are 100 percent bioavailable is highly unlikely based on soil chemistry. Elements such as lead and zinc are common constituents of soil and crustal materials. In the solid soil matrix, most of these elements are not bioavailable, and are thus not taken up into organisms exposed to these soils. The environmental behavior (and thus the bioavailability) of metals in environmental soils is complex and not well understood. The solubility and availability of these metals is dependent on a number of factors including soil Eh, pH, and availability of ligands (chemical constituents capable of bonding with metal ions) (Bodek et al., 1988).

A conservative assumption made for the Mariana fruit bat, Mariana crow, and the yellow bittern was that the foraging range for them was 100 percent at Site 9 with respect to incidental soil exposure, and over the entire Andersen AFB for tissue concentrations. The assumption of

100 percent soil exposure from the site is very conservative, as all of these receptors have a wide foraging range.

Exposure and subsequent risk to worms and plants was represented by mean values instead of upper level exposures such as the maximum concentration or UCLM. This was done because ecological risk (as long as the receptor is not a threatened and endangered species) is based on the population level rather than individual level risks as is performed in a human health risk assessment. Thus, while some individuals may be impacted by a COC in an ERA, risks are acceptable as long as the population of receptors is not impacted. An example of this may be represented by impaired reproduction of a field mouse due to exposure to a given COC. As long as the other mice in that field population can compensate for the impacted individual, ecological risks are acceptable. Consequently, the use of mean concentrations rather than upper limit estimates is more representative of population exposure than individual exposure.

3.7.2.4.2.6 Uncertainties for Toxicity Reference Values

Toxicological data used in the risk characterization represent significant uncertainty. Because there are no known data on the effects of chemical constituents on the Mariana crow, yellow bittern, or Mariana fruit bat, toxicological data for surrogate species were used, and this adds uncertainty. This uncertainty is to some extent controlled by choosing the lowest available screening values, consistent with USEPA (1997a) guidance to "be consistently conservative in selecting literature values..."

Consistent with Oak Ridge National Laboratory (ORNL) procedures (Sample et al., 1996), an allometric (weight difference) conversion was performed to modify the toxicity value from the test species to the Mariana fruit bat. This is due to the finding that smaller animals, such as rats and mice that are commonly used as test species in toxicity tests, have higher metabolic rates, and detoxify contaminants faster than larger animals. Alternatively, similar studies have shown that this is not true for avian species, thus the measured NOAEL of LOAEL has been directly used for the TRV for avian receptors.

In several instances, there were missing TRVs for various ROCs. This included earthworms (antimony, 2,4-dinitrotoluene, benzoic acid, benzyl alcohol, bis[2-chloroethyl]ether, and methylene chloride), avian receptors (antimony, cobalt, cyanide, silver, 2,4-dinitrotoluene, benzoic acid, benzyl alcohol, bis[2-chloroethyl]ether, and methylene chloride), mammals (cobalt, silver, 2,4-dinitrotoluene, benzoic acid, benzyl alcohol, bis[2-chloroethyl]ether, and methylene chloride) and plants (cyanide, total DDT, dieldrin, benzoic acid, benzyl alcohol, bis[2-chloroethyl]ether, and methylene chloride). In those instances some concentrations found at Site 9 were compared with Andersen AFB background, and in some cases, site concentrations used to estimate risk were lower than BTVs. In these circumstances, the biota would have been expected to adapt to the unique geological conditions of Guam, and risks to these receptors from these contaminants should be acceptable.

Concentrations of inorganics that may be a potential risk for all habitats (copper, lead, and zinc) at Site 9 were investigated separately for the limestone habitat to make sure that potential risk did not exist just in the critical habitat and that all habitats had similar results. This was completed in order to make certain that species on the Guam Endangered Species List were not

in a greater risk category. The data for each COC that may be a potential risk were again tested for normality or lognormality using the Shapiro-Wilk test (Shapiro and Wilk, 1965). Results showed that exposure concentrations were similar to overall results of all habitats. Therefore, no further investigation was needed and it is concluded that the critical limestone habitat and all species within are at the same concentration levels as the mixed shrub and *Leucaena* forest.

3.7.2.4.2.7 Uncertainties for Cumulative Hazard Indices

Section 2.7.2.4.2.7 presents information about Uncertainties for Cumulative Hazard Indices; this information is common to Chapters 2, 3, and 4 (Decision Summaries for Sites 6, 9, and 12, respectively).

3.7.2.4.2.8 Uncertainties for Population Level Effects

The goal of an ERA is to protect the populations of organisms living on or near the site of concern. When the potential or observed presence of threatened and endangered species is found, such as the Mariana crow, Mariana fruit bat, and the ufa tree at Site 9, these receptors deserve a special level of protection, protecting each individual organism. However, for most organisms, the protection of the populations remains the goal. Toxic endpoints used for plants tend to be individual, such as reduced weight or shoot length. Toxic endpoints for earthworms, mammals, and birds are those that could have an impact on the population, such as reproduction. In addition, for this ERA, concentrations of metals in soil were represented by lognormal means, which are more reflective of what the populations of organisms are likely to be exposed to at the site.

3.8 Remedial Action Objectives

RAOs are medium-specific or site-specific remediation goals for protecting the human health and the environment. Based on the HHRA results at Site 9, antimony, chromium (total), copper, lead, benzo(a)pyrene, benzo(b)fluoranthene, and indeno(1,2,3-c,d)pyrene were determined to be surface soil COCs (Table 3-2). Antimony, (total), copper, lead, benzo(a)pyrene, and DDE were determined to be subsurface soil COCs (Table 3-3). Under the exposure conditions of the RME scenarios, the future resident child would be under health risk from the non-carcinogenic effects of two COCs (antimony and copper) in surface soil (HIs = 3.6 and 1.4, respectively) and subsurface soils (HIs = 2.3 and 1.5, respectively) at Site 9. The predicted mean blood lead concentration for resident children hypothetically exposed to surface and subsurface soils at Site 9 exceeded the 10 μg/dL "level of concern" when all data are included in the mean lead concentration at Site 9 (15.1 μg/dL for exposure to surface soil and 13.2 μg/dL for exposure to subsurface soil). Under both the exposure conditions of the RME and CT conditions, future resident adults and trespassers/occasional users would not be under health risk from the non-carcinogenic effects of COCs in the surface and subsurface soils at Site 9. Chromium and benzo(a)pyrene were the only COCs for which the cancer risk exceeded 10^{-6} (5.7×10^{-5} and 6.3×10^{-5}, respectively) for future residents (adults and children); however, it was within the "acceptable risk range" of 10^{-6} to 10^{-4}. The remainder of the Site 9 COCs did not exceed an HI of 1, nor exceed the USEPA cumulative cancer risk target of 10^{-6}. Cumulative cancer risks for the trespasser/occasional user did not exceed USEPA's risk target of 10^{-6}. Therefore, there are

no COCs identified in surface soil at Site 9 for the occasional user/trespasser exposure pathway. Table 3-12 identifies RGs for Site 9. Table 3-13 along with Figures 3-6 and 3-7 are presented to show the spatial distribution of COC-impacted soils at Site 9.

Because of the potential for dermal, ingestion, and inhalation exposures to the COC-impacted surface and subsurface soils at Site 9, there would be a potential adverse health effect on site residents who may come into prolong contact with soil at Site 9. The adverse health effects may include cancer or damage to blood (such as from exposure to antimony) and the gastro-intestinal system (such as from exposure to copper). There are no plans to develop this site for residential use in the future because of: 1) the rugged topography (e.g., steep cliffs) and 2) the Andersen AFB land-use plans (BCP) exclude future residential reuse for Site 9 and adjacent areas. However, as a conservative assumption and to serve as a baseline, risks to potential future resident pathways were evaluated for Site 9. Under current use conditions at Site 9, the only potential current receptors are trespassers/occasional users. The results of this HHRA indicate that there are no unacceptable risks for the trespasser/occasional user exposed to specific COCs at the site. Non-cancer risks for occasional users/trespassers are below USEPA's risk target of 1.0. Cumulative cancer risks for the trespasser/occasional user exposure to COC at Site 9 did not exceed USEPA's risk target of 10^{-6}. Therefore, under current use of the site, there are no unacceptable risks posed to human health.

Based upon the ERA, lead in soil was determined to pose potential unacceptable risks to the Mariana crow, yellow bittern, and terrestrial plants. In addition, copper and zinc in soil may pose potential unacceptable risks to terrestrial plants and soil invertebrates.

Based on the results of the HHRA and ERA, the following RAOs were developed for Site 9 above the cliffline to allow for unrestricted land use above the cliffline:

- Prevent future residential exposures to antimony lead, and benzo(a)pyrene in surface and subsurface soil above the cliffline at concentrations greater than the respective RGs of 63, 400, and 1.4 mg/kg.

There are no RGs derived for chromium (total) and copper in soil above the cliffline as elevated concentrations of theses COCs were only observed below the cliffline. Also, there were no unacceptable risks to ecological receptors above the cliffline and no associated ecological RGs were derived.

Based on the results of the HHRA and ERA, the following RAOs were developed for Site 9 below the cliffline:

- Prevent future residential adult and child exposures to antimony, chromium, copper lead, and benzo(a)pyrene in surface and subsurface soil above the cliffline at concentrations greater than the respective RGs of 63, 1,080, 3,100, 400, and 1.4 mg/kg.

- Mitigate potential risks to soil invertebrate ROCs (earthworms) associated with copper and zinc in surface soil at concentrations greater than 72 and 120 mg/kg, respectively).

- Mitigate potential risks to avian ROCs (Mariana crows and yellow bitterns) associated with lead in surface soil (900 mg/kg).

Due to presence of native limestone forest habitat below the cliffline cleanup is not recommended in that area. The physical stressors related to implementing a cleanup action below the cliffline would potentially have a greater negative impact than benefit on the habitat. In addition, the limited access to the site below the cliffline would make the use of standard equipment (e.g., excavators, loaders, backhoes, compactors, etc.) impractical. For the most part, mobilizing the necessary equipment to the base of the cliffline would require transport via a large crane or helicopter and the clearing (destruction) of a large area of limestone forest. The transport of equipment would be dangerous and the cleanup activities would disrupt the existing wildlife habitat in the area. The remoteness of the site also makes it impractical to install and maintain engineering controls such as chain-link fences, and the cliffline serves as a control for human access. Furthermore, such engineering controls such as a fence would have little or no effect on protecting the potentially impacted ecological receptors (i.e., Mariana crow, yellow bittern, or Mariana fruit bat). Subsequently, only the surface benzo(a)pyrene-, antimony-, and lead-impacted soils (samples S-037, S-038, S-076, S-077, and S-039) and subsurface lead-impacted soil (sample S-043) above the cliffline were recommended for remediation (Figures 3-1 and 3-2).

No RAOs were derived relative to groundwater because Site 9 is located downgradient of aquifer recharge zones and will not impact current or future groundwater production wells. The freshwater lens is anticipated to be relatively thin beneath the site, and becomes even thinner and more brackish as it approaches the nearby Pacific Ocean.

Site 9 has been included in the MMRP list of sites at Andersen AFB. RAOs to address the mitigation of potential chemical and physical hazards related to UXO will be developed as part of future MMRP response actions and will be suitable for the intended reuse at the completion of the remedial action. All response actions involving UXO will be protective of human health and the environment and will comply with ARARs.

3.9 Description of Alternatives

Using USEPA guidelines (40 CFR 300.430(e)(7)) for screening remediation technologies, 33 remedial technologies for soil were considered for use at Site 9. Many of these were eliminated from further consideration because they were not feasible for the physical and chemical properties of the Site 9 COCs and/or the unique environmental setting of Site 9. For instance, the major COCs at Site 9 are metals. Most biological treatment technologies (e.g., bioventing, enhanced bioremediation, composting, and landfarming) are ineffective in reducing metals concentrations to levels that would not pose a risk to human health or the environment. Similarly, treatment technologies such as vapor extraction and solar denitrification are not designed to treat metals and, therefore, are not feasible at Site 9. The remaining remedial technologies that were potentially feasible for the mitigation of Site 9 risks were screened according to their effectiveness, implementability, and, to a lesser extent, cost. Remedial technologies retained from the screening process were grouped into remedial alternatives that were further screened based on their effectiveness, implementability, and cost. Based on the

remedial technology and alternative screenings, the following four remedial alternatives were retained for detailed analysis at Site 9:

- No Action
- Institutional Controls
- Soil Cover
- Soil Removal and Treatment.

Each of these four remedial alternatives is summarized below. A more complete, detailed presentation of each alternative is presented in Chapter 3 of the FS (EA, 2006). A summary of the comparative analysis of these alternatives and a further description of the Selected Remedy for Site 9 are presented in Sections 3.10 and 3.12, respectively, of this ROD.

3.9.1 *No Action* Alternative

Pursuant to Section 300.430(e)(6) of the revised NCP, a "No Action" alternative is required to be developed to provide a baseline against which the other remedial alternatives are to be compared. By definition under the NCP and USEPA guidance, the No Action alternative includes no remedial actions or institutional controls. COC-impacted soil, other debris, and the identified human health risks, therefore, would remain at the site.

There are no costs associated with this alternative.

3.9.2 *Institutional Controls* Alternative

The *Institutional Controls* alternative includes the following components to achieve the RAOs for Site 9:

LUCs – The *Institutional Controls* alternative would mitigate the identified human health risks through a deed restriction (via implementation of LUCs) to prohibit residential reuse of the site and by the installation of a fence at the top of the cliffline to limit access to the lower portion of the site. Furthermore, implementing the *Institutional Controls* alternative with deed restrictions for the approximately 3.5 acres below the cliffline was included for each of the remedial alternatives (except no action) due to the potential impact to habitat and technical feasibility of conducting a cleanup on the lower portion of the site. A detailed discussion of the LUC objectives, the LUCs, and the actions the USAF will be required to ensure proper implementation of LUCs at Site 9 is provided in Table A-2 (Appendix A).

- Five-year reviews – Following successful implementation of the above actions, the site would be suitable for continued use by the USAF as open space, but would not be suitable for unrestricted use and unlimited exposures (e.g., residential) because COCs above RGs would remain onsite above and below the cliffline. Therefore, the USAF, in conjunction with the USEPA and Guam EPA, would conduct 5-year reviews to ensure that the *Institutional Controls* alternative is effective in the future protection of human health and the environment. The reviews would focus on the site conditions, the current

and planned future site use, the results of any nearby monitoring programs (e.g., the Basewide Long-term Groundwater Monitoring Program), evaluations of ecological conditions and/or risks in the areas of impacted soil below the cliffline, and the LUC-compliance reports. The 5-year reviews would be conducted until the site was deemed to be suitable for unrestricted use.

Following implementation of the *Institutional Controls* alternative, the site would be rendered suitable for continued use by Andersen AFB. Although soil COCs would remain onsite, the *Institutional Controls* alternative would control exposure to resident children and adults by prohibiting development of the land for residential use.

For some CERCLA sites, *Institutional Controls* alternatives would include installing a fence around the impacted area to reduce access. However, because the COCs at Site 9 do not pose a potential threat to trespassers/occasional users (potential site users under current conditions), the *Institutional Controls* alternative for Site 9 would not require fencing off the area. *Institutional Controls* for the approximately 3.5 acres below the cliffline will be necessary due to remoteness and technical feasibility of conducting remediation below a 180-foot cliff at the lower portion of the site. Therefore, no fencing is included in this alternative for the area below the cliffline. Work conducted at the site would require a clearance permit that must be approved by the Andersen AFB Civil Engineer Squadron.

The present worth for implementing the *Institutional Controls* alternative for 30 years is approximately $231,700 (Table 3-14), including regular O&M and five-year reviews. Approximately $39,900 of the total costs are capital costs associated with installing a fence at the top of the cliffline. The remaining $191,800 relate to long-term costs.

3.9.3 *Soil Cover* Alternative

The *Soil Cover* alternative includes the following components to achieve the RAOs for Site 9:

- Soil Cover – An engineered soil cover would be constructed over the lateral extent of the site located above the cliffline that contains COCs above RGs. The soil cover, consisting (conceptually) of selected low permeability soil(s), would prevent human and ecological contact with impacted soil above the cliffline. The soil cover would be constructed with a slope to prevent the onsite ponding of water. The soil cover would be vegetated (e.g., minimum-maintenance native grass and shrub species) and maintained indefinitely by the USAF to prevent damage from erosion, deep rooted vegetation, and/or burrowing animals.

- LUCs – The USAF would implement LUCs through amendments to the BCP to ensure the continued protection of human health and the environment. The full scope of the LUCs would be presented in a LUCMP to be developed by the USAF in coordination with the USEPA and Guam EPA, subsequent to completing the ROD. The LUCs would be applied to the extent of Site 9 areas with COCs exceeding RGs. Conceptually, the LUCs would include (1) a prohibition on the redevelopment or disturbance of the soil cover without prior approvals from the USAF, the USEPA, and the Guam EPA; (2) a

prohibition on the residential redevelopment (3) limitations and controls on any future excavation/maintenance activities at the site (e.g., worker requirements, soil management, waste disposal); and (4) a requirement for intrusive activities to be first reviewed and approved by the Andersen AFB Civil Engineer Squadron. The LUCMP would include additional provisions such as (1) requirements for periodic (e.g., annual) inspections of the site conditions and use to ensure compliance with the LUCs; (2) periodic (e.g., annual) LUC-compliance reporting requirements to the USEPA and Guam EPA; (3) protocols for property lease or transfer (note: currently, there are no plans for property lease or transfer); and (4) protocols for notification and correction of any LUC non-compliant events. The LUCs would remain in effect for as long as the site conditions are not suitable for unrestricted use and unlimited exposure.

- Five-year reviews – Following successful implementation of the above actions, the site would be suitable for continued use as open space, but would not be suitable for unrestricted use and unlimited exposure because COCs above RGs would remain onsite, both above and below the cliffline. Therefore, the USAF, in conjunction with the USEPA and Guam EPA, would conduct 5-year reviews to ensure that the remedial alternative remains effective in the future for the continued protection of human health and the environment. The reviews would focus on the site conditions, the current and planned future site use, soil cover maintenance records, the results of any nearby monitoring programs (e.g., the Basewide Long-term Groundwater Monitoring Program), evaluations of ecological conditions and/or risks in the areas of impacted soil below the cliffline, and the LUC-compliance reports. The 5-year reviews would be conducted until the site was deemed suitable for unrestricted use.

Following implementation of the *Soil Cover* alternative, the site would be rendered suitable for continued use by Andersen AFB. Although the *Soil Cover* alternative would leave COCs in place, this alternative would prevent direct exposure to COCs by covering a portion of the contaminated soils of Site 9 (i.e., the upper portion of the site).

The present worth cost for this alternative is approximately $400,400 for implementing the *Soil Cover* alternative (Table 3-15). Approximately $146,200 of these are capital costs associated with the installing the soil cover. The remaining $254,200 relate to long-term costs for O&M of the soil cover and implementing *Institutional Controls*.

3.9.4 *Soil Removal with Treatment Above the Cliffline and Institutional Controls Below the Cliffline* Alternative

The *Soil Removal with Treatment Above the Cliffline and Institutional Controls Below the Cliffline* alternative (herein referred to as the *Removal* alternative) includes the following components to achieve the RAOs for Site 9:

- Excavation – Surface and subsurface soil containing COC concentrations exceeding the RGs will be excavated above the cliffline. Soil removal activities will use backhoes or other similar equipment. Excavated soil will be stockpiled in a designated area onsite. For the excavation, additional soil will be excavated near the surface to ensure that the

excavation walls are stable. This additional soil may not exceed RGs, and will be stockpiled onsite and analyzed for TAL-metals to determine whether the soil requires offsite disposal or can be placed back into the excavation. Composite samples will be collected. If the soil is below the RGs, then the soil can be used as onsite backfill. Limited compaction and grading along the upper cliff face may be required. The cut and fill material will need to be sloped at not less than 1:2 or based on sound engineering recommendations. Confirmatory sampling will be performed after excavation to verify that soil exceeding the RGs has been removed. Samples will be collected from the excavation area and analyzed for TAL metals. If analytical results demonstrate that the remaining soil still exceeds the RGs, then additional soil removal and confirmatory sampling will be repeated until the appropriate levels are achieved, as feasible. Surface and subsurface COC-impacted soil volumes are estimated at approximately 315 and 105 bcy at Site 9, respectively. The soil removal consists of excavating and disposing of impacted surface and subsurface soil to a depth of 4 feet bgs in the areas shown in Figures 3-6 and 3-7.

- Triple Super Phosphate (TSP) Treatment (stabilization) – Based on the concentrations of metals in subsurface soil samples collected at the site, some soil may potentially be classified as a hazardous waste (i.e. for lead). Composite soil samples will be collected from the soil stockpiles and analyzed for hazardous waste characteristics utilizing TCLP for lead. In order to avoid having to ship hazardous waste to an off-island facility for disposal (i.e., expensive and does not meet the statutory preference for not transporting and disposing hazardous or impacted materials offsite when practical treatment technologies are available), material classified as hazardous waste would be treated with TSP. The TSP Treatment Method is implemented by mixing TSP with the excavated soil. The TSP stabilizes metals in soil, thereby lowering TCLP metals concentrations, and TSP-treated soil can be disposed of as non-hazardous waste. This method has been successfully used at other sites at Andersen AFB and has proven to be an effective and feasible method of stabilizing metal-impacted soil, particularly lead-contaminated soil. This is a viable alternative to shipping the impacted soil off-island, for the TSP method essentially would lower TCLP metals concentrations to below the hazardous concentration level, thus enabling the soil to be disposed of at the Andersen AFB CU.

- Offsite disposal – Excavated soil (non-hazardous waste and TSP-treated hazardous waste) will be disposed at the Andersen AFB CU.

LUCs – The USAF will implement LUCs through amendments to the BCP to ensure the continued protection of human health and the environment. The full scope of the LUCs will be presented in a LUCMP to be developed by the USAF in coordination with the USEPA and Guam EPA, subsequent to completion of the ROD. The LUCs will be applied the portions of Site 9 that were not remediated to concentrations below RGs. The LUCs will include (1) a prohibition on the residential use in areas where unrestricted use is not allowed, (2) limitations and controls on any future excavation/maintenance activities in the 3.5-acre area below the cliffline (e.g., worker requirements, soil management, waste disposal); and (3) a requirement for any intrusive activities to be first reviewed and approved by the Andersen AFB Civil Engineer Squadron. The LUCMP will include additional provisions such as (1) requirements for periodic (e.g., annual) inspections of the site conditions and use to ensure compliance with the LUCs; (2)

periodic (e.g., annual) LUC-compliance reporting requirements to the USEPA and Guam EPA; (3) protocols for property lease or transfer (note: currently, there are no plans for property lease or transfer); and (4) protocols for notification and correction of any LUC non-compliant events. The LUCs will remain in effect for as long as the site conditions are not suitable for unrestricted use and unlimited exposure. A detailed discussion of the LUC objectives, the LUCs, and the actions the USAF will be required to ensure proper implementation of LUCs at Site 9 is provided in Table A-2 (Appendix A).

- Five-year reviews – Because the area below the cliffline will still contain COC concentrations above RGs, the USAF, in conjunction with the USEPA and Guam EPA, will conduct 5-year reviews to ensure that the remedial alternative below the cliffline remains effective in the future protection of human health and the environment. The reviews will focus on the site conditions, the current and planned future site use, the results of any nearby any nearby monitoring programs (e.g., the Basewide Long-term Groundwater Monitoring Program), evaluations of ecological conditions and/or risks in the areas of impacted soil below the cliffline, and the LUC-compliance reports. The 5-year reviews will be conducted until the site was deemed to be suitable for unrestricted use.

Following successful implementation of the above actions, the site will be suitable for continued use as open space. The area of Site 9 above the cliffline will be suitable for unrestricted use and unlimited exposure, however use of the area below the cliffline will be restricted because COC concentrations will remain above RGs.

The present worth cost for the *Soil Removal with Treatment Above the Cliffline with Institutional Controls Below the Cliffline* alternative is $457,700. This includes $297,300 in capital costs for the soil removal, plus $160,400 in long-term costs (Table 3-16).

3.10 Comparative Analysis of Alternatives

Evaluation criteria for comparison of remedial alternatives are based on CERCLA statutory requirements, earlier program initiatives promulgated in the 20 November 1985 NCP, and site-specific experience gained in the Superfund program. A total of nine criteria are developed for comparing the merits of each remedial alternative as follows:

- Overall Protection of Human Health and the Environment
- Compliance with ARARs
- Short-Term Effectiveness
- Long-Term Effectiveness and Permanence
- Reduction of Toxicity, Mobility, or Volume Through Treatment
- Implementability
- Cost
- Territorial (Guam) Acceptance
- Community Acceptance

The first two criteria are threshold factors that must be met by each alternative. The next five criteria are the primary balancing factors upon which the comparison of remedial alternatives is based. The last two criteria are modifying factors and are applied to ensure that the final remedial alternative would meet public acceptance. The final step is a cost analysis for a few feasible cleanup alternatives before presenting the final cleanup alternative for public review and comment.

The above-mentioned nine criteria will each be presented in the following sections and a comparison of the four alternatives will be made in decreasing order from the most to least advantageous alternative.

3.10.1 Overall Protection of Human Health and the Environment

This threshold criterion addresses whether each alternative provides adequate protection of human health and environmental and describes how risks posed through the exposure pathways are eliminated, reduced, or controlled, through treatment, engineering controls, and/or institutional controls.

Each of the alternatives, except the *No-Action* alternative, is at least partially protective of human health and the environment by reducing or controlling risks posed by the site through treatment of soil COCs, engineering controls, and/or institutional controls.

The *Removal* alternative would protect human health and the environment at the upper portion of the site through removal of the potential for dermal contact, incidental ingestion, or inhalation of the COC-impacted surface and subsurface soil. Zinc was not selected as a surface soil COC for humans (i.e., concentrations are below the residential PRG). Therefore, an additional RG for protection of ecological receptors is necessary. Because sample S-039 (upper portion of the site) revealed high lead and zinc concentrations, remediation of this localized area is anticipated to improve environmental conditions. Institutional controls for COC-impacted soil located below the cliffline would be protective for that portion of the site by removing the human health exposure pathways there.

The *Soil Cover* alternative protects human health in the upper portion of the site more than the *Institutional Controls* alternative through removal (by covering) of the potential for dermal contact, incidental ingestion, or inhalation of the COC-impacted surface, but the contaminants remain at the site. Therefore, perpetual cover maintenance (and associated costs) would be required to ensure the continued level of protection.

The *Institutional Controls* alternative would be protective of human health as it would eliminate exposure to residential receptors by preventing residential development on or adjacent to the site. However, it does not protect sensitive ecological receptors because would not remove or reduce the volume of soil exceeding RGs.

The *No Action* alternative would not adequately meet the criteria for overall protection of human health and the environment, both short term and long term, from risks posed by COCs in the soil at the site. This alternative would not remove, reduce, or control the volume of soil exceeding

RGs. Since it does not meet the most important of the criteria, it was not be fully evaluated on the other eight criteria.

3.10.2 Compliance with ARARs

This threshold criterion evaluates a remedial alternative's compliance with the federal and territorial (Guam) ARARs as defined in CERCLA Section 121. The applicable ARARs are those legally enforceable federal and territorial (Guam) requirements that specifically address hazardous substances, pollutants, removal actions, locations, or other circumstances found at the impacted areas. The ARARs or TBC criteria for the site are presented in Tables 3-17 and 3-18.

The *Removal* alternative will satisfy the PRGs and RGs for soil cleanup ARARs for the upper portion of the site. Institutional controls for COC-impacted soil exceeding RGs at the lower portion of the site located below the cliffline will satisfy the soil cleanup ARARs by removing the human health exposure pathways there.

The *Soil Cover* alternative for the upper portion of the site would comply with the ARARs, but COC-impacted surface and subsurface soil exceeding RGs would remain at the site.

The *Institutional Controls* alternative would comply with the ARARs, but the COC-impacted surface and subsurface soils exceeding RGs would remain at the site.

The *No Action* alternative would not violate any ARARs, but it also would not meet the risk-based RGs.

3.10.3 Short-Term Effectiveness

This balancing criterion addresses the impact of the remedial action during the construction and start-up phase. Factors evaluated include protection of workers during the remedial actions, environmental impacts resulting from the implementation of the remedial action, and the time required to implement the proposed remedial alternative at the site.

The *Removal* alternative will provide short-term mitigation of associated human health risks by removing the identified exposure pathways in the upper portion of the site. This alternative will have some short-term effectiveness concerns due to disturbance of contaminated soils by removal contractor workers. Removal contractor workers may have slight exposure to COCs from incidental inhalation or ingestion of dust particles during excavation activities. Workers will wear appropriate protective clothing to prevent exposure. Dust suppression techniques will be applied, as conditions require.

The *Soil Cover* alternative would have similar short-term effectiveness concerns due to the potential for disturbance of contaminated soils by site workers. Remedy contractor workers may have slight exposure to COCs from incidental inhalation or ingestion of dust particles during excavation activities. Workers will wear appropriate protective clothing to prevent exposure. Dust suppression techniques would be applied, as conditions require.

The *Institutional Controls* alternative would satisfy the short-term effectiveness criterion because there would be no exposure of workers to COC-impacted soil during implementation of this alternative and because the LUCs would be put into effect quickly to control site risks.

Although active remediation is not specified, the *No Action* alternative would not be effective in the short-term because RAOs would not be achieved.

3.10.4 Long-Term Effectiveness and Permanence

This balancing criterion addresses the effectiveness of each remedial alternative over the life of the remedial action. It also assesses the results of the remedial action in terms of the risk remaining after the response objectives have been met. Particularly, the effectiveness of the controls is applied to manage the risk posed by the residual COCs in the impacted areas at the site.

The *Removal* alternative would provide long-term mitigation of associated human health risks by removing the identified exposure pathways to COC-impacted soil at the upper portion of the site. Institutional controls, deed restrictions, and associated annual O&M costs will also be necessary for the approximately 3.5 acres at the lower portion of the site located below the cliffline due to remoteness and technical infeasibility of conducting remediation below a 180-foot cliff at the lower portion of the site where COC-impacted soil exceeding RGs would remain.

The *Soil Cover* alternative at the upper portion of the site would not meet long-term effectiveness. The contaminants would be left in place and the USAF would have to maintain Site 9 indefinitely. The future use of the property would be limited because, although partially covered, COC-impacted soil exceeding RGs would remain on site.

The *Institutional Controls* alternative would be effective in the long-term for protecting human health for as long as the LUCs are maintained. The USAF would have to maintain *Institutional Controls* as long as the site cannot be utilized for unrestricted use and unlimited exposures. Future use of the property would be limited. This alternative would not be effective for mitigating ecological risks.

The *No Action* alternative would not be effective for addressing human receptor risk of exposure to COCs. There would be no controls for this alternative to manage the risks posed by the COCs in soil.

3.10.5 Reduction of Toxicity, Mobility, or Volume Through Treatment

This balancing criterion assesses how each alternative would reduce the principal threats of the total mass of COCs, provide the degree to which the treatment is irreversible in COC mobility, and/or to reduce the total volume of impacted media. Factors of this criterion that are evaluated include the treatment process, the amount of COCs destroyed or treated, the degree of reduction in toxicity, mobility, or volume expected, and the type and quantity of untreated COC residuals.

The *Removal* alternative reduces the toxicity, mobility, and volume including treatment of COC-impacted surface and subsurface soil excavated from the upper portion of the site. The TSP treatment method has been successfully used at other sites at Andersen AFB and has proven to be an effective and feasible method of stabilizing metal-impacted soil, particularly lead-contaminated soil.

The *Soil Cover* alternative at the upper portion of the site does not reduce the toxicity or volume through treatment. It does reduce mobility of the contaminants to a degree, but does not prevent downward migration because there is no liner. This alternative does not include treatment of the COC-impacted soil.

The *Institutional Controls* alternative would not reduce the toxicity, mobility, or volume through treatment of COCs in soil.

The *No Action* alternative would not reduce the toxicity, mobility, or volume of soil COCs exceeding RGs. No treatment, removal, or cover would be proposed using this alternative.

3.10.6 Implementability

This balancing criterion assesses the technical and administrative feasibility of implementing a remedial action and the availability of various services and materials required during implementation. Factors of technical feasibility include construction and operational difficulties, reliability of technology, ease of undertaking additional remedial actions, and the ability to monitor the effectiveness of the remedy.

Each of the alternatives is easily implemented at the upper portion of the site, but the removal and capping alternatives are not technically feasible to implement at the lower portion of the site located below the cliffline. Materials and equipment necessary for the removal and capping alternatives are readily available.

Excavation of soil is a proven method for soil cleanup actions at Andersen AFB and technically and administratively feasible to implement. The *Removal* alternative at the upper portion of the site would not be difficult to implement. Technically, it would not be difficult to address the surface and subsurface soil “hot spots” at the upper portion of the site. There is the possibility that some of the soil (e.g., a localized hot spot area associated with S-039) may need to be shipped off island if it is deemed as hazardous waste, pending TCLP results.

The *Soil Cover* alternative at the upper portion of the site would be technically and administratively feasible to implement.

The *Institutional Controls* alternative would be technically and administratively feasible to implement. It would require little to no technical effort, but would require greater administrative efforts due to the needed periodic site review.

The *No Action* alternative is technically simple to implement as it includes no remedial or administrative actions; however, it is not implementable in an administrative sense as it does not satisfy threshold criteria.

3.10.7 Territorial (Guam) Acceptance

This modifying criterion factor accounts for the technical and administrative issues concerning the Territory of Guam regarding each of the remedial alternatives. This factor includes the remedial actions that the territory would support, oppose, or would be concerned about. The territorial acceptance was evaluated based on comments received from the Guam EPA representatives during RPMs. The Territory of Guam has expressed its support for the *Removal* alternative. This alternative will be the most acceptable alternative for GovGuam because it allows for the least restrictive future land-use scenario for the upper portion of Site 9 and imposes little stress to the habitat in the lower portion of the site. There will still be LUCs and associated annual O&M costs for the lower portion of the site located below the cliffline where COC-impacted soil would remain.

The *Soil Cover* alternative at the upper portion of the site would be acceptable with GovGuam relative to current land use conditions. However, if the property was transferred to GovGuam in the future, additional measures may be warranted, as the potential risk for human health exposure likely would increase. Maintaining restricted access in a residential or public access area would be difficult, if not impossible.

The *Institutional Controls* alternative would be less acceptable with GovGuam relative to land use restrictions at the upper portion of the site.

The *No Action* alternative would not be acceptable with GovGuam.

3.10.8 Community Acceptance

This modifying criterion accounts for the issues and concerns the property owner and the public may have regarding each of the remedial actions. The factors included the remedial actions that the property owner or the community would support, oppose, or would be concerned about. Community Acceptance was evaluated based on comments received at the Public Meeting to present the Proposed Plan for Sites 6, 9, and 12, held on 6 April 2006. Also the public was asked for written comments during the Public Comment Period (30 March 2006-29 April 2006).

The *Removal* alternative would be the most acceptable alternative to the community because it allows for the least restrictive future land-use scenario for the upper portion of Site 9. However, there would still be LUCs and associated annual O&M for the lower portion of the site located below the cliffline where COC-impacted soil would remain. During the Public Meeting, Ms. Joanne Brown (Guam Senator and RAB member) expressed her concern with leaving contaminants in place and stated that she would prefer that the Air Force clean up the Site 9 both above and below the cliffline.

The *Soil Cover* alternative at the upper portion of the site would be acceptable to the community relative to current land use conditions. However, institutional controls would be necessary for the soil cover and would restrict future land use activities at the upper portion of the site.

The *Institutional Controls* alternative would be acceptable to the community relative to current land use conditions. However, institutional controls would be necessary for the soil cover and would restrict future land use activities at the upper portion of the site.

The *No Action* alternative would not be acceptable to the community.

The USAF has responded to the comments and concerns that were received during the Public Meeting and Public Comment Period for this ROD (see Sections 5 and 6).

3.10.9 Cost

This balancing criterion assesses the projected cost for the final list of alternatives at the conclusion of the remedial alternatives screening process. Present worth analysis allows remedial actions to be compared on the basis of a single cost representing an amount that, if invested in the base year and disbursed as needed, would be sufficient to cover all costs associated with the remedial action over its planned life. When applicable, an assumed operating performance period of 30 years was used in calculating the present worth of the alternatives. The remedial costs included capital costs and annual/long-term O&M costs. Capital costs consist of both direct and indirect costs. Direct costs include expenditures for the equipment, labor, and materials necessary to install removal actions. Indirect costs include expenditures for engineering, financial, and other services required when installing a remedial alternative at a site. Annual O&M costs include auxiliary monitoring, materials and energy required to install remedial actions, disposal of residue, purchased services, administrative costs, insurance, taxes, license costs, maintenance reserve and contingency funds, rehabilitation costs, and costs for periodic site reviews.

The total present worth costs for the alternatives, not including the *No Action* alternative, range from $231,700 for the *Institutional Controls* alternative to $457,700 for the *Removal* alternative. Summaries of the cost of each alternative can be found in Tables 3-14 through 3-16.

There would be no direct capital costs associated with the *No Action* alternative.

3.11 Principal Threat Posed by Waste

According to USEPA guidelines, treatment alternatives must be used to address the principal threats posed by any site whenever practicable. In general, the term “principal threat wastes” includes:

- Liquid source material, such as waste contained in drums, lagoons or tanks, and free product in the subsurface containing COCs.

- Mobile source material, such as surface soil or subsurface soil containing high concentrations of COCs that are mobile due to wind entrainment, volatilization, surface runoff, or subsurface transport.

- Highly-toxic source materials, such as buried drums containing non-liquid wastes, buried tanks containing non-liquid wastes, or soils containing significant concentrations of highly toxic materials (USEPA, 1999a).

Wastes that are generally considered as "non-principal threat" include:

- Non-mobile contaminated source material of low to moderate toxicity, such as surface soil containing COCs that generally are relatively immobile in air and groundwater in the specific environmental setting.

- Low toxicity source materials, such as surface soil and subsurface soil with concentrations of COCs not greatly above reference dose levels or that present an excess cancer risk near acceptable risk range (USEPA, 1999a).

As presented in Section 3.5.4 of this ROD, there was evidence of stressed vegetation and there were areas of concentrated tar and/or asphalt present at Site 9. Containers, including 55-gallon drums that were observed at Site 9, were deteriorated and empty.

The COC-impacted surface and subsurface soils at Site 9 are a non-principal threat because:

- The major COCs are metals that are relatively immobile in the alkaline conditions of the limestone formations at the site.

- The site is not currently, nor is it planned to be, a residential area.

3.12 Selected Remedy

The USAF and USEPA Region 9 co-selected the *Removal* alternative in conjunction with concurrence from the Guam EPA. The cleanup of Site 9 is currently scheduled for 2007.

3.12.1 Summary of the Rationale for the Selected Remedy

The major rationale for selecting *Removal* alternative as a remedial alternative for Site 9 is that the USAF, USEPA Region 9, and Guam EPA have agreed that this alternative would allow the unlimited use and unrestricted exposure at the upper portion of Site 9. LUCs and associated annual O&M costs will also be necessary for the approximately 3.5 acres of the site located below the cliffline due to remoteness and technical infeasibility of conducting remediation below a 180-foot cliff at the lower portion of the site where COC-impacted soil would remain.

As presented in Section 2.10 of this ROD, the *Removal* alternative has major advantages over the *Soil Cover* and the *Institutional Controls* alternatives and the *No Action* alternative. The *Removal* alternative:

- Achieves RAOs as feasible.

- Removes the non-principal threats of COC-impacted soils from the more readily accessible upper portion of the site.

- Provides a permanent solution to the non-principal threats by leaving no residual contamination at the upper portion of Site 9. However, there would still be LUCs and associated annual O&M costs for the lower portion of the site located below the cliffline where COC-impacted soil would remain.

3.12.2 Detailed Description of the Selected Remedy

A detailed description of the actions the USAF is required to perform to properly implement institutional controls and LUCs at Site 9 is provided in Table A-2 (Appendix A). Table A-2 provides a summary of: (1) site risks relevant to the selected remedy, (2) a description of the property including current and anticipated future property ownership, land use, and restrictions, (3) a description of onsite structures, (4) a description of LUC objectives, (5) a list of applicable engineering and institutional controls and other specific measures that are required to implement LUCs consistent with the selected remedy, (6) monitoring and reporting requirements, and (7) specific corrective actions to address non-compliant LUC events. The components necessary for implementation of the *Removal* alternative are summarized in the following bullets.

- Phase 1—Site Preparation, mobilization, and surveying
- Phase 2—Surface soil removal, treatment with TSP, and disposal of COC-impacted soils.
- Phase 3—Subsurface oil removal, treatment with TSP, and disposal of COC-impacted soils.
- Phase 4—Confirmation sampling, revegetation, and demobilization.
- Phase 5—Development of LUCMP and implementation of LUCs.
- Phase 6—Periodic (5 year) site reviews

Under the *Removal* alternative, both the surface and subsurface soil with COC concentrations exceeding the RGs will be excavated from the upper portion of Site 9 (area just above the steep slope or cliff face). Soil removal activities will use backhoes or other similar equipment. Excavated soil will be stockpiled in a designated area on site. Based on the concentrations of metals in subsurface soil samples collected at the site, some soil may potentially be hazardous waste. Composite soil samples will be collected from the stockpiles and analyzed for hazardous waste characteristics utilizing TCLP for lead. If the soil is not characterized as hazardous waste, the soil will be disposed of at the CU. If the material is classified as hazardous waste, the debris fill will be treated with the TSP.

The TSP treatment method is implemented by mixing TSP with the soil. The TSP stabilizes metals in soil, lowering TCLP metals concentrations, and TSP-treated soil can be disposed of as

nonhazardous waste. This method has been successfully used at other sites at Andersen AFB and has proven to be an effective and feasible method of stabilizing metal-impacted soil, particularly lead-contaminated soil. This is a viable alternative to shipping the impacted soil off island, for the TSP method essentially would lower TCLP metals concentrations to below the hazardous concentration level, thus enabling the soil to be disposed of at the CU.

For the deep excavation, additional soil would be excavated near the surface to ensure that the slope excavation is stable. This additional soil may not exceed RGs, and should be stockpiled on site and analyzed for the TAL metals to determine if soil needs disposal. Composite samples will be collected. If the soil is below the RGs, the soil will be used as backfill. Limited compaction and grading along the upper cliff face may be required. The cut and fill material will need to be sloped at not less than 1:2 or based on sound engineering recommendations.

Confirmatory sampling will be performed after excavation to verify that soil exceeding the RGs has been removed. Samples would be collected from the excavation area and analyzed for TAL metals. If analytical results demonstrate that the remaining soil still exceeds the criteria, additional soil removal and confirmatory sampling will be repeated until the appropriate levels are achieved, as feasible. A USEPA- and Guam EPA-approved SAP will be adhered to during performance of confirmatory sampling.

LUCs and associated annual O&M costs will also be necessary for the approximately 3.5 acres of the site located below the cliffline due to remoteness and technical infeasibility of conducting remediation below a 180-foot cliff at the lower portion of the site where COC-impacted soil would remain.

3.12.3 Summary of the Estimated Remedy Costs

A summary of the *Removal* alternative cost estimate is presented in Table 3-16. Implementation of this alternative is estimated to cost about $457,700 (30 year present worth). This is an engineering cost estimate that is expected to be within + 50 to –30 percent of the actual project cost. The cost information presented in Table 3-16 is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. Major changes may be documented in the form of a memorandum in the AR, in an ESD, or a ROD amendment.

3.12.4 Expected Outcome of the Selected Remedy

Currently, this property is undeveloped. Using the *Removal* alternative, the RAOs will be achieved and the upper portion of Site 9 will be clear of non-principal threats from COC-impacted soils within 2 years. This will allow for unlimited use and unrestricted exposure for the future of the upper portion of Site 9. LUCs and periodic site reviews will be performed for the lower portion of Site 9.

3.13 Statutory Determination

According to USEPA guidelines (USEPA, 1999b), the lead agency must select remedies that are protective of human health and the environment, comply with ARARs, are cost effective, and utilize permanent solutions and alternative treatment or resource recovery technologies to the maximum extent practicable. Additionally, a preference is given for remedies that permanently and significantly reduce the toxicity, volume, or mobility of hazardous waste materials.

The Selected Remedy (the *Removal* alternative) is protective of human health and the environment at the upper portion of Site 9; complies with Federal and Territory of Guam requirements that are applicable or relevant and appropriate to the remedial action; includes treatment of the excavated soil; significantly reduces the toxicity, volume, and mobility of COC-impacted surface and subsurface soil at the upper portion of the site; and is cost-effective.

Because the *Removal* alternative will result in hazardous substances, pollutants, or contaminants remaining on-site (i.e., at the lower portion of the site located below the cliffline) above levels that do not allow for unlimited use and unrestricted exposure, a five-year review will be required for this remedial action. Additionally, LUCs and associated annual O&M will also be necessary for the approximately 3.5 acres of the lower portion of the site located below the cliffline due to remoteness and technical infeasibility of conducting remediation below a 180-foot cliff at the lower portion of the site.

3.13.1 Protection of Human Health and the Environment

The *Removal* alternative would protect human health and the environment at the upper portion of Site 9. Because sample S-039 (above the cliffline) revealed high lead concentrations, remediation of this localized area is anticipated to improve environmental conditions.

3.13.2 Compliance with ARARs

The *Removal* alternative will comply with ARARs. The alternative will satisfy the PRGs and RGs for soil cleanup ARARs (Tables 3-17 and 3-18) at the upper portion of the site. LUCs and associated annual O&M costs will also be necessary for the approximately 3.5 acres at the lower portion of the site located below the cliffline due to remoteness and technical infeasibility of conducting remediation below a 180-foot cliff at the lower portion of the site where COC-impacted soil exceeding RGs would remain.

3.13.3 Cost Effectiveness

The estimated, 30-year present worth cost for the *Removal* alternative is $457,700 (Table 3-16). This includes long-term costs for implementing institutional controls in the lower portion of the site. Using TSP treatment lowers the cost of the *Removal* alternative by approximately 30 percent as it renders some lead-contaminated soil nonhazardous and reduces the associated disposal costs. From a cost perspective the *Removal* alternative would be more cost effective ($457,700) than the *Soil Cover* alternative ($400,400) and the *Institutional Controls* alternative

($231,700) as it would allow for unrestricted use and unlimited access to the upper portion of the site.

3.13.4 Utilization of Permanent Solution

Under the *Removal* alternative, COC-impacted soils exceeding RGs will be removed from the upper portion of Site 9 and disposed offsite, thereby rendering the upper portion of Site 9 suitable for unrestricted use and unlimited exposure. The lower portion of the site will be addressed through the implementation of LUCs and periodic site reviews for the mitigation of COC risks.

3.13.5 Preference for Treatment as a Principal Element

Under the *Removal* alternative, the excavated COC-impacted soils from the upper portion of Site 9 will be treated with TSP, and as such, this alternative is considered as a preferred technology.

3.13.6 Five-Year Review Requirement

Five-year reviews of this ROD will be necessary because residual contaminants will be left at the lower portion of Site 9 after implementing the *Removal* alternative, per 42 USC§9621(c) and 40 CFR 300.430(f)(5)(iii)(C).

3.14 Documentation of Significant Changes

On 29 March 2006, the Proposed Plan for the Sites 6, 9, and 12 was released to the public for review and comments, with a Public Comment Period extending from 30 March to 29 April 2006. A public meeting was held in the Holiday Resort in Tumon on 6 April 2006 to present the Proposed Plan to the public.

The same *Removal* alternative that is presented in this ROD for Site 9 was also presented in Proposed Plan and the public meeting as preferred alternative. The USAF, USEPA Region 9, and Guam EPA have agreed that the *Removal* alternative is the preferred alternative to clean up Site 9. Therefore, there are no significant changes to the remedy as originally identified in the March 2006 Proposed Plan.

TABLE 3-1. SELECTION OF EXPOSURE PATHWAYS, SITE 9, ANDERSEN AFB, GUAM.

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type Of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current	Groundwater	Groundwater	Tap Water	Commercial Worker	Adult	Ingestion	Onsite	None	No workers currently at site.
	Surface Soil	Surface Soil	Site 9	Trespasser/Occasional User	Adult	Ingestion	Onsite	Quant	Trespasser may visit the area.
						Dermal	Onsite	Quant	Trespasser may visit the area.
				Commercial Worker	Adult	Ingestion	Onsite	None	No workers are present at site.
						Dermal	Onsite	None	No workers are present at site.
		Air	Site 9	Trespasser/Occasional User	Adult	Inhalation	Onsite	Quant	Trespasser may visit the area.
				Commercial Worker	Adult	Inhalation	Onsite	None	No workers are present at site.
		Animal tissue	Wild Deer Meat	Hunter	Adult	Ingestion	Onsite	Quant	Risks are evaluated on a facility-wide basis.
					Child	Ingestion	Onsite	Quant	Risks are evaluated on a facility-wide basis.
		Animal tissue	Wild Pig Meat	Hunter	Adult	Ingestion	Onsite	Quant	Risks are evaluated on a facility-wide basis.
					Child	Ingestion	Onsite	Quant	Risks are evaluated on a facility-wide basis.
	Subsurface Soil	Subsurface Soil	Site 9	Utility Worker	Adult	Ingestion	Onsite	None	No utilities are present at site.
						Dermal	Onsite	None	No utilities are present at site.
		Air	Site 9	Utility Worker	Adult	Inhalation	Onsite	None	No utilities are present at site.
	Sediment	Sediment	Site 9	Trespasser/Occasional User	Adult	Ingestion	Onsite	None	No sediment found at site.
	Surface Water	Surface Water	Site 9	Trespasser/Occasional User	Adult	Dermal	Onsite	None	No surface water found at site.
Future	Groundwater	Groundwater	Tap Water	Resident	Adult	Ingestion	Onsite	None	Groundwater is evaluated under a separate program.
					Child	Ingestion	Onsite	None	Groundwater is evaluated under a separate program.
	Surface Soil	Surface Soil	Site 9	Resident	Adult	Ingestion	Onsite	Quant	Future use of site assumes residential exposures.
						Dermal	Onsite	Quant	Future use of site assumes residential exposures.
					Child	Ingestion	Onsite	Quant	Future use of site assumes residential exposures.
						Dermal	Onsite	Quant	Future use of site assumes residential exposures.
		Air	Site 9	Resident	Adult	Inhalation	Onsite	Quant	Future use of site assumes residential exposures.
					Child	Inhalation	Onsite	Quant	Future use of site assumes residential exposures.
	Subsurface Soil	Subsurface Soil	Site 9	Resident	Adult	Ingestion	Onsite	Quant	Future use of site assumes residential exposures.
						Dermal	Onsite	Quant	Future use of site assumes residential exposures.
					Child	Ingestion	Onsite	Quant	Future use of site assumes residential exposures.
						Dermal	Onsite	Quant	Future use of site assumes residential exposures.
				Construction Worker	Adult	Ingestion	Onsite	None	Residents are evaluated as future worst case scenario.
						Dermal	Onsite	None	Residents are evaluated as future worst case scenario.
		Air	Site 9	Resident	Adult	Inhalation	Onsite	Quant	Future use of site assumes residential exposures.
					Child	Inhalation	Onsite	Quant	Future use of site assumes residential exposures.
				Construction Worker	Adult	Inhalation	Onsite	None	Residents are evaluated as future worst case scenario.
	Sediment	Sediment	Site 9	Resident	Adult	Ingestion	Onsite	None	No sediment found at site.
	Surface Water	Surface Water	Site 9	Resident	Child	Ingestion	Onsite	None	No surface water found at site.

TABLE 3-2. SUMMARY OF CONTAMINANTS OF CONCERN AND MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATIONS FOR SURFACE SOIL, SITE 9, ANDERSEN AFB, GUAM.

Scenario Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil

Exposure Point	COC	Concentration Detected		Units	BTV	Residential PRG	Industrial PRG	Frequency of Detection	EPC	Statistical Measure
		Min	Max							
Site 9	Antimony	0.21	266	ppm	63	31	**410**	25/30	114	95% UCL-T
	Chromium, Total	1	1,110	ppm	**1,080**	210	450	52/52	226	95% UCL-T
	Copper	8.6	4,180	ppm	72.2	3,100	**41,000**	30/30	4,036	95% UCL-T
	Benzo(a)pyrene	0.00102	1.2707	ppm	NA	0.062	**0.21**	45/51	0.91	95% UCL-T

Key
Bold/Shaded: Higher of BTV & Industrial PRG (USEPA, 2004)
BTV: Background Threshold Value
COC: Contaminant of concern
EPC: Exposure point concentration
Max: Maximum concentration
Min: Minimum concentration
ppm: Parts per million
PRG: USEPA Region 9 Preliminary Remediation Goal
USEPA: U.S. Environmental Protection Agency
95% UCL-T: 95% Upper Confidence Limit of Log-transformed Data

The table presents the COCs and EPC for each of the COCs detected in surface soil (i.e., the concentration that was used to estimate the exposure and risk from each COC in the surface soil). The table includes the range of concentrations detected for each COC, as well as the frequency of detection (i.e., the number of times the chemical was detected in the samples collected at the surface site), the EPC, and how the EPC was derived. The table indicates that total chromium is the most frequently detected COC in soil at the site. The 95%UCL of Log-transformed Data was used as the EPC for antimony, total chromium, copper, and benzo(a)pyrene.

TABLE 3-3. SUMMARY OF CONTAMINANTS OF CONCERN AND MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATIONS FOR SUBSURFACE SOIL, SITE 9, ANDERSEN AFB, GUAM.

Scenario Timeframe: Current/Future
Medium: Subsurface Soil
Exposure Medium: Subsurface Soil

Exposure Point	COC	Concentration Detected		Units	BTV	Residential PRG	Industrial PRG	Frequency of Detection	EPC	Statistical Measure
		Min	Max							
Site 9	Antimony	3.7	73.5	ppm	63	31	**410**	5/5	73.5	Max [1]
	Copper	222	4,230	ppm	72.2	3,100	**41,000**	5/5	4,230	Max [1]
	Lead	0.3	7,510	ppm	166	400	**800**	12/12	7,510	Max [1]

Key
Bold/Shaded: Higher of BTV & Industrial PRG (USEPA, 2004)
BTV: Background Threshold Value
COC: Contaminant of concern
EPC: Exposure point concentration
Max: Maximum concentration
Min: Minimum concentration
ppm: Parts per million
PRG: USEPA Region 9 Preliminary Remediation Goal
USEPA: U.S. Environmental Protection Agency
1: 95% UCL exceeds maximum detected concentration. Therefore, maximum concentration used for EPC.

The table presents the COCs and EPC for each of the COCs detected in surface soil (i.e., the concentration that was used to estimate the exposure and risk from each COC in the surface soil). The table includes the range of concentrations detected for each COC, as well as the frequency of detection (i.e., the number of times the chemical was detected in the samples collected at the surface site), the EPC, and how the EPC was derived. The table indicates that lead is the most frequently detected COC in soil at the site. Because the 95% UCL exceeded the maximum detected concentration for antimony, copper, and lead, the maximum concentration was used as the default EPC for these COC.

TABLE 3-4. SUMMARY OF SURFACE SOIL HHRA RESULTS FOR FUTURE RESIDENT CHILDREN UNDER REASONABLE MAXIMUM EXPOSURE, SITE 9, ANDERSEN AFB, GUAM.

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk[1]				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Site 9	ANTIMONY	--	--	--	--	ANTIMONY	blood	3.6E+00	--	--	3.6E+00
			CHROMIUM, TOTAL	--	--	--	--	CHROMIUM, TOTAL		9.6E-01	--	--	9.6E-01
			COPPER	--	--	--	--	COPPER	GI System	1.4E+00	--	--	1.4E+00
			LEAD	--	--	--	--	LEAD		--	--	--	--
			BENZO[A]PYRENE	4.5E-06	--	1.8E-06	6.3E-06	BENZO[A]PYRENE		--	--	--	--
			BENZO[B]FLUORANTHENE	6.5E-07	--	2.7E-07	9.2E-07	BENZO[B]FLUORANTHENE		--	--	--	--
			INDENO[1,2,3-C,D]PYRENE	5.3E-07	--	2.2E-07	7.5E-07	INDENO[1,2,3-C,D]PYRENE		--	--	--	--
			(Total)	5.68E-06	--	2.29E-06	7.97E-06	(Total)		5.96E+00	--	--	5.96E+00
	Air	Site 9	ANTIMONY	--	--	--	--	ANTIMONY		--	--	--	--
			CHROMIUM, TOTAL	--	5.7E-06	--	5.7E-06	CHROMIUM, TOTAL		--	--	--	--
			COPPER	--	--	--	--	COPPER		--	--	--	--
			LEAD	--	--	--	--	LEAD		--	--	--	--
			BENZO[A]PYRENE	--	1.7E-09	--	1.7E-09	BENZO[A]PYRENE		--	--	--	--
			BENZO[B]FLUORANTHENE	--	2.5E-10	--	2.5E-10	BENZO[B]FLUORANTHENE		--	--	--	--
			INDENO[1,2,3-C,D]PYRENE	--	2.0E-10	--	2.0E-10	INDENO[1,2,3-C,D]PYRENE		--	--	--	--
			(Total)	--	5.70E-06	--	5.70E-06	(Total)		--	--	--	--
						Total Risk Across Medium	1.37E-05					Total Hazard Index Across All Media and All Exposure Routes	5.96E+00

(1) Carcinogenic risks are combined for Resident Adults and Children.

Total blood HI =	3.6E+00
Total GI System HI =	1.4E+00

The carcinogenic portion of this table provides risk estimates for the significant routes of exposure. These risk estimates are based on a reasonable maximum exposure and were developed by taking into account various conservative assumptions about the frequency and duration of a child's exposure to soil and groundwater, as well as the toxicity of the COCs. The combined total risk from direct exposure to contaminated soil at this site to a current/future adult and children resident is estimated to be 1.4E-05. This risk level indicates that if no clean-up action is taken, an individual would have an increased probability of 1.4 in 100,000 of developing cancer as a result of site-related exposure to the COCs.

The non-carcinogenic portion of this table provides hazard quotients (HQs) for each route of exposure and the hazard index (sum of hazard quotients) for all routes of exposure. The Risk Assessment Guidance (RAGS) for Superfund states that, generally, a hazard index (HI) greater than 1 indicates the potential for adverse noncancer effects. The estimated HI of 6 indicates that the potential for adverse noncancer effects could occur from exposure to contaminated soil containing antimony, total chromium, copper.

TABLE 3-5. SUMMARY OF SUBSURFACE SOIL HHRA RESULTS FOR FUTURE RESIDENT CHILDREN UNDER REASONABLE MAXIMUM EXPOSURE, SITE 9, ANDERSEN AFB, GUAM.

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk (1)				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Subsurface Soil	Subsurface Soil	Site 09	ANTIMONY	--	--	--	--	ANTIMONY	blood	2.3E+00	--	--	2.3E+00
			COPPER	--	--	--	--	COPPER	GI System	1.5E+00	--	--	1.5E+00
			LEAD	--	--	--	--	LEAD		--	--	--	--
			BENZO[A]PYRENE	5.4E-07	--	2.2E-07	7.6E-07	BENZO[A]PYRENE		--	--	--	--
			DDE	4.0E-07	--	3.8E-08	4.38E-07	DDE		--	--	--	--
			(Total)	9.40E-07	--	2.58E-07	1.20E-06	(Total)		3.80E+00			3.80E+00
	Air	Site 09	ANTIMONY	--	--	--	--	ANTIMONY		--	--	--	--
			COPPER	--	--	--	--	COPPER		--	--	--	--
			LEAD	--	--	--	--	LEAD		--	--	--	--
			BENZO[A]PYRENE	--	2.1E-10	--	2.1E-10	BENZO[A]PYRENE		--	--	--	--
			DDE	--	3.6E-10	--	3.6E-10	DDE		--	--	--	--
			(Total)	--	5.70E-10	--	5.70E-10	(Total)		--	--	--	--
						Total Risk Across Medium	1.20E-06					Total Hazard Index Across All Media and All Exposure Routes	3.80E+00

(1) Carcinogenic risks are combined for Resident Adults and Children.

Total blood HI =	2.3E+00
Total GI System HI =	1.5E+00

The carcinogenic portion of this table provides risk estimates for the significant routes of exposure. These risk estimates are based on a reasonable maximum exposure and were developed by taking into account various conservative assumptions about the frequency and duration of a child's exposure to soil and groundwater, as well as the toxicity of the COCs. The combined total risk from direct exposure to contaminated soil at this site to a current/future adult and children resident is estimated to be 1.2E-06. This risk level indicates that if no clean-up action is taken, an individual would have an increased probability of 1.2 in 1,000,000 of developing cancer as a result of site-related exposure to the COCs.

The non-carcinogenic portion of this table provides hazard quotients (HQs) for each route of exposure and the hazard index (sum of hazard quotients) for all routes of exposure. The Risk Assessment Guidance (RAGS) for Superfund states that, generally, a hazard index (HI) greater than 1 indicates the potential for adverse noncancer effects. The estimated HI of 3.8 indicates that the potential for adverse noncancer effects could occur from exposure to contaminated soil containing antimony and copper.

TABLE 3-6. ECOLOGICAL CONTAMINANTS OF CONCERN FOR SITE 9, ANDERSEN AFB, GUAM.

Analyte	Ecological Screening Value (mg/kg)	Range of Detections	Frequency of Detection	Samples Greater Than Screen	Outliers That Exceed Bulk of Samples	COC	Rationale For Selection
INORGANIC COMPOUNDS							
ALUMINUM	173500	251 - 107000	30/30	0/30		No	BSL
ANTIMONY	63	0.21 - 266	25/30	1/30	Yes	**Yes**	ASL
ARSENIC	62	0.87 - 20.6	29/30	0/30		No	BSL
BARIUM	335	4.8 - 563	30/30	1/30	Yes	**Yes**	ASL
BERYLLIUM	3.4	0.12 - 3.1	26/30	0/30		No	BSL
CADMIUM	6.5	0.94 - 180	30/30	12/30	Yes	**Yes**	ASL
CALCIUM METAL	N/A	47600 - 371000	30/30	0/30		No	NUT
CHROMIUM, TOTAL	1080	1 - 1110	52/52	1/52	Yes	**Yes**	ASL
COBALT	70	1 - 52.7	30/30	0/30		No	ASL
COPPER	72	8.6 - 4180	30/30	20/30	Yes	**Yes**	ASL
CYANIDE	11	0.13 - 1.81	51/52	2/52		No	ASL
IRON	N/A	302 - 350000	30/30	0/30		No	NUT
LEAD	166	9.1 - 13700	52/52	32/52	Yes	**Yes**	ASL
MAGNESIUM	N/A	1180 - 6090	30/30	0/30		No	NUT
MANGANESE	3150	186 - 2340	30/30	0/30		No	BSL
MERCURY (INORGANIC)	2.2	0.07 - 0.82	30/30	0/30		No	ASL
NICKEL	243	1.4 - 833	30/30	1/30	Yes	**Yes**	ASL
POTASSIUM	N/A	97.8 - 1840	26/30	0/30		No	NUT
SELENIUM	3.3	1.2 - 1.2	1/30	0/30		No	BSL
SILVER	14.9	0.7 - 36.1	19/30	2/30	Yes	**Yes**	ASL
SODIUM	N/A	85.7 - 828	29/30	0/30		No	NUT
THALLIUM	1.4	0.111 - 1	19/30	0/30		No	BSL
VANADIUM	206	1.2 - 40.6	28/30	0/30		No	BSL
ZINC	130	9.8 - 19400	30/30	22/30	Yes	**Yes**	ASL
POLYCYCLIC AROMATIC HYDROCARBONS (PAHs)							
ANTHRACENE	21	0.00045 - 0.1251	22/51	N/A		N/A	N/A
BENZ[A]ANTHRACENE	21	0.00056 - 0.3132	44/51	N/A		N/A	N/A
BENZO[A]PYRENE	21	0.00102 - 1.2707	45/51	N/A		N/A	N/A
BENZO[B]FLUORANTHENE	21	0.00281 - 1.6855	43/51	N/A		N/A	N/A
BENZO[G,H,I]PERYLENE	21	0.118 - 0.748	8/51	N/A		N/A	N/A
BENZO[K]FLUORANTHENE	21	0.0005 - 0.6518	44/51	N/A		N/A	N/A
CHRYSENE	21	0.00099 - 0.5106	45/51	N/A		N/A	N/A
DIBENZ[A,H]ANTHRACENE	21	0.00083 - 0.1221	34/51	N/A		N/A	N/A
FLUORANTHENE	21	0.0007 - 0.4404	42/51	N/A		N/A	N/A
INDENO[1,2,3-C,D]PYRENE	21	0.00164 - 1.0832	44/51	N/A		N/A	N/A
PYRENE	21	0.00052 - 0.3989	37/45	N/A		N/A	N/A
Total PAH	21	0.05292 - 6.7592	47/52	0/52		No	BSL
POLYCHLORINATED BIPHENYLS (PCBs)							
AROCLOR-1016	N/A	0.01778 - 0.01778	1/30	N/A		N/A	N/A
AROCLOR-1260	N/A	0.00287 - 0.1079	23/30	N/A		N/A	N/A
Total PCB *	1.1	0.00454 - 0.109665	23/30	0/30		No	BSL
PESTICIDES							
ALPHA-CHLORDANE	6.25	0.00023 - 0.0403	15/52	0/52		N/A	N/A
ALPHA-HCH	1	0.00015 - 0.00134	4/51	N/A		N/A	N/A
BETA-HCH	1	0.0002 - 0.00316	10/51	N/A		N/A	N/A
DELTA-BHC	1	0.00012 - 0.00034	4/52	N/A		N/A	N/A
GAMMA-HCH (LINDANE)	1	0.00011 - 0.02914	12/52	N/A		N/A	N/A
Total HCH/BHC	1	0.000255 - 0.029985	17/52	0/52		No	BSL
DDD	2	0.00042 - 5.605	31/52	N/A		N/A	N/A
DDE	2	0.00042 - 1.311	45/52	N/A		N/A	N/A
DDT	2	0.00071 - 10.96	42/52	N/A		N/A	N/A
Total DDT	2	0.00098 - 11.122	45/52	2/52	Yes	**Yes**	ASL
ALDRIN	0.18	0.00024 - 0.00108	5/52	0/52		No	BSL
DIELDRIN	0.011	0.00015 - 0.0138	14/52	1/52	Yes	**Yes**	ASL
ENDOSULFAN I	0.18	0.00016 - 0.00404	7/52	0/52		No	BSL
ENDOSULFAN II	0.18	0.00047 - 0.0142	10/52	0/52		No	BSL
ENDOSULFAN SULFATE	0.18	0.00029 - 0.0254	9/52	0/52		No	BSL
ENDRIN	0.03	0.00012 - 0.00264	8/52	0/52		No	BSL
ENDRIN ALDEHYDE	0.03	0.00094 - 0.0278	5/47	0/47		No	BSL
GAMMA-CHLORDANE	6.25	0.000241 - 0.01095	6/52	0/52		No	BSL
HEPTACHLOR	6.25	0.00065 - 0.00065	1/52	0/52		No	BSL
HEPTACHLOR EPOXIDE	6.25	0.00029 - 0.00217	6/52	0/52		No	BSL
METHOXYCHLOR	6.25	0.0004 - 0.0136	16/52	0/52		No	BSL
SEMIVOLATILE ORGANIC COMPOUNDS (SVOCs)							
2,4-DINITROTOLUENE	1	10.6 - 10.6	1/52	1/52	Yes	**Yes**	ASL
2,6-DINITROTOLUENE	1	0.662 - 0.662	1/52	0/52		No	BSL
BENZOIC ACID	N/A	0.423 - 0.423	1/50	0/50	No	**Yes**	No Screening Value
BENZYL ALCOHOL	N/A	0.354 - 0.528	2/52	0/52	No	**Yes**	No Screening Value
BIS(2-CHLOROETHYL)ETHER	N/A	1.39 - 1.54	2/48	0/48	Yes	**Yes**	No Screening Value
BIS(2-ETHYLHEXYL)PHTHALATE	30	0.204 - 0.573	2/52	N/A		No	BSL
DIBUTYLPHTHALATE	30	0.13 - 0.13	1/52	N/A		No	BSL
Total Phthalates	30	0.20315 - 0.6431	3/52	0/52		No	BSL
N-NITROSODIPHENYLAMINE	20	1.3 - 1.3	1/52	0/52		No	BSL
VOLATILES ORGANIC COMPOUND (VOCs)							
METHYLENE CHLORIDE	N/A	0.0011 - 0.0018	5/5	0/5	No	**Yes**	No Screening Value

COC = Contaminant of concern
N/A = Not applicable
Total concentration used for PAHs, PCB's, DDT, and HCH/BHC
ASL = Above Screening Level
BSL = Below Screening Level
NUT = Nutrient

TABLE 3-7. ECOLOGICAL RISK ASSESSMENT ENDPOINTS FOR SITE 9, ANDERSEN AFB, GUAM.

Assessment Endpoint	Null Hypothesis	Measurement Endpoint	Specifics of Assessment
Ecological health of terrestrial plant communities	Soils are not exhibiting a detrimental effect on population plant survival and growth.	Evaluation of soil chemistry with respect to vegetation toxicity values	• Comparison of soil concentrations to vegetation toxicity values.
Ecological health of terrestrial invertebrate communities	Soils are not exhibiting a detrimental effect on invertebrate population survival and growth.	Evaluation of soil chemistry with respect to soil invertebrate toxicity values	• Comparison of soil concentrations to soil invertebrate toxicity values.
Long-term health and reproductive capacity of omnivorous avian species (Mariana crow)	Ingestion of COPC in prey does not have a negative impact on growth, survival, and reproductive success of the species.	Evaluation of dose in prey based on surface soil, fruit, and reptile data in dietary exposure models	• The risk associated with the calculated dose will be evaluated by comparison to Toxicity Reference Values (TRVs). • Fruit and reptile dose approximated using measured concentrations and other appropriate exposure assumptions.
Long-term health and reproductive capacity of carnivorous avian species (yellow bittern)	Ingestion of COPC in prey does not have a negative impact on growth, survival, and reproductive success of the species.	Evaluation of dose in prey based on surface soil and reptile data in dietary exposure models	• The risk associated with the calculated dose will be evaluated by comparison to TRVs. • Reptile dose approximated using measured concentrations and other appropriate exposure assumptions.
Long-term health and reproductive capacity of threatened and endangered fruitivorous mammalian species (Mariana fruit bat)	Ingestion of COPC in food does not have a negative impact on growth, survival, and reproductive success individual organisms.	Evaluation of dose in prey based on surface soil and fruit data in dietary exposure models	• The risk associated with the calculated dose will be evaluated by comparison to TRVs. • Fruit dose approximated using measured concentrations and other appropriate exposure assumptions.

TABLE 3-8. SUMMARY OF ERA RESULTS FOR SITE 9, ANDERSEN AFB, GUAM.

Assessment Endpoint	Measurement Endpoint	Result
Ecological health of terrestrial plant communities	Evaluation of soil chemistry with respect to vegetation toxicity values	• EQ is less than 1.0 for barium, cadmium, and 2,4-dinitrotoluene, indicating acceptable plant risk levels from these COPCs. • EQ is between 1 and 29 for antimony, chromium, nickel, and silver; however, representative exposure concentrations were less than representative background concentrations of these same metals. This would indicate that plants at Site 09 have adapted for the concentrations of these metals found in the unique geology of northern Guam. Risk to vegetation from these metals is *deminimus*. • EQ is greater than 1.0 for copper, lead, and zinc, and representative concentrations of these metals at Site 09 exceeded background concentrations, indicating a potential for risk to plants. • No screening values were found for most of the organic COPCs; however, the low concentrations of these chemicals at Site 09 are not expected to cause any adverse effects.
Ecological health of terrestrial invertebrate communities	Evaluation of soil chemistry with respect to soil invertebrate toxicity values	• EQ for barium, cadmium, chromium, copper, lead, nickel, silver, DDD, DDE, DDT, and dieldrin were all less than 1.0, indicating acceptable invertebrate risk levels. • Copper and zinc may be potential risks with hazard quotients above 1.0 (18 and 22, respectively). • No screening values were found for most of the organic COPCs; however, the low concentrations of these chemicals at Site 09 are not expected to cause any adverse effects.
Long-term health and reproductive capacity of omnivorous avian species (Mariana crow)	Evaluation of dose in prey based on surface soil, fruit, and reptile data in dietary exposure models	• NOAEL HQ for barium, cadmium, chromium, copper, nickel, zinc, total DDT, and dieldrin were less than 1.0, indicating that the Mariana crow risks from these inorganics and organics are acceptable, and no further evaluation is necessary. • HQ was greater than 1.0 (4.21) for lead exposure to the omnivorous Mariana crow. Risk may exist from exposure to lead. • No screening values were found for most of the volatile and semivolatile organic chemicals; however, concentrations found at Site 09 are low and are not expected to cause adverse effects.
Long-term health and reproductive capacity of carnivorous avian species (yellow bittern)	Evaluation of dose in prey based on surface soil and reptile data in dietary exposure models	• NOAEL HQ for all COPCs was less than 1.0 except lead, indicating that the yellow bittern risks from these metals are acceptable. • HQ was greater than 1.0 (7.5) for lead exposure to the carnivorous yellow bittern. There may be a risk to the yellow bittern from exposure to lead.

TABLE 3-8. SUMMARY OF ERA RESULTS FOR SITE 9, ANDERSEN AFB, GUAM.

Assessment Endpoint	Measurement Endpoint	Result
Long-term health and reproductive capacity of threatened and endangered fruitivorous mammalian species (Mariana fruit bat)	Evaluation of dose in prey based on surface soil and fruit data in dietary exposure models	• NOAEL HQ for barium, cadmium, chromium, copper, lead, nickel, zinc, total DDT, and dieldrin were less than 1.0, indicating that the Mariana fruit bat risks from these inorganics and organics are acceptable and no further evaluation is necessary. • The NOAEL HQ for antimony was slightly greater than 1.0 (1.63) for the Mariana fruit bat; however, the representative site antimony concentration (36 mg/kg) is less than the representative Andersen AFB background concentration (63 mg/kg). This indicates that risks to the Mariana fruit bat from antimony are acceptable. • No screening values were found for most of the volatile and semivolatile organic chemicals; however, concentrations found at Site 09 are low, and are not expected to cause adverse effects.

TABLE 3-9. FOOD-WEB RISK RESULTS FOR THE MARIANA CROW FOR SITE 9, ANDERSEN AFB, GUAM.

Analyte	Mean			Soil Bioavailability [3]	Area Use Factor [3]	Dose				TRV [4]		NOAI
	Soil (mg/kg)	Fruit [1] (mg/kg)	Reptile [2] (mg/kg)			Soil	Fruit	Reptile	Total	NOAEL	LOAEL	
						mg/kg-bw/day						
Antimony	36.0	0.04	0.04	1	1	0.0431	0.0042	0.0042	0.0515	ND	ND	NC
Barium	93.0	0.23	0.23	1	1	0.1113	0.0242	0.0242	0.1596	20.8	41.7	0.01
Cadmium	9.0	0.04	0.227	1	1	0.0108	0.0042	0.0238	0.0388	1.45	20	0.03
Chromium	144.0	3.07	1.1	1	1	0.1724	0.3224	0.1155	0.6102	1	5	0.61
Copper	1128.0	3.1	5	1	1	1.3502	0.3255	0.5250	2.2007	47	61.7	0.05
Lead	2718.0	0.0717	14.2	1	1	3.2534	0.0075	1.4910	4.7520	1.13	11.3	**4.21**
Nickel	43.0	0.637	0.846	1	1	0.0515	0.0669	0.0888	0.2072	77.4	107	0.00
Silver	11.80	0.22	0.394	1	1	0.0141	0.0231	0.0414	0.0786	ND	ND	NC
Zinc	2590	5.84	36.8	1	1	3.1002	0.6132	3.8640	7.5774	14.5	131	0.52
Total DDT	0.7	0.005	0.005	1	1	0.0008	0.0005	0.0005	0.0019	0.0028	0.028	0.67
Dieldrin	0.0004	0.0017	0.0017	1	1	0.0000	0.0002	0.0002	0.0004	0.077	0.77	0.00
2,4-Dinitrotoluene	0.1	0.034	0.034	1	1	0.0001	0.0036	0.0036	0.0073	ND	ND	NC
Benzoic Acid	0.17	0.07	0.07	1	1	0.0002	0.0074	0.0074	0.0149	ND	ND	NC
Benzyl Alcohol	0.09	0.033	0.033	1	1	0.0001	0.0035	0.0035	0.0070	ND	ND	NC
Bis(2-chloroethyl)ether	0.12	0.04	0.04	1	1	0.0001	0.0042	0.0042	0.0085	ND	ND	NC
Methylene Chloride	0.0013	0.0005	0.0005	1	1	0.0000	0.0001	0.0001	0.0001	ND	ND	NC

Additional model parameters [5]: diet soil fraction = 0.02; food ingestion rate = 0.21 kg/kg-bw/day;
% dry matter in fruit = 23 and reptiles = 34 (combined % dry matter in food = 28.5)

Food web Model Calculations:

Dose Soil = soil mean X soil bioavailability X area use factor X fraction soil X food ingestion rate X 0.285 combined fraction dry weight in food

Dose Fruit = fruit mean X area use factor X food ingestion rate X 0.5 fraction fruit in diet

Dose Reptile = reptile mean X area use factor X food ingestion rate X 0.5 fraction reptiles in diet

Dose Total = Dose Soil + Dose Reptile + Dose Fruit

Notes:

(1) Fruit mean concentrations from EA (1995)

(2) Reptile mean concentrations from EA (1995)

(3) Soil bioavailability and area use factor conservatively assumed to be 100%

(4) NOAEL and LOAEL TRVs from Sample et al. (1996)

(5) Diet soil fraction, food ingestion rate, and % dry matter in reptiles and fruit based on USEPA (1

ND = No Data, NC = Not Calculated

TABLE 3-10. FOOD-WEB RISK RESULTS FOR THE YELLOW BITTERN FOR SITE 9, ANDERSEN AFB, GUAM.

Analyte	Mean		Soil Bioavailability [2]	Area Use Factor [2]	Dose			TRV [3]		HQ	
	Soil (mg/kg)	Reptile [1] (mg/kg)			Soil	Reptile	Total	NOAEL	LOAEL	NOAEL	LOAEL
					mg/kg-bw/day						
Antimony	36.0	0.04	1	1	0.0636	0.0104	0.0740	ND	ND	NC	NC
Barium	93.0	0.23	1	1	0.1644	0.0598	0.2242	20.8	41.7	0.01	0.01
Cadmium	9.0	0.227	1	1	0.0159	0.0590	0.0749	1.45	20	0.05	0.00
Chromium (total)	144.0	1.1	1	1	0.2546	0.2860	0.5406	1	5	0.54	0.11
Copper	1128.0	5	1	1	1.9943	1.3000	3.2943	47	61.7	0.07	0.05
Lead	2718.0	14.2	1	1	4.8054	3.6920	8.4974	1.13	11.3	**7.52**	0.75
Nickel	43.0	0.846	1	1	0.0760	0.2200	0.2960	77.4	107	0.00	0.00
Silver	11.80	0.394	1	1	0.0209	0.1024	0.1233	ND	ND	NC	NC
Zinc	2590	36.8	1	1	4.5791	9.5680	14.1471	14.5	131	0.98	0.11
Total DDT	0.7	0.005	1	1	0.0012	0.0013	0.0025	0.0028	0.028	0.91	0.09
Dieldrin	0.0004	0.0017	1	1	0.0000	0.0004	0.0004	0.077	0.77	0.01	0.00
2,4-Dinitrotoluene	0.1	0.034	1	1	0.0002	0.0088	0.0090	ND	ND	NC	NC
Benzoic Acid	0.17	0.07	1	1	0.0003	0.0182	0.0185	ND	ND	NC	NC
Benzyl Alcohol	0.09	0.033	1	1	0.0002	0.0086	0.0087	ND	ND	NC	NC
Bis(2-chloroethyl)ether	0.12	0.04	1	1	0.0002	0.0104	0.0106	ND	ND	NC	NC
Methylene Chloride	0.0013	0.0005	1	1	0.0000	0.0001	0.0001	ND	ND	NC	NC

Additional model parameters [4]: diet soil fraction = 0.02; food ingestion rate = 0.26 kg/kg-bw/day;
% dry matter in reptiles = 34

Food web Model Calculations:

Dose Soil = soil mean X soil bioavailability X area use factor X fraction soil X food ingestion rate X 0.34 fraction dry weight in food

Dose Reptile = reptile mean X area use factor X food ingestion rate

Dose Total = Dose Soil + Dose Reptile

Notes:

(1) Reptile mean concentrations from EA (1995)

(2) Soil bioavailability and area use factor conservatively assumed to be 100%

(3) NOAEL and LOAEL TRVs from Sample et al. (1996)

(4) Diet soil fraction, food ingestion rate, and % dry matter in reptile based on USEPA (1993)

ND = No Data NC = Not Calculated

TABLE 3-11. FOOD-WEB RISK RESULTS FOR THE MARIANA FRUIT BAT FOR SITE 9, ANDERSEN AFB, GUAM.

Analyte	Mean		Soil Bioavailability [2]	Area Use Factor [2]	Dose			TRV [3]	
	Soil (mg/kg)	Fruit [1] (mg/kg)			Soil	Fruit	Total	NOAEL	LOAEL
					mg/kg-bw/day				
Antimony	36.0	0.04	1	1	0.0828	0.0200	0.1028	0.063	0.63
Barium	93.0	0.23	1	1	0.2139	0.1150	0.3289	4.78	18.6
Cadmium	9.0	0.04	1	1	0.0207	0.0200	0.0407	0.94	9.4
Chromium (total)	144.0	3.07	1	1	0.3312	1.5350	1.8662	2564.00	ND
Copper	1128.0	3.1	1	1	2.5944	1.5500	4.1444	14.3	18.8
Lead	2718.0	0.0717	1	1	6.2514	0.0359	6.2873	7.5	75
Nickel	43.0	0.637	1	1	0.0989	0.3185	0.4174	37.5	75
Silver	11.80	0.22	1	1	0.0271	0.1100	0.1371	ND	ND
Zinc	2590	5.84	1	1	5.9570	2.9200	8.8770	150	300
Total DDT	0.7	0.005	1	1	0.0016	0.0025	0.0041	0.7500	3.75
Dieldrin	0.0004	0.0017	1	1	0.0000	0.0009	0.0009	0.0190	0.19
2,4-Dinitrotoluene	0.1	0.034	1	1	0.0002	0.0170	0.0172	ND	ND
Benzoic Acid	0.17	0.07	1	1	0.0004	0.0350	0.0354	ND	ND
Benzyl Alcohol	0.09	0.033	1	1	0.0002	0.0165	0.0167	ND	ND
Bis(2-chloroethyl)ether	0.12	0.04	1	1	0.0003	0.0200	0.0203	ND	ND
Methylene Chloride	0.0013	0.0005	1	1	0.0000	0.0003	0.0003	ND	ND

Additional model parameters [4]: diet soil fraction = 0.02 mg/kg-bw/day; food ingestion rate = 0.5 kg/kg-bw/day;
% dry matter in fruit = 23

Foodweb Model Calculations:

Dose Soil = soil mean X soil bioavailability X area use factor X fraction soil X food ingestion rate X 0.23 fraction dry weight in food (fruit)

Dose Fruit = fruit mean X area use factor X food ingestion rate

Dose Total = Dose Soil + Dose Fruit

Notes:

(1) Fruit mean concentrations from EA (1995)

(2) Soil bioavailability and area use factor conservatively assumed to be 100%

ND = No Data, NC = Not Calculated

(3) NOAEL and LOAEL TRVs calculated allometrically (Sample et a

(4) Diet soil fraction, food ingestion rate, and % dry matter in fruit ba

TABLE 3-12. SUMMARY OF CLEANUP STANDARDS FOR SITE 9, ANDERSEN AFB, GUAM.

Future Site Users	Cleanup Matrix	COC	PRG Residential (mg/kg)	PRG Industrial (mg/kg)	BTV (mg/kg)	RG (mg/kg)
Resident Adults and Children	**Surface Soil**	Lead	400	800	166	**400##**
		Antimony	31.3	410	63	**63#**
		Copper	3,100	41,000	72	**3,100***
		Chromium	210	450	1,080	**1,080#**
		Benzo(a)pyrene	0.62	N/A	N/A	**1.4****
Resident Adults and Children	**Subsurface Soil**	Lead	400	800	166	**400##**
		Antimony	31.3	N/A	63	**63#**
		Copper	3,100	41,000	72	**3,100***
						Total Cleanup Volume

Notes: COC = contaminant of concern; BTV = background threshold value; PRG = 2004 USEPA Region 9 Preliminary Remediation Goal; RG = Remediation Goal; mg/kg = milligrams per kilogram; N/A=not applicable; # = RG based on BTV; ## = RG based on OSWER Directive/IEUBK Model; * = RG based on PRG non-cancer risks; ** = RG based on 10-5 cancer risk; *** = RG based on ecological risks

Surface cleanup volumes are estimated based on Best Professional Judgment and experience gained during former removal projects at Andersen AFB for 1-foot-deep excavations.

Subsurface soil cleanup volume is estimated based on a depth 4 feet below ground surface (bgs), 30 feet in diameter.

TABLE 3-13. SUMMARY OF CLEANUP VOLUMES FOR THE REMOVAL ALTERNATIVE AT SITE 9, ANDERSEN AFB, GUAM.

Future Site Users	Cleanup Matrix	COC	RG (mg/kg)	Cleanup Sample Locations	Estimated COC Total Cleanup Area (sq ft)	Estimated COC Total Cleanup Volume (bcy)	Estimated COC Cleanup Area Above Cliffline Only (sq ft)	Estimated COC Cleanup Volume Above Cliffline	
								(bcy)	(lcy)
Resident Adults and Children	**Surface Soil**	Lead	400##	S-003, S-004, S-006, S-007, S-008, S-009, S-010, S-011, S-012, S-013, S-014, S-015, S-017, S-018, S-019, S-020, S-021, S-023, S-025, S-038, S-039, S-052, S-053, S-061, S-066, S-070, S-071, S-073, S-074	115,870	**4,290**	8,480	**315**	**410**
		Antimony	63#	S-039					
		Copper	3,100*	S-025					
		Chromium	1,080#	S-018					
		Benzo(a)pyrene	1.4**	S-037, S-076, S-078, S-021, S-025, S-067, S-012, S-068, S-006, S-018, S-070, S-013, S-071, S-004, S-014, S-054, S-003, S-064, S-066, S-011, S-010, S-052, S-053, S-073, S-078, S-007, S-078, S-074, S-075					
Resident Adults and Children	**Subsurface Soil**	Lead	400##	S-016, S-027, S-029, S-030, S-031, S-032, S-043, S-051, S-060, S-082	31,090	**1,150**	2,830	**105**	**140**
		Antimony	63#	S-033					
		Copper	3,100*	S-033					
				Total Cleanup Volume		**5,440**		**420**	**550**

Notes: COC = contaminant of concern; sq ft = square feet; bcy = bank cubic yard; lcy = loose cubic yard (assuming 30% "fluff" factor), # = RG based on BTV, ## = RG based on OSW Directive/IEUBK Model, * = RG based on PRG non-cancer risks, ** = based on 10E-05 cancer risk
Surface cleanup volumes are estimated based on Best Professional Judgment and experience gained during former removal projects at Andersen AFB for 1-foot-deep excavations.
Subsurface soil cleanup volume is estimated based on a depth 4 feet below ground surface (bgs), 30 feet in diameter.

TABLE 3-14. COST ESTIMATE FOR INSTITUTIONAL CONTROLS AT SITE 9, ANDERSEN AFB, GUAM.

Item	Quantity	Unit	Rate ($)	Year 1 Capital Costs ($)	Present Worth ($) at 5% for 30 years (rounded)
Capital Cost. Initial Implementation (Install Fence at Top of Cliff)					
Labor					
Project Manager	Hour	16	$ 150	$ 2,400	
Field Supervisor	Hour	40	$ 75	$ 3,000	
Subtotal Labor				$ 5,400	
ODCs					
Project Travel/Per Diem	Lump Sum	1	$ 2,000	$ 2,000	
Fence Installation	Linear Feet	800	$ 35	$ 28,000	
Subtotal ODCs				$ 30,000	
10% Markup on ODC				$ 3,000	
4% Guam Tax on Labor & ODCs				$ 1,416	
Total Soil Cover Cost				$ 39,816	$ 39,900
			TOTAL Capital Cost	**$ 39,816**	**$ 39,900**
Long Term O&M Cost. 5-Year Interval; Through Year 25					
Labor					
Field Supervisor	Hour	40	$ 75	$ 3,000	
Subtotal Labor				**$ 3,000**	
ODCs					
Fence Maintenance	Lump Sum	1	$ 2,500	$ 2,500	
Project Travel/Per Diem	Lump Sum	1	$ 2,500	$ 2,500	
Subtotal ODCs				**$ 5,000**	
10% Markup on ODC				$ 500	
4% Guam Tax on Labor & ODCs				$ 320	
			TOTAL Long-Term O&M Cost	**$ 8,820**	**$ 31,400**
Long-Term Cost. Periodic Review Costs Shared by multiple sites with ICs (Table 2-24)				**$ 24,891**	**$ 94,200**
30-Year IC Costs Limited to Areas Below Cliffline (assumes 40% of total IC costs)					**$ 66,200**
				TOTAL Long-Term Cost	**$ 191,800**
				TOTAL COST	**$ 231,700**

Notes: Costs are based on 2005 estimates.

O&M = Operation & Maintenance; ODC = Other Direct Costs; IC = Institutional Control

TABLE 3-15. COST ESTIMATE FOR SOIL COVER AT SITE 9, ANDERSEN AFB, GUAM.

Item	Quantity	Unit	Rate ($)	Year 1 Capital Costs ($)	Present Worth at 5% for 30 years (rounded)
Captital Costs. Soil Cover					
Labor to Write Work Plan & Provide Field Oversight					
Senior Review	Hour	16	$ 135	$ 2,160	
Engineer/Scientist	Hour	160	$ 135	$ 21,600	
CADD Operator	Hour	16	$ 60	$ 960	
Clerical	Hour	16	$ 60	$ 960	
Field Supervisor	Hour	160	$ 75	$ 12,000	
Subtotal Labor				**$ 37,680**	
ODCs					
Project Travel/Per Diem	Lump Sum			$ 8,000	
Surface Debris Removal Equipment	Day	5	$ 1,100	$ 5,500	
Mob/Demob	Lump Sum			$ 1,200	
Trackhoe Rental	Day	15	$ 800	$ 12,000	
Grader Rental	Day	5	$ 800	$ 4,000	
Dump Truck and Driver	Day	15	$ 450	$ 6,750	
Steam/Water Truck	Day	1	$ 1,100	$ 1,100	
Clean Backfill	Cubic Yard	900	$ 26	$ 23,400	
Seeding (includes labor)	Square Feet	12,000	$ 0	$ 5,400	
Survey	Day	5	$ 900	$ 4,500	
Sample Shipping and Analysis	Each	10	$ 1,700	$ 17,000	
Shipping	Lump Sum	1	$ 5,000	$ 5,000	
Subtotal ODCs				**$ 93,850**	
10% Markup on ODC				$ 9,385	
4% Guam Tax on Labor & ODCs				$ 5,261	
Total Soil Cover Cost				**$ 146,176**	$ 146,200
				TOTAL Capital Cost	**$ 146,200**
Long-Term O&M Cost. 5-Year Interval; Through Year 25					
Labor					
Field Supervisor	Hour	40	$ 75	$ 3,000	
Subtotal Labor				**$ 3,000**	
ODCs					
Soil Cover	Cubic Yard	80	$ 26	$ 2,080	
Dump Truck and Driver	Day	4	$ 450	$ 1,800	
Grader Rental	Day	4	$ 800	$ 3,200	
Oversight, Prep, Mob/Demob	Hour	50	$ 65	$ 3,250	
Seeding	Square Feet	9,000	$ 1	$ 4,500	
Subtotal ODCs				**$ 14,830**	
10% Markup on ODC				$ 1,483	
4% Guam Tax on Labor & ODCs				$ 713	
			Total Long-Term O&M Cost	**$ 26,411**	**$ 93,800**
Long-Term Cost. Periodic Review Costs Shared by multiple sites with ICs (Table 2-24)				**$24,891**	**$ 94,200**
30-Year IC Costs Limited to Areas Below Cliffline (assumes 40% of total IC costs)					**$ 66,200**
				TOTAL Long-Term Cost	**$ 254,200**
				TOTAL COST	**$ 400,400**

Notes: Costs are based on 2005 estimates.

O&M = Operation & Maintenance; ODC = Other Direct Costs; IC = Institutional Control

TABLE 3-16. COST ESTIMATE FOR REMOVAL OF SURFACE AND SUBSURFACE SOIL WITH TSP TREATMENT AT SITE 9, ANDERSEN AFB, GUAM.

Item	Quantity	Unit	Rate ($)	Year 1 Capital Costs ($)	Present Worth at 5% for 30 years (rounded)
Capital Cost. Soil Excavation and Disposal					
Labor to Write Work Plan & Provide Field Oversight					
Senior Review	Hour	16	$ 135	$ 2,160	
Engineer/Scientist	Hour	80	$ 135	$ 10,800	
CADD Operator	Hour	40	$ 60	$ 2,400	
Clerical	Hour	40	$ 60	$ 2,400	
Field Supervisor	Hour	200	$ 75	$ 15,000	
Subtotal Labor				**$ 32,760**	
ODCs					
Project Travel/Per Diem	Lump Sum			$ 17,000	
Mob/Demob	Each	2	$ 600	$ 1,200	
Trackhoe Rental	Day	10	$ 800	$ 8,000	
Surface Debris Removal Equipment	Day	10	$ 1,100	$ 11,000	
Dump Truck and Driver	Day	10	$ 450	$ 4,500	
Steam/Water Truck	Day	10	$ 1,100	$ 11,000	
Clean Backfill	Cubic Yard	550	$ 26	$ 14,300	
Seeding	Square Feet	6,000	$ 1	$ 3,000	
Front-end Loader	Hour	80	$ 65	$ 5,200	
Mob/Demob of Front-end Loader	Each	1	$ 400	$ 400	
Hazardous Waste Transport/Disposal Assumes 2% of 550 cubic yard is Hazardous Waste (using $2,000/cubic yard)	Cubic Yard	10	$ 2,000	$ 20,000	
TSP-treatment of 18% of 550 cubic yard (at $220/cubic yard)	Cubic Yard	100	$ 220	$ 22,000	
Nonhazardous Transport Assumes 80% of 550 is Nonhazardous Waste ($10/cubic yard)	Cubic Yard	440	$ 10	$ 4,400	
Subtotal ODCs				**$ 122,000**	
10% Markup on ODC				$ 12,200	
4% Guam Tax on Labor & ODCs				$ 6,190	
Subtotal				**$ 173,150**	**$ 173,200**
Capital Cost. Confirmatory Sampling and Closure Report					
Labor					
Field Supervisor	Hour	80	$ 75	$ 6,000	
Engineer/Scientist	Hour	80	$ 135	$ 10,800	
CADD Operator	Hour	40	$ 60	$ 2,400	
Subtotal Labor				**$ 19,200**	
ODCs					
Analytical Costs	Each	40	$ 1,650	$ 66,000	
HazWaste Characterization	Each	20	$ 1,000	$ 20,000	
Shipping, Handling. & Materials (per sample)	Each	60	$ 100	$ 6,000	
Subtotal ODCs				**$ 92,000**	
10% Markup on ODC				$ 9,200	
4% Guam Tax on Labor & ODCs				$ 3,680	
Subtotal				**$ 124,080**	**$ 124,100**
				TOTAL Capital Cost	**$ 297,300**
Long-Term Cost. Periodic Review Costs Shared by multiple sites with ICs (Table 2-24)				**$24,891**	**$ 94,200**
30-Year IC Costs Limited to Areas Below Cliffline (assumes 40% of total IC costs)					**$ 66,200**
				TOTAL Long-Term Cost	**$ 160,400**
				TOTAL COST	**$ 457,700**

Notes: Costs are based on 2005 estimates.

O&M = Operation & Maintenance; ODC = Other Direct Costs; IC = Institutional Control

TABLE 3-17. SUMMARY OF PERTINENT ARARs AND TBCs FOR SITE 9, ANDERSEN AFB, GUAM.

AUTHORITY	CITATION	ARAR DETERMINATION (note: may not pertain to every remedial alternative)	SYNOPSIS OF REQUIREMENT
Chemical Specific			
Federal			
USEPA Region 9 PRGs to screen and establish RGs	USEPA Region 9 PRGs Table (2004)	To Be Considered	Generic RBCs that are intended to assist risk assessors and others in initial screening-level evaluations of environmental measurements.
Risk Assessment Guidance - Cancer Slope Factors and Reference Doses	USEPA Integrated Risk Information System Database and U.S. Department of Energy Risk Assessment Information System	To Be Considered	Used in HHRAs as guidance values to evaluate the potential carcinogenic hazard caused by exposure to COCs.
Territorial (No chemical specific territorial ARARs or TBCs have been identified.)			
Location Specific			
Federal			
Endangered Species Act	16 USC 1531 and 50 CFR 200, 402	Relevant and Appropriate	Promotes actions to conserve endangered species or habitats.
Territorial			
Guam Wellhead Protection Program	Guam EPA (August 1993)	Relevant and Appropriate	Protects groundwater in wells/well fields that supply drinking water.
Historical Objects and Sites	21 Guam Code Annotated, Chapter 76	Relevant and Appropriate	Promotes historic preservation, restoration and presentation of historic sites and objects.
Fish, Game, Forestry & Conservation	5 Guam Code Annotated, Chapter 63	Relevant and Appropriate	Promotes actions to conserve endangered species or habitats.
Action Specific			
Federal			
RCRA regulations for Identification of Hazardous Waste 40 CFR 261, Transport of Hazardous, and for LDRs and landfills	40 CFR 261 40 CFR 263	Applicable	These requirements identify the maximum concentrations of contaminants for which a waste would be considered a RCRA characteristic waste due to toxicity. The analytical test specified in Appendix II of 40 CFR 61 is referred to as the TCLP.

TABLE 3-17. SUMMARY OF PERTINENT ARARs AND TBCs FOR SITE 9, ANDERSEN AFB, GUAM.

AUTHORITY	CITATION	ARAR DETERMINATION (note: may not pertain to every remedial alternative)	SYNOPSIS OF REQUIREMENT
RCRA Generator Requirements for Manifesting Waste for Offsite Disposal	40 CFR 262	Applicable	Standards for manifesting, marking, and recording hazardous waste shipments for offsite treatment/disposal.
RCRA - Subpart I, Use and Management of Containers	40 CFR 264, Subpart I	Applicable	Outlines use and management standards applicable to owners and operators of all hazardous waste facilities that store containers of hazardous waste.
RCRA Standards Applicable to Generators of Hazardous Waste	40 CFR 262	Applicable	These regulations establish standards for generators of hazardous waste including labeling, manifesting, and reporting requirements.
RCRA Chemical, Physical, and Biological Treatment	40 CFR Part 265, Subpart Q	Applicable	These regulations apply to owners and operators of facilities treating hazardous waste by chemical, physical or biological methods in units other than tanks, surface impoundments, and land treatment facilities (which are addressed in Subparts J, K, and M, respectively). General operating, waste analysis and trial tests, inspection and closure requirements are established.
EPA OSWER	Publication 9345.3-03 FS (January 1992)	To Be Considered	Management of wastes generated during remedial activities must ensure protection of human health and the environment.
LDR (“Land Ban”)	40 CFR 268	Applicable	LDR treatment standards for contaminated soils require that contaminated soils that will be land disposed be treated to reduce concentrations of hazardous constituents by 90 percent or meet hazardous constituent concentrations that are ten times the universal treatment standards.
Clean Air NAAQSs	40 CFR 50	To Be Considered	NAAQSs define guideline air quality levels that should be achieved to ensure protection of human health and welfare.
CAMU Regulations	40 CFR 264.552	Relevant and Appropriate	Regulates the management and disposal of RCRA defined hazardous waste as part of corrective response actions and remedial actions

TABLE 3-17. SUMMARY OF PERTINENT ARARs AND TBCs FOR SITE 9, ANDERSEN AFB, GUAM.

AUTHORITY	CITATION	ARAR DETERMINATION (note: may not pertain to every remedial alternative)	SYNOPSIS OF REQUIREMENT
Military Munitions Rule	40 CFR 266.203, 205, and 206	Applicable	Establishes the statutory requirements for munitions response sites. To implement the Military Munitions Rule the DoD established the management structure and initial program requirements (MMRP) in the September 2001 *Management Guidance for the Defense Environmental Restoration Program*.
Territorial			
Solid Waste Management Act	10 Guam Code Annotated, Chapter 51	Applicable	Regulates the management of solid waste and hazardous waste.
Water Pollution Control Act	10 Guam Code Annotated, Chapter 47	Applicable	Regulates the discharge of pollutants to water resources on Guam.
Air Pollution Control Act	10 Guam Code Annotated, Chapter 49	Applicable	Prohibits the generation of fugitive dust emissions.

ARAR = Applicable or Relevant and Appropriate Requirements
COC = Contaminant of Concern
HHRA = human health risk assessment
MMRP = Military Munitions Response Program
OSWER = Office of Solid Waste and Emergency Response
RBC = Risk-based concentration
RG = Remediation Goal
TCLP = Toxic Characteristic Leaching Procedure
USEPA = United States Environmental Protection Agency
CFR = Code of Federal Regulations
DoD = Department of Defense
LDR = Land Disposal Restrictions
NAAQC = National Ambient Air Quality Standard
PRG = Preliminary Remediation Goal
RCRA = Resource Conservation and Recovery Act or 1976
TBC = To Be Considered
USC = United States Code

TABLE 3-18. SUMMARY OF ARARs AND TBCs FOR REMEDIAL ALTERNATIVES FOR SITE 9, ANDERSEN AFB, GUAM.

ACT/AUTHORITY	REMEDIAL ALTERNATIVE			
	No Action	**Institutional Controls**	**Soil Cover**	**Soil Removal with Treatment Above the Cliffline and Institutional Controls Below the Cliffline**
Chemical Specific				
USEPA Region 9 PRGs to screen and establish RGs	Preliminary cleanup criteria will not be met; no waiver is justified.	Probability of exposure to soils exceeding RGs will be reduced.	Construct a soil cover using clean fill over areas where soil exceeds RGs. Human exposure pathways above the cliffline will be eliminated.	Transport soil from Site 9 and dispose at the CU. Human exposure pathways above the cliffline will be eliminated.
Risk Assessment Guidance - Cancer Slope Factors and Reference Doses	Cancer and non-cancer risk was evaluated at site incorporating slope factors and reference doses.	Cancer and non-cancer risk was evaluated at site incorporating slope factors and reference doses.	Cancer and non-cancer risk was evaluated at site incorporating slope factors and reference doses.	Cancer and non-cancer risk was evaluated at site incorporating slope factors and reference doses.
Location Specific				
Endangered Species Act	NA	NA	Endangered species are not on the site. This remedy is not anticipated to impact habitat of endangered species. However, soil cover installation activities will be assessed to ensure that there is no impact to roosting, nesting, or foraging habitat of endangered species.	Endangered species are not present on the site. Removal action is not anticipated to impact habitat of endangered species. However, removal activities will be assessed to ensure that there is no impact to roosting, nesting, or foraging habitat of endangered species.

TABLE 3-18. SUMMARY OF ARARs AND TBCs FOR REMEDIAL ALTERNATIVES FOR SITE 9, ANDERSEN AFB, GUAM.

ACT/AUTHORITY	REMEDIAL ALTERNATIVE			
	No Action	**Institutional Controls**	**Soil Cover**	**Soil Removal with Treatment Above the Cliffline and Institutional Controls Below the Cliffline**
Guam Wellhead Protection Program	NA	NA	Groundwater is not a media of concern. However, all groundwater on the Northern Plateau has been designated as a Sole Source Aquifer. Guam EPA must review any project in this aquifer regardless if a permit is required.	Groundwater is not a media of concern. However, all groundwater on the Northern Plateau has been designated as a Sole Source Aquifer. Guam EPA must review any project in this aquifer regardless if a permit is required.
Historical Objects and Sites - 21 Guam Code Annotated, Chapter 76	NA	NA	If historic objects or sites are discovered, then the substantive requirements of these regulations will be followed.	If historic objects or sites are discovered, then the substantive requirements of these regulations will be followed.
Fish, Game, Forestry & Conservation	NA	NA	Endangered species are not on the site. This remedy is not anticipated to impact habitat of endangered species. However, soil cover installation activities will be assessed to ensure that there is no impact to roosting, nesting, or foraging habitat of endangered species.	Endangered species are not on the site. Removal action is not anticipated to impact habitat of endangered species. However, removal activities will be assessed to ensure that there is no impact to roosting, nesting, or foraging habitat of endangered species.

TABLE 3-18. SUMMARY OF ARARs AND TBCs FOR REMEDIAL ALTERNATIVES FOR SITE 9, ANDERSEN AFB, GUAM.

ACT/AUTHORITY	REMEDIAL ALTERNATIVE			
	No Action	**Institutional Controls**	**Soil Cover**	**Soil Removal with Treatment Above the Cliffline and Institutional Controls Below the Cliffline**
Action Specific				
RCRA regulations for Identification of Hazardous Waste 40 CFR 261, Transport of Hazardous, and for LDRs and landfills	NA	NA	NA	Removal action may produce hazardous waste. If soil exhibits at least one of the four hazardous waste characteristics (ignitability, reactivity, corrosivity, or TCLP), the material will be treated as hazardous waste.
RCRA Generator Requirements for Manifesting Waste for Offsite Disposal	NA	NA	NA	If remedial actions require the offsite disposal of RCRA-defined hazardous waste, then the substantive requirements of these regulations will be followed.
RCRA - Subpart I, Use and Management of Containers	NA	NA	NA	If remedial actions require storage of hazardous waste in containers, then the substantive requirements of these regulations will be followed.
RCRA Standards Applicable to Generators of Hazardous Waste	NA	NA	NA	Remediation-derived waste may be characterized as hazardous waste. If so, the material will be handled in compliance with the substantive requirements of these standards.
RCRA Chemical, Physical, and Biological Treatment	NA	NA	NA	If a remedial activity involves the treatment of RCRA hazardous waste by chemical, physical, or biological methods in units other than tanks, surface impoundments, and land treatment facilities, these requirements would be met.

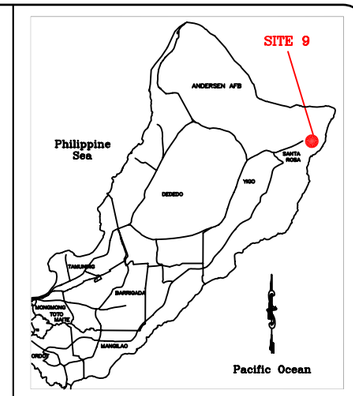
TABLE 3-18. SUMMARY OF ARARs AND TBCs FOR REMEDIAL ALTERNATIVES FOR SITE 9, ANDERSEN AFB, GUAM.

ACT/AUTHORITY	REMEDIAL ALTERNATIVE			
	No Action	**Institutional Controls**	**Soil Cover**	**Soil Removal with Treatment Above the Cliffline and Institutional Controls Below the Cliffline**
RCRA LDRs	NA	NA	NA	Any soil classified as a hazardous waste which is to be disposed offsite would be treated, as necessary, to meet the established LDR treatment standards.
CAMU Regulations 40 CFR 264.552	NA	NA	NA	No hazardous waste or recently generated waste will be placed at the site. Groundwater in the vicinity of the site will be monitored under a separate program.
Military Munitions Rule	The substantive requirements of this regulation would not be met.	Probability of exposure to physical hazards would be reduced. If institutional controls are not implemented effectively, probability of exposure to physical hazards may increase. The substantive requirements of this regulation would not be met.	Probability of exposure to physical hazards would be minimized. Intrusive work on site (digging, drilling) would pose risk of exposure to physical hazards. The substantive requirements of this regulation would not be met.	Since OEW/UXO were not identified above the cliffline this regulation does not apply. Below the cliffline, physical risks associated with OEW/UXO will be mitigated through the implementation of ICs, including land use and engineering controls until OEW/UXO are addressed under MMRP. The substantive requirements of this ARAR would be met.

TABLE 3-18. SUMMARY OF ARARs AND TBCs FOR REMEDIAL ALTERNATIVES FOR SITE 9, ANDERSEN AFB, GUAM.

ACT/AUTHORITY	REMEDIAL ALTERNATIVE			
	No Action	**Institutional Controls**	**Soil Cover**	**Soil Removal with Treatment Above the Cliffline and Institutional Controls Below the Cliffline**
Solid Waste Management Act, 10 Guam Code Annotated**,** Chapter 51	NA	NA	Solid de-contamination wastes (i.e., non-hazardous waste) or liquids will be analyzed in accordance with 40 CFR part 261 to ensure that the material is not hazardous waste, and transported and disposed of properly.	Solid decontamination wastes (i.e., non-hazardous wastes) or liquids will be analyzed in accordance with 40 CFR Part 261 to ensure that the material is not hazardous waste, and transported and disposed of properly:
Water Pollution Control Act 10 Guam Code Annotated, Chapter 47	NA	NA.	Removal would be conducted in a manner to prevent surface erosion of soil to nearby marine waters.	Removal would be conducted in a manner to prevent surface erosion of soil to nearby marine waters.
Air Pollution Control Act	NA	NA	Remedial activities would be conducted in a manner to minimize fugitive dust emissions.	Remedial activities would be conducted in a manner to minimize fugitive dust emissions.

ARAR = Applicable or Relevant and Appropriate Requirements
COC = Contaminant of Concern
LDR = Land Disposal Restrictions
OSWER = Office of Solid Waste and Emergency Response
RCRA = Resource Conservation and Recovery Act or 1976
TBC = To Be Considered
USC = United States Code
CFR = Code of Federal Regulations
HHRA = human health risk assessment
NAAQC = National Ambient Air Quality Standard
PRG = Preliminary Remediation Goal
RG = Remediation Goal
TCLP = Toxic Characteristic Leaching Procedure
USEPA = United States Environmental Protection Agency



LEGEND:

- AREA OF MOUNDED STRUCTURES WITH FILL MATERIAL
- AREA OF CONCENTRATED DETERIORATED METAL
- AREA OF CONCENTRATED TAR AND/OR ASPHALT
- AREA OF CONCENTRATED DETERIORATED 55-GALLON DRUMS
- MISCELLANEOUS DEBRIS
- OEW/UXO
- DETERIORATED 55 GALLON DRUM/DRUM REMNANT
- AIRCRAFT AND AUTO TIRE
- AIRCRAFT PARTS

SYMBOLS/LEGEND :

- EDGE OF VEGETATION
- A-0+00 GEOPHYSICAL SURVEY POINT
- SURVEY CONTROL POINT
- 500 CONTOUR LINE
- BOUNDARY LINE
- CLIFF LINE
- TRENCH LINE
- ESTIMATED EXTENT OF IMPACTED FILL MATERIAL

NOTES :

1. VERTICAL AND HORIZONTAL CONTROL WAS BASED FROM 4X4 CONCRETE MONUMENTS AAFB-13, AND AAFB-14, WITH THE FOLLOWING 1945 GRID COORDINATES :
   1. AAFB-13
      N 202,018.67
      E 230,514.98
      EL=602.21
   2. AAFB-14
      N 202,415.88
      E 231,394.57
      EL=609.45
2. CONTOURS ARE AT 5 FEET INTERVALS.
2. CONTOURS SHOULD NOT BE USED FOR ANY CIVIL DESIGN PURPOSES.

Figure 3-1.
Suspected Sources of Contamination at Site 9, Andersen AFB, Guam.

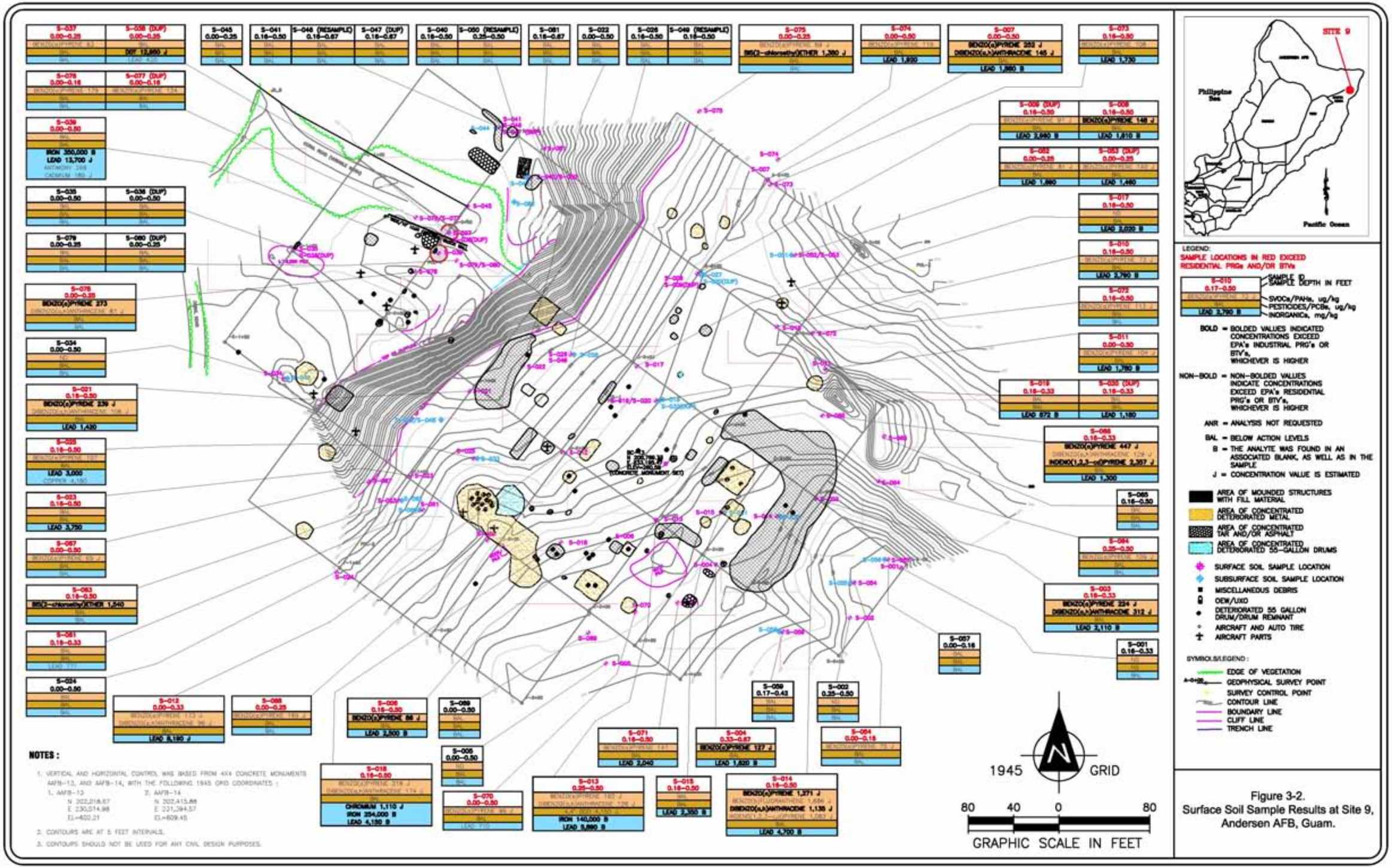


Figure 3-2.
Surface Soil Sample Results at Site 9, Andersen AFB, Guam.

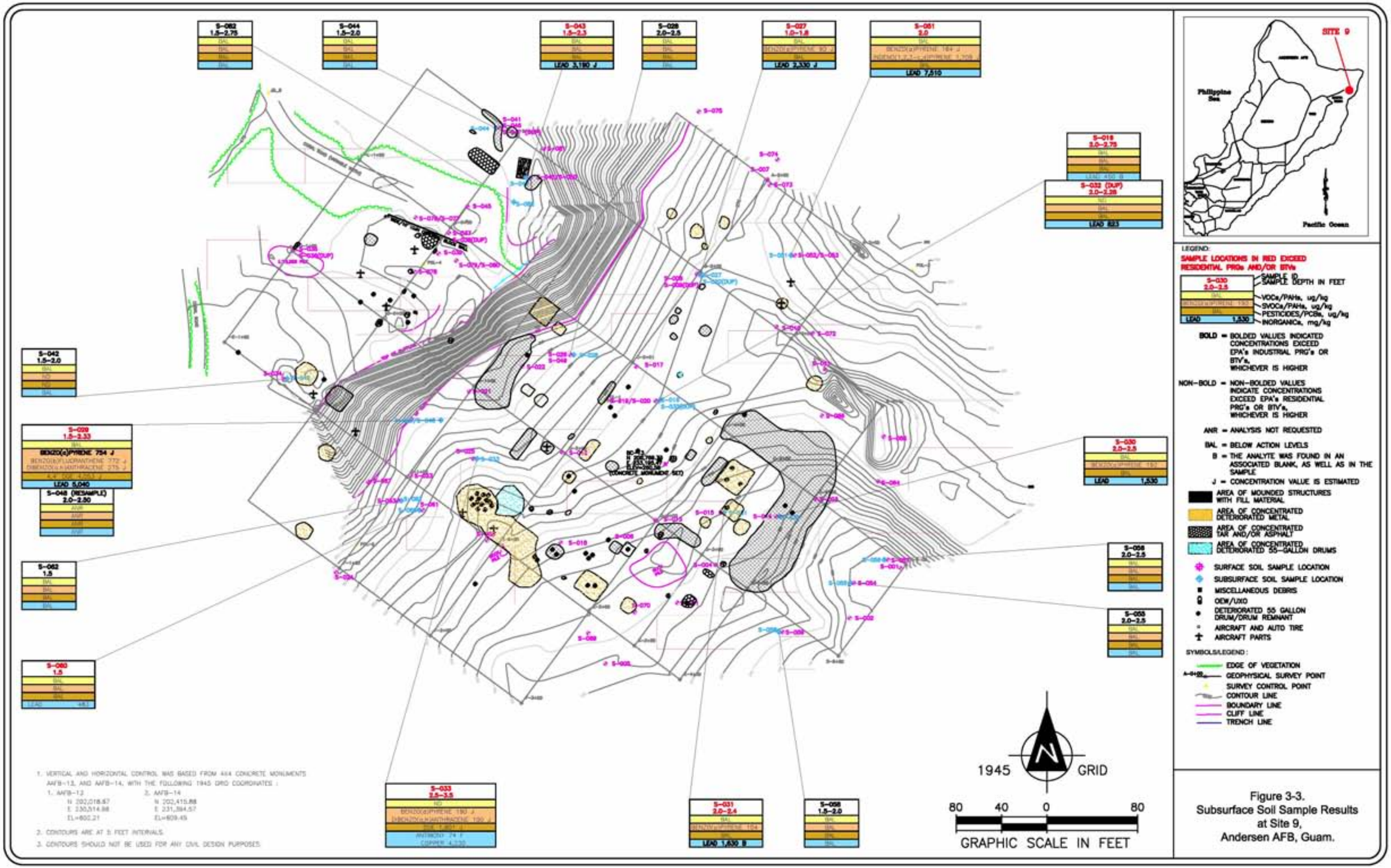
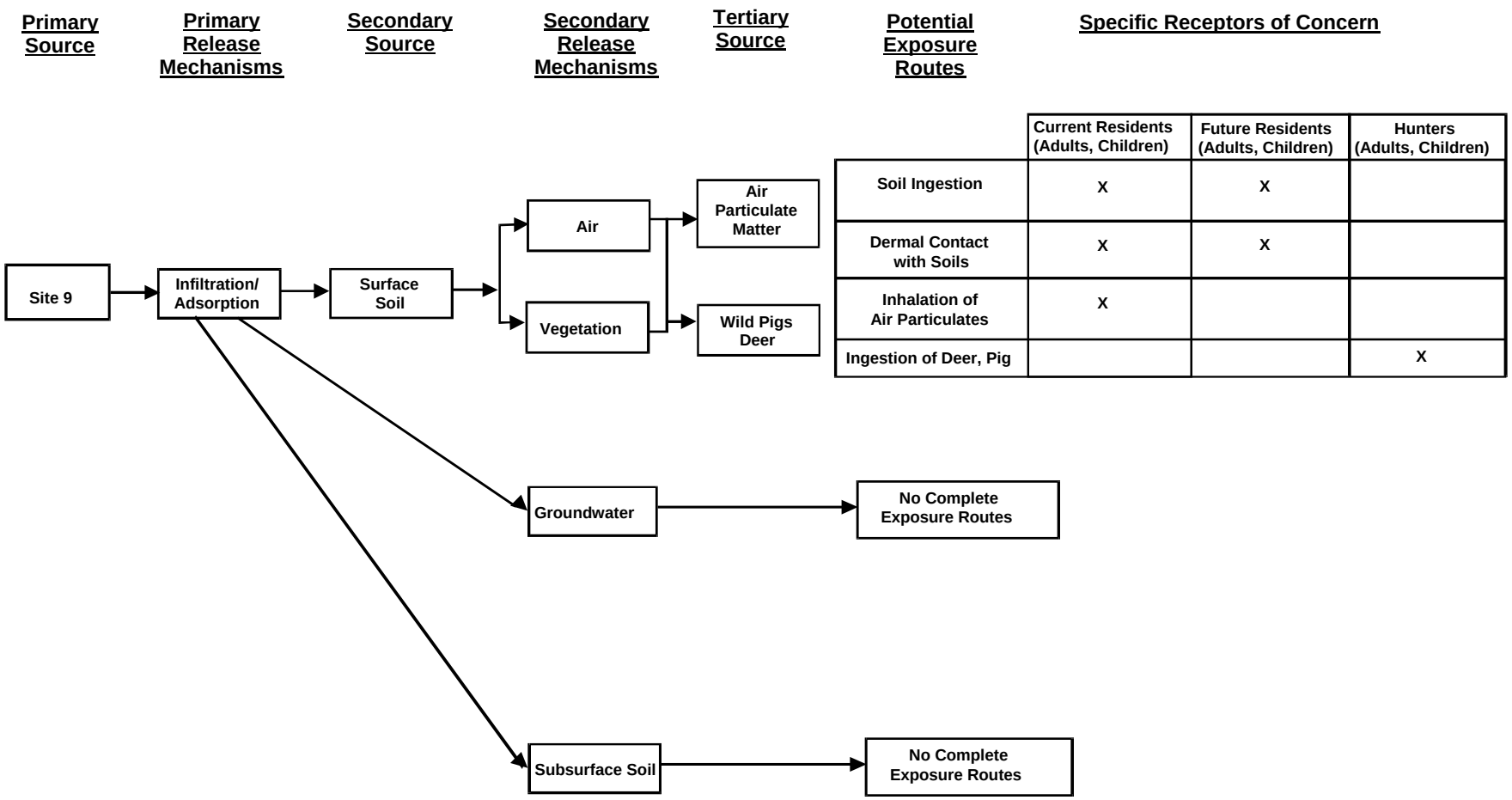


Figure 3-3.
Subsurface Soil Sample Results
at Site 9,
Andersen AFB, Guam.



Specific Receptors of Concern

	Current Residents (Adults, Children)	Future Residents (Adults, Children)	Hunters (Adults, Children)
Soil Ingestion	X	X	
Dermal Contact with Soils	X	X	
Inhalation of Air Particulates	X		
Ingestion of Deer, Pig			X

Figure 3-4. Human Health Risk Assessment Conceptual Site Model for Site 9, Andersen AFB, Guam.

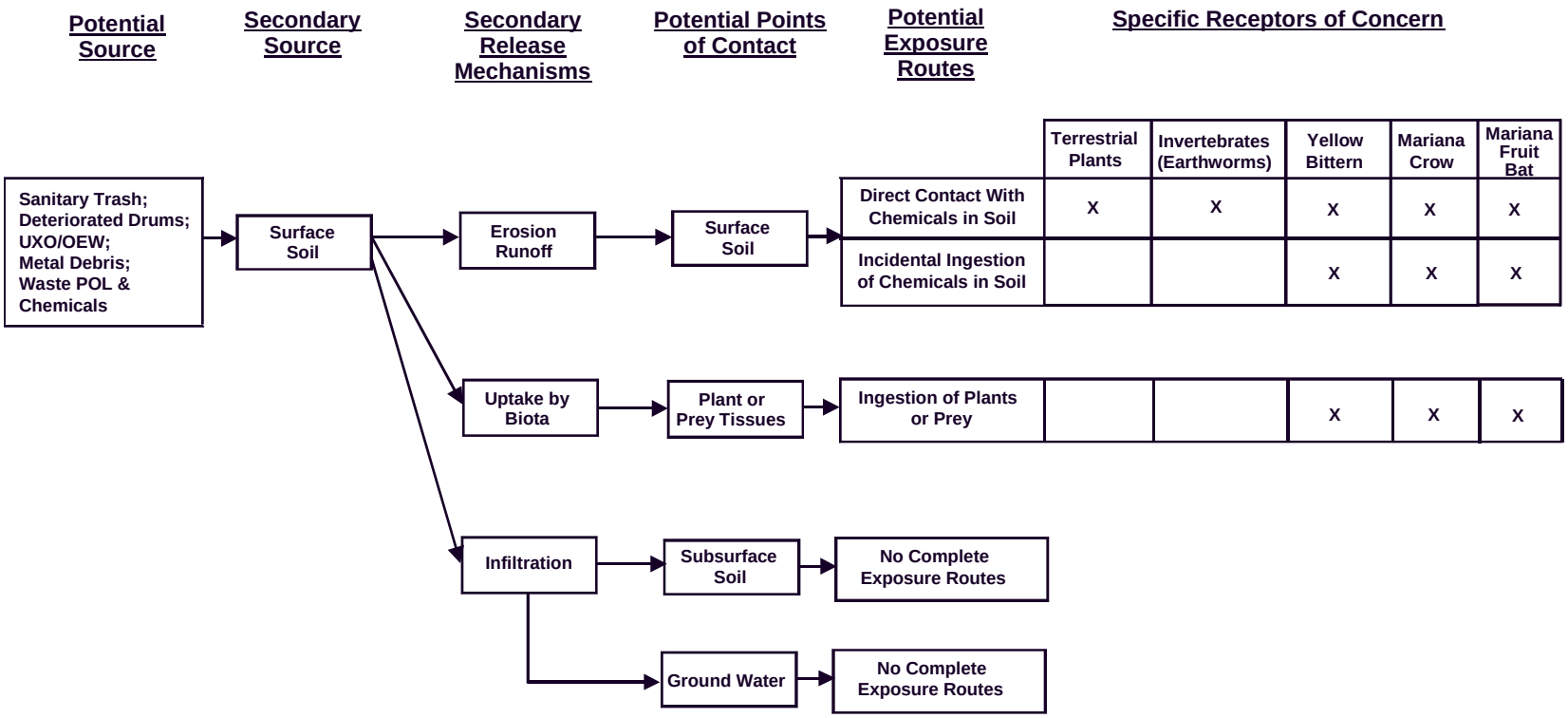


Figure 3-5. Ecological Risk Assessment Conceptual Site Model for Site 9, Andersen AFB, Guam.

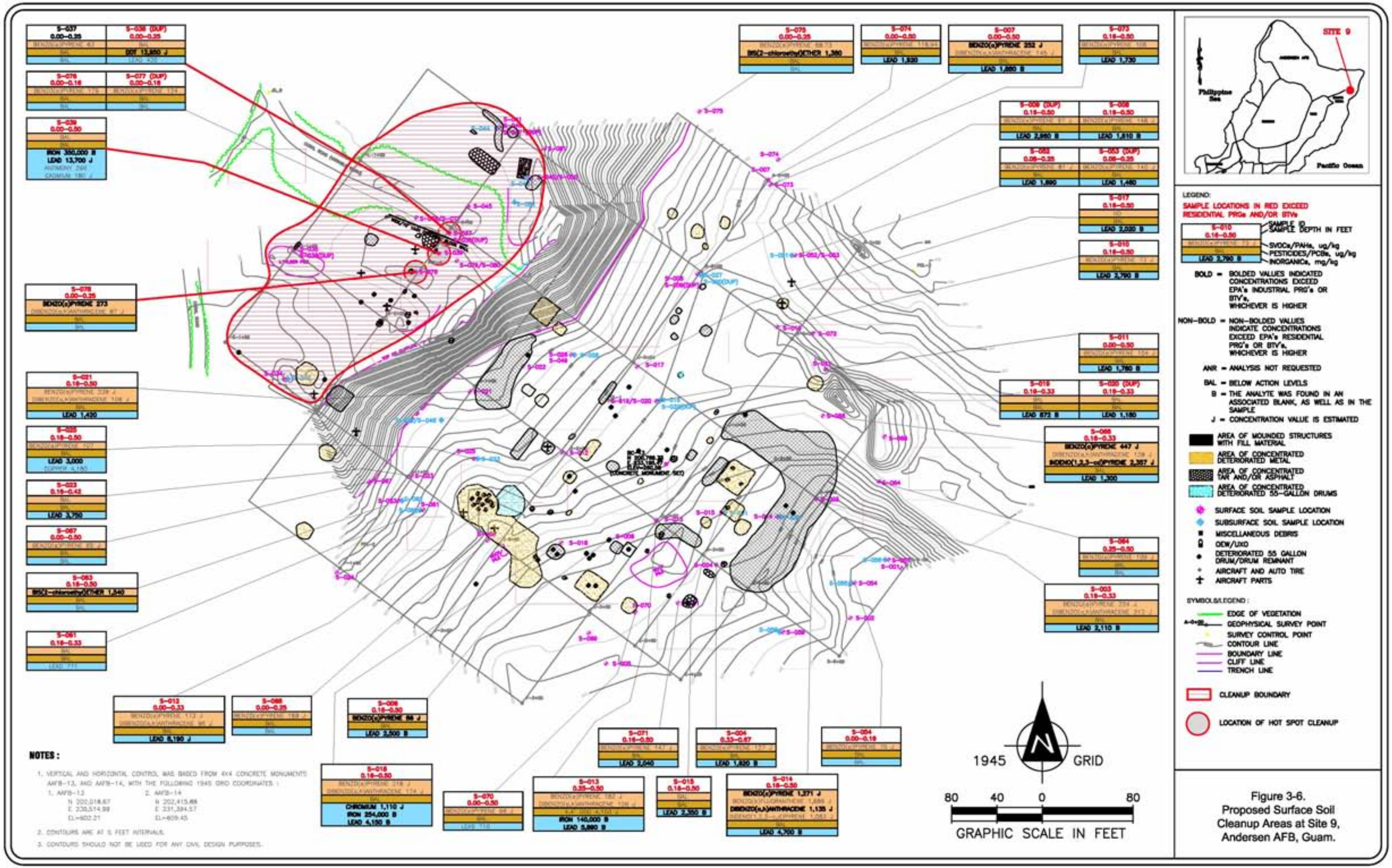


Figure 3-6.
Proposed Surface Soil Cleanup Areas at Site 9, Andersen AFB, Guam.

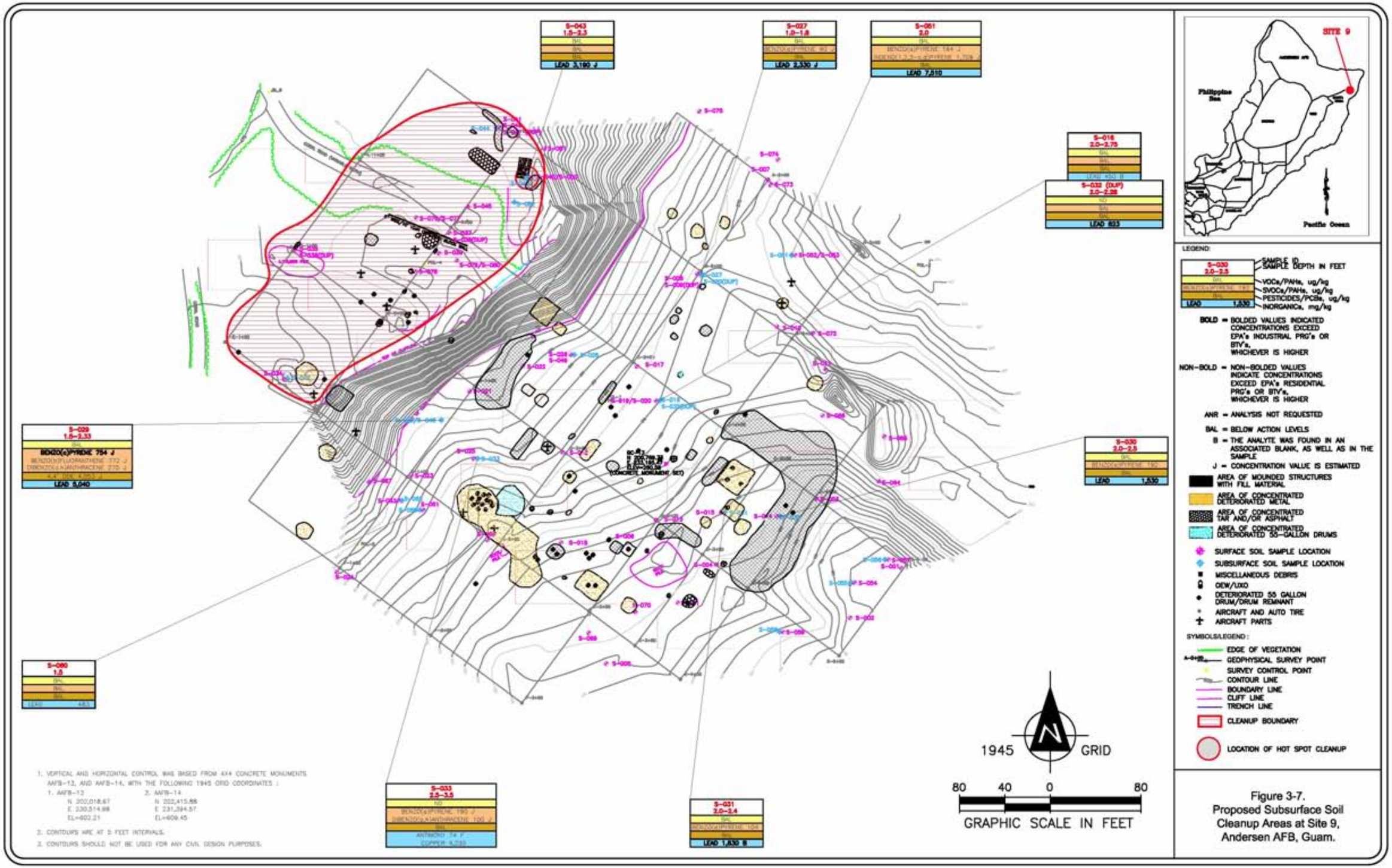


Figure 3-7.
Proposed Subsurface Soil Cleanup Areas at Site 9, Andersen AFB, Guam.

4. DECISION SUMMARY FOR SITE 12

This decision summary for Site 12 presents an overview of the site description, environmental characteristics, history, public involvement, nature and extent of contamination, associated human health and ecological risks, remedial alternatives, and rationale for selecting the preferred remedial actions in light of the statutory requirements. A detailed RI/FS for Site 12 was complete in June 2006 (EA, 2006).

This decision summary was prepared for Site 12, which is located in the northern portion of the Main Base OU at Andersen AFB, Guam (Figure 1-2). Site 12 is located along the cliffline north of the active runways, and covers an area of approximately 24 acres. It is comprised of six subsites, referred to as Areas A through F, which are adjacent to the former Weapons Storage Area (WSA) (Figure 1-6). Topography of Site 12 varies from a relatively flat limestone plateau to a much steeper cliffline. The location and description is presented in Section 4.6.

Funding for the cleanup of Site 12 is provided under the USAF Environmental Restoration Account. Although the USAF is the lead agency under CERCLA, the USEPA and the Guam EPA are support agencies for cleanup activities. Site 12 is included in the National Superfund electronic database under CERCLIS identification number GU6571999519.

4.1 Site 12 History (Areas A through F)

According to the IRP Phase I Records Search (ESE, 1985), Site 12 consisted of approximately 2.5 acres and was used between 1945 and 1949 for disposal of sanitary trash and excess equipment such as trucks and airplane parts. According to the report, the waste materials were disposed of over the steep-walled cliff onto the lower terraces. Site 12 was included in the IRP Phase I Records Search but did not receive a HARM score. No site visit was conducted because of the site's isolated location and heavy vegetation. The report identified the site as having minimal potential for contamination and recommended that the USAF eliminate it from further consideration.

The 1986 RFA Report (SAIC, 1986) inaccurately identified Site 12 as the EOD area located on the north beach approximately 10 feet above msl. Due to this error, the area described as Site 12 in the IRP Phase I Records Search Report was not investigated during the 1986 RFA. Site 12 was not included during the Phase II investigation, Stages 1 and 2 (Battelle, 1989 and SAIC, 1991). Site 12 was described in the IRP Phase II, Stage 1 Final Report, but was not investigated during Stage 1 activities based on the decision process discussed in the Phase I Records Search. The site was removed from further consideration.

In 1992, field observations completed in conjunction with the OU6 Basewide Work Plan (ICF, 1994b) and the Work Plan Addendum to OU6 for OU5 (ICF, 1994a) estimated the size of Site 12 as approximately 23 acres. In addition, between 100 and 200 drums were observed in the area of Site 12. Most of the drums were crushed, empty, and partially buried, and appeared to contain limestone boulders. Metal debris was observed throughout the area, and approximately 75 nickel-cadmium (NiCd) batteries were noted in the area known as the Pati Point Dump (currently designated as Area F on Figure 1-6).

The Records Search for Andersen AFB (ICF, 1996a) described Site 12 as occupying 23 acres, active from late 1940s to 1984, and containing sanitary trash, excess equipment, NiCd batteries, and empty paint drums. USAF documentation confirms that an over-the-cliff trash dump at Site 12 started as early as 1952 and that access to the site was restricted beginning in 1985.

An 8 November 1990 memorandum from the Headquarters 633rd Air Base Wing requested the inclusion of four additional sites, including the Pati Point Dumpsite (currently designated as Area F on Figure 1-6), in the Andersen AFB IRP. The memo stated that the Pati Point Dumpsite, located at the bottom of the cliff, was littered with NiCd batteries, empty paint drums, and potentially live 50-caliber cartridges. The site was suspected of being active in the late 1950s; however, access was restricted in 1985 after a fence was installed (ICF, 1996a).

According to a 28 April 1952 drawing entitled "*Area No. 1, Andersen AFB, Plot Plan, Existing Facilities*," a road led from 32nd Street to the cliffline. The area at the end of the road was labeled as a "trash dump." The 1955 Base Master Plan indicates that trash and inorganic waste materials that had no salvage value were disposed over the cliff. According to the Master Plan, wastes had been previously disposed over the cliff, and the continuation of this practice after 1955 was planned (ICF, 1996a).

Base Real Property records indicate at least three structures were present on the top portion of Area B. One building, designated as Facility T-2046, was used as a "Training Aid Gas Chamber." The building occupied a 20-foot by 48-foot area (960 square feet), and according to a 19 December 1961 "Request for Approval to Dispose of Real Property" form, the building had deteriorated beyond the point of economical repair and restoration, and was dismantled on 18 January 1962. The location of Area B is shown on Figure 1-6.

In 1963, a small-arms range was constructed at Area B. The range consisted of a "Range Control House" (Facility T-2047) and a "Lateral Moving Target" (Facility T-2043). Facility T-2047 was an L-shaped structure. During Typhoon Karen, in November 1962, the building was partially or completely destroyed and was removed from Real Property records in November 1963. Facility T-2043 was a long, linear structure that was used in conjunction with a large earthen mound located near the cliffline that was used as a backdrop for a shooting range. As a result, spent bullets and shell casings are scattered throughout the vicinity of the mound. Facility T-2043 was reassigned as Facility 51203 sometime between April 1965 and September 1967, when it was abandoned in place and the facility was deleted from the Real Property records.

A field investigation of Site 12 was completed in 1999 through 2000 and the results of that investigation are incorporated in the RI/FS (EA, 2006).

4.2 Enforcement Activities

Section 2.2 provides information about Enforcement Activities; this information is common to Chapters 2, 3, and 4 (Decision Summaries for Sites 6, 9, and 12, respectively).

4.3 Community Participation

Section 2.3 provides information about Community Participation; this information is common to Chapters 2, 3, and 4 (Decision Summaries for Sites 6, 9, and 12, respectively).

4.4 Scope and Role of the Operable Unit or Response Action

Section 2.4 provides information about Scope and Role of the Operable Unit or Response Action; this information is common to Chapters 2, 3, and 4 (Decision Summaries for Sites 6, 9, and 12, respectively).

4.5 Names, Locations, Descriptions, Field Results, and Characteristics of Areas A Through F

4.5.1 Area A

4.5.1.1 Area A Characteristics

4.5.1.1.1 Area A Physical Setting

Area A is approximately 3 acres in size and is located at the westernmost portion of Site 12. Elevations at Area A range from 400 feet above msl along the base of the cliffline, to 575 feet above msl at the top of the cliffline (Figure 4-1). The majority of Area A lies along the slope and is characterized by limestone outcrops at the cliff face.

A site reconnaissance and DSI were conducted at Area A in 1999 to accurately characterize the environmental setting and boundaries of the site, including identification of potentially hazardous wastes. During the DSI, the physical characteristics of the site and areas containing surface debris that may be potential sources of contamination were documented (Section 4.6.1.2.3). A summary of the related findings is presented on Figure 4-1.

The soils present at Site 12 consist of the Ritidian-Rock outcrop complex series. This consists of 45 percent Ritidian extremely cobbly clay loam and 35 percent Rock outcrop. The Ritidian-Rock outcrop complex develops on limestone plateaus, escarpments, and occasionally on benches and vertical cliffs (Young, 1988).

Area A of Site 12 is located along the cliffline, and is situated predominantly on the reefal facies of the Mariana Limestone. The depth to groundwater may vary from approximately 500 feet bgs at the top of the cliffline to approximately 390 feet bgs along the lower portion of the site located below the cliffline. The aquifer beneath Site 12 is highly permeable and porous (ICF, 1995). No rivers or streams are present at the site and precipitation, except that portion lost to evapotranspiration, contributes to the groundwater. Based on the site location and topography, the prevailing groundwater flow direction would be generally north, toward the Pacific Ocean (Figure 1-6). Site 12 is located downgradient of aquifer recharge zones and will not impact current or future groundwater production wells within the recharge zones. The freshwater lens

would be relatively thin beneath the site and becomes even thinner and more brackish as it approaches the nearby Pacific Ocean.

An ecological survey was performed at Area A in January 2000 and two endangered species were observed within close proximity of Site 12. The Mariana fruit bat *(Pteropus mariannus)* appears on both the United States Endangered Species List and GESL. Several fruit bats were observed flying over the limestone forest habitats of the Site 12 Areas E and F during the field program. *Tabernaemontana rotensis* is a rare native tree species observed in the limestone forest habitats of Areas A and B and also observed between the other Areas of Site 12. *Tabernaemontana rotensis* is currently proposed for addition to the GESL. A discussion of these species, along with a description of the ecological habitats and other ecological receptors at each of the six Site 12 Areas, are provided in Section 4.10.2 of this document.

4.5.1.1.2 Sampling History for Area A

Prior to the RI, there was no sampling performed at Area A. A total of 30 surface soil samples, including three duplicate samples, were collected from Area A during two sampling events. Fourteen surface soil samples, including one duplicate sample, were collected and analyzed for SVOCs, PAHs, pesticides, PCBs, and inorganics in January 2000. Based on these analytical results, a second sampling event was conducted in July 2000 to delineate contamination around sample locations with concentrations that exceeded screening levels (residential PRGs and BTVs). The surface soil sample results are summarized in Figure 4-2.

Eight subsurface soil samples, including one duplicate, were collected from Area A in February 2000 and were analyzed for VOCs, SVOCs, PAHs, pesticides, PCBs, and inorganics. Based on the initial sample results, two confirmatory subsurface soil samples were collected in July 2000. These samples were analyzed for PAHs, pesticides, and specific inorganics. The subsurface soil sample results are summarized in Figure 4-3.

One composite sample was collected from a drum at Area A in February 2000 and analyzed for VOCs, TPH, and PCBs.

4.5.1.1.3 Suspected Contamination Sources of Area A

A site reconnaissance and DSI were conducted to accurately define the environmental setting and boundaries of the site, including identification of potentially hazardous wastes. During the DSI, the physical characteristics of the site and areas containing surface debris that may be potential sources of contamination were documented and are summarized on Figure 4-1.

The area of fill, which includes soil and debris, extends down the slope approximately 200 feet and along the cliffline approximately 200 feet. In addition to large limestone boulders, various types of debris were observed, including three partially buried 55-gallon drums containing a petroleum-like substance, approximately 85 empty 55-gallon drums, construction debris, mechanical parts (engines, electric generator, radiator, etc.), rubber tires, one five-cell battery, aircraft parts, and sanitary trash.

4.5.2 Area B

4.5.2.1 Area B Characteristics

4.5.2.1.1 Area B Physical Setting

Area B, located approximately 600 feet east of Area A, is approximately 9 acres in size. Half of Area B is situated along the cliffline slope and the other half is located atop the grassy plateau (Figure 4-4). Area B ranges in elevation from 585 feet above msl at the top of the plateau to 465 feet above msl along the slope. Many small, 1- to 3-foot-high mounds were observed on the plateau at the top of Area B. Records indicate three structures were located on the upper portion of Area B. One building, designated as Facility T-2046, was used as a training aid gas chamber, which was dismantled in January 1962, according to Base Real Property records. In 1963, a small-arms range was constructed at Area B that consisted of a Range Control House (Facility T-2047) and a lateral moving target (Facility T-2043). According to Base Real Property records, these facilities were dismantled in 1967. One large mound (60 feet by 30 feet by 90 feet), located near the edge of the cliffline, was used as the backdrop for the small-arms range lateral target. Spent bullets and shell casings are scattered throughout the vicinity of the mound.

A site reconnaissance and DSI were conducted at Area B in 1999 to accurately characterize the environmental setting and boundaries of the site, including identification of potentially hazardous wastes. During the DSI, the physical characteristics of the site and areas containing surface debris that may be potential sources of contamination were documented (Section 4.6.2.2.3). A summary of the related findings is presented on Figure 4-4.

Section 4.6.1.2.1 provides a information about the soils, hydrogeology, and ecological survey; this information is common to Areas A through F. The depth to groundwater may vary from approximately 500 feet bgs at the top of the cliffline to approximately 455 feet bgs along the lower portion of the site located below the cliffline.

4.5.2.1.2 Sampling History for Area B

Prior to the RI, there was no sampling performed at Area B. A total of 76 surface soil samples (including six duplicate samples) were collected at Area B from depths of 0 to 0.5 feet bgs. Samples were collected at Area B during two field efforts, December 1999 and July 2000. In December 1999, 37 surface soil samples, including three duplicate samples, were collected and analyzed for SVOCs, PAHs, pesticides, and inorganics (Figure 4-5). Based on the initial sampling analytical results, additional samples were collected in July 2000 to delineate contamination around sample locations with concentrations that exceeded screening levels (residential PRGs and BTVs). As none of the 37 surface soil samples submitted for SVOC, pesticide, or PCB analyses had concentrations that exceeded residential PRGs, no surface soil confirmatory samples were submitted for these parameters. Thirty-nine confirmatory samples, including three duplicate samples, were collected and were selectively analyzed for PAHs (30 samples), aluminum (nine samples), antimony (five samples), arsenic (five samples), chromium (five samples), lead (16 samples), and manganese (nine samples). Sample locations are presented on Figure 4-5.

Twenty-nine subsurface soil samples (including three duplicate samples) were collected from test pits that were excavated at Area B (Figure 4-6). Twelve subsurface soil samples were collected in January and February 2000 and analyzed for VOCs, SVOCs, PAHs, pesticides, and inorganics. Seventeen confirmatory samples, including three duplicate samples, were collected in July 2000 and analyzed for PAHs (in each of the samples) and for lead (in only four of the samples) (Figure 4-6).

One drum sample (Q002) was collected at Area B in February 2000 and analyzed for VOCs. The location of this sample is shown on Figure 4-6.

4.5.2.1.3 Suspected Contamination Sources of Area B

Many small, 1- to 3-foot-high mounds were observed on the plateau at the top of Area B. The mounds consisted of soil, pieces of metal, trash, fire hose, solid asphalt, and concrete debris. There is one large mound that was used as a target range backstop that is located along the edge of the plateau on the "00" line, between lines "G" and "J" (Figure 4-4). Scattered around the backstop mound are bullets and casings of various calibers. A partially buried, 4-gallon container was observed along the 200R line, between lines "J" and "K". The container held approximately 1 liter of petroleum-like liquid. Few other items of surface debris were observed at the top of Area B.

The fill extends approximately 100 feet down the cliffline slope. More than 100 drums were observed along the slope at Area B; however, the exact number of drums was difficult to ascertain as many of the drums were piled among trees and boulders where the fill material is unstable. Other surface debris scattered along the slope included aircraft parts, truck parts, electrical and mechanical parts, various construction debris, sanitary trash, paint cans, metal signs, 30- and 50-caliber bullets and casings, concrete and asphalt debris, telephone poles, dumpsters, and limestone boulders. A total of 14 test ditches were excavated on the Area B plateau. The ditches ranged from 12 to 89 feet in length, and were excavated to an average depth of 2.75 feet bgs. Six of the 14 test ditches contained fill material, which included fragments of clay pigeon targets, metal angle iron, concrete blocks, a metal container, metal strapping, and bullet and shotgun shell casings. OEW material identified during test ditch excavations included expended 30-and 50-caliber shell casings; therefore, OEW on site do not pose a physical hazard to human and ecological receptors.

4.5.3 Area C

4.5.3.1 Area C Characteristics

4.5.3.1.1 Area C Physical Setting

Area C, located approximately 1,500 feet east of Area B, occupies less than 1 acre along the cliffline slope. Elevations at Area C range from 620 feet above msl on the plateau to 465 feet above msl along the cliffline slope (Figure 4-7).

A site reconnaissance and DSI were conducted at Area C in 1999 to accurately characterize the environmental setting and boundaries of the site, including identification of potentially

hazardous wastes. During the DSI, the physical characteristics of the site and areas containing surface debris that may be potential sources of contamination were documented (Section 4.6.3.2.3). A summary of the related findings is presented on Figure 4-7.

Section 4.6.1.2.1 provides information about the soils, hydrogeology, and ecological survey; this information is common to Areas A through F. The depth to groundwater may vary from approximately 525 feet bgs at the top of the cliffline to approximately 455 feet bgs along the lower portion of the site.

4.5.3.1.2 Sampling History for Area C

Prior to the RI, there was no sampling performed at Area C. A total of three surface soil samples were collected at Area C in June 2000 and were analyzed for SVOCs, PAHs, and inorganics. Sample locations are shown on Figure 4-8.

One subsurface soil sample was collected (Figure 4-8) and analyzed for SVOCs, PAHs, and inorganics.

4.5.3.1.3 Suspected Contamination Sources of Area C

Large limestone boulders were observed in Area C along with small amounts of debris, including an aircraft propeller, plastic and fiberglass flooring tiles, a 3-gallon bucket, electrical wire, chain-link fence, 14-inch steel pipe, office chair, flashlights, twisted cable, oxygen tank, canvas material, barbed wire, plastic pieces, and rubber disks.

4.5.4 Area D

4.5.4.1 Area D Characteristics

4.5.4.1.1 Area D Physical Setting

Area D, located approximately 500 feet east of Area C, is similar in size and physical characteristics to Area C. Elevations at Area D range from 610 feet above msl on the plateau to 450 feet above msl along the cliffline slope (Figure 4-9).

A site reconnaissance and DSI were conducted at Area D in 1999 to accurately characterize the environmental setting and boundaries of the site, including identification of potentially hazardous wastes. During the DSI, the physical characteristics of the site and areas containing surface debris that may be potential sources of contamination were documented (Section 4.6.4.2.3). A summary of the related findings is presented on Figure 4-9.

Section 4.6.1.2.1 provides information about the soils, hydrogeology, and ecological survey; this information is common to Areas A through F. The depth to groundwater may vary from approximately 510 feet bgs at the top of the cliffline to approximately 440 feet bgs along the lower portion of the site located below the cliffline.

4.5.4.1.2 Sampling History for Area D

Prior to the RI, there was no sampling performed at Area D. A total of three surface soil samples were collected at Area D in June 2000 and were analyzed for PAHs, pesticides, and inorganics. Sample locations are shown on Figure 4-10.

One subsurface soil sample was collected at Area D in June 2000 (Figure 4-10) and analyzed for PAHs, pesticides, PCBs, and inorganics.

4.5.4.1.3 Suspected Contamination Sources of Area D

The small amounts of debris that were observed at Area D included: barbed wire, fence posts with concrete footings, an empty alodine bottle, a telephone pole, metal brackets, cement blocks, galvanized pipe, electrical wire, construction debris, and sanitary trash.

4.5.5 Area E

4.5.5.1 Area E Characteristics

4.5.5.1.1 Area E Physical Setting

Area E, located approximately 300 feet east of Area D, is 9 acres in size, with approximately 5 acres located along the steep hillside and the remaining 4 acres situated on the top of the plateau. This area is comprised of thick shrubs and trees with small debris mounds containing fill. Elevations at Area E range from 610 feet above msl on the plateau to 275 feet above msl near its base (Figure 4-11). The southwest portion of this area is characterized by a limestone outcrop that forms the steep cliffline slope. On the northeast edge of the plateau is an area of large limestone boulders that appear to have been quarried from the bedrock. These boulders may have been used as tools for the clearing of vegetation at the different areas of Site 12 and would have allowed for easy disposal of debris down the cliff. The base of the site contains similar boulders that have two-inch-diameter holes that may be have been drilled during the quarrying.

A site reconnaissance and DSI were conducted at Area E in 1999 to accurately characterize the environmental setting and boundaries of the site, including identification of potentially hazardous wastes. During the DSI, the physical characteristics of the site and areas containing surface debris that may be potential sources of contamination were documented (Section 4.6.5.2.3). A summary of the related findings is presented on Figure 4-11.

Section 4.6.1.2.1 presents information about the soils, hydrogeology, and ecological survey; this information is common to Areas A through F. The depth to groundwater may vary from approximately 510 feet bgs at the top of the cliffline to approximately 265 feet bgs along the lower portion of the site located below the cliffline.

4.5.5.1.2 Sampling History for Area E

Prior to the RI, there was no sampling performed at Area E. A total of 43 surface soil samples (including four duplicate samples) were collected at Area E during two sampling events (Figure 4-12). From December 1999 to January 2000, 22 surface soil samples, including two duplicate samples, were collected and analyzed for SVOCs, PAHs, pesticides, PCBs, and inorganics. Twenty-one confirmatory samples, including two duplicate samples, were collected in June 2000 and analyzed for PAHs (seven samples), pesticides (seven samples), chromium (five samples), copper (five samples), and lead (four samples). Sample locations are presented on Figure 4-12.

Eleven subsurface soil samples, including two duplicate samples, were collected at Area E in January/February 2000 (Figure 4-13) and were analyzed for VOCs, PAHs, pesticides, PCBs, and inorganics.

Three drum samples were collected at Area E in February 2000 (Figure 4-13) and analyzed for VOCs, TPH, PCBs, and reactivity-ignitability-corrosivity (RIC).

4.5.5.1.3 Suspected Contamination Sources of Area E

Of the 38 grid cells that make up Area E, approximately 16 are located on the plateau above the cliffline. Areas of scattered debris were observed along the top of the cliffline along with fill and buried trash, to an approximate depth of approximately 9 feet bgs. Figure 4-11 shows the approximate boundaries of the fill material. Observed surface and subsurface debris included: alodine and deoxidine bottles, 55-gallon drums, 3-gallon containers, dried resin-like material, mechanical parts, electrical parts, and construction debris.

The portion of Area E located downslope is comprised of approximately 22 grid cells. Fill material extends approximately 400 feet down the slope and is approximately 400 feet wide. More than 80 drums were observed along the slope; however, the exact number of drums was difficult to determine, as much of the slope was unstable. Five drums contained a petroleum-like liquid; three of the drums were approximately 80 percent full with an unknown liquid, and two drums were approximately 10 percent full. Other debris observed included grease canisters, respirator cartridges, 6-inch-diameter POL pipe, aircraft parts, 500-pound bomb end-caps, hardened paint, vehicle parts, rubber tires, construction debris, and sanitary trash. A total of 14 test ditches were excavated on the plateau at the top of Area E. The ditches ranged from 27 to 100 feet in length and to an average depth of 3.5 feet bgs, where bedrock was encountered. Debris was observed in 9 of the 10 test ditches and included aluminum aircraft parts, sheet metal, glass bottle, electrical wire, solid asphalt, and concrete blocks. Two separate pieces of OEW (expended incendiary bomblets) were observed in two of the test ditches; these OEW do not pose a physical hazard to human and ecological receptors.

4.5.6 Area F

4.5.6.1 Area F Characteristics

4.5.6.1.1 Area F Physical Setting

Area F (previously designated as Pati Point Dumpsite) is located approximately 400 feet east of Area E. The area is less than 2 acres in size and is situated at the base of a 170-foot vertical cliff (Figure 4-14). Due to the vertical cliff there was no topographic map generated for this area.

A site reconnaissance and DSI were conducted at Area F in 1999 to accurately characterize the environmental setting and boundaries of the site, including identification of potentially hazardous wastes. During the DSI, the physical characteristics of the site and areas containing surface debris that may be potential sources of contamination were documented (Section 4.6.6.2.3). A summary of the related findings is presented on Figure 4-14.

Section 4.6.1.2.1 presents information about the soils, hydrogeology, and ecological survey; this information is common to Areas A through F. The depth to groundwater anticipated to be approximately 400 feet bgs at the top of the cliffline.

4.5.6.1.2 Sampling History for Area F

Prior to the RI, there was no sampling performed at Area F. A total of eight surface soil samples, including one duplicate, were collected during two sampling events (Figure 4-15). Five surface soil samples, including one duplicate sample, were collected during January 2000 and analyzed for SVOCs, PAHs, pesticides, PCBs, and inorganics. Three confirmatory surface soil samples were collected in June 2000 and analyzed for cadmium. Two drum samples were collected at Area F in February 2000 and analyzed for VOC and RIC (Figure 4-15).

4.5.6.1.3 Suspected Contamination Sources of Area F

A large amount of debris is piled to an unknown depth at the base of the cliff (Figure 4-14). The material includes aircraft parts, approximately forty-three 55-gallon drums, two 14-volt batteries, NiCd batteries, air conditioners, vehicle parts, bomb tail fins, fire extinguishers, refrigeration radiators, a trailer with wheels, construction debris, and sanitary trash. Approximately four of the 55-gallon drums are partially filled with an unknown liquid. Due to the shear cliff and narrow lateral extent of the site, a survey of the topography and site boundary was not performed.

4.6 Conceptual Site Model for Site 12

Site 12 is part of the Main Base OU and was formerly included as part of OU5. Site 12 is comprised of six subsites, designated Areas A through F, that cover approximately 24 acres along a cliffline north of the active runways and adjacent to the WSA (Figure 1-6). The Pacific Ocean is located approximately 1,600 feet to the north of Site 12 (Figure 1-6). The site is an

inactive disposal area that was reportedly used for the disposal of waste materials, municipal-like trash, and excess equipment between 1945 and 1949.

Area A is approximately 3 acres in size and is located at the westernmost portion of Site 12 (Figure 1-6). Area A is situated along the northern cliffline and is comprised of the following fill material: soil, solid asphalt and concrete rubble, coral boulders, drums, aircraft parts, electrical parts, construction debris, and sanitary trash.

Area B, located approximately 600 feet east of Area A, is approximately 9 acres in size (Figure 1-6). Half of the area is situated along the cliffline and the other half is located on the grassy plateau. The cliffline slope has the following types of fill material: soil and limestone boulders, drums, aircraft parts, electrical parts, intact and spent 50-caliber bullets and casings, construction debris, and sanitary trash.

Records indicate three structures were located on the upper portion of Area B. One building, designated as Facility T-2046, was used as a training aid gas chamber. According to Base Real Property records, Facility T-2046 was dismantled in January 1962. In 1963, a small-arms range was constructed at Area B that consisted of a Range Control House (Facility T-2047) and a lateral moving target (Facility T-2043). According to Base Real Property records, these facilities were dismantled in 1967. One large mound (60 feet by 30 feet by 90 feet), located near the edge of the cliffline, was used as the backdrop for the small-arms range lateral target. Spent bullets and shell casings are scattered throughout the vicinity of the mound. The northern and eastern portions of the site on top of the plateau also contain several smaller mounds with lesser amounts of surface debris.

Area C, located approximately 1,500 feet east of Area B, occupies less than 1 acre along the cliffline (Figure 1-6). The area consists of scattered sanitary trash, limestone boulders, and sparse vegetation.

Area D, located approximately 500 feet east of Area C, is similar in size and physical characteristics to Area C (Figure 1-6).

Area E, located approximately 300 feet east of Area D, is approximately 9 acres in size (Figure 1-6). Approximately 5 acres of Area E are located along the steep hillside and are comprised of the following types of fill material: soil and limestone boulders, drums, aircraft parts, construction and mechanical equipment, and sanitary trash. The remaining 4 acres of Area E are situated on the top of the plateau. This area is comprised of thick shrubs and trees with localized small debris mounds containing similar fill material as noted along the hillside. The eastern edge of the plateau contains many large limestone boulders.

Area F is located approximately 400 feet east of Area E (Figure 1-6). The area is less than 2 acres in size and is situated at the base of a 170-foot vertical cliff. Large amounts of debris are piled at the base of the cliff, including drums, NiCd batteries, aircraft parts, mechanical equipment, construction debris, vehicle parts, office equipment, and sanitary trash.

Currently there are no people working or living on or near the site. The site is not fenced and can be accessed, even though the steep slopes make access difficult. The slope and areas downgradient of the site are designated as part of the Guam National Wildlife Overlay (United

States Fish and Wildlife Service [USFWS], 1995). Due to the steep terrain, the proximity to active runways, and the presence of the Guam National Wildlife Overlay, there are no plans to develop the site for commercial or residential use in the future. Due to these restrictions present and future receptors at the site are limited to occasional users/trespassers. However, a conservative approach was utilized and baseline assumption risks to potential future residents and children were evaluated for Site 12.

Media of concern identified at the site are surface soil, subsurface soil, and air exposures, which could result from dispersion of surface and subsurface soil into air. Groundwater is not considered as a medium of concern. There are no monitoring wells within the 0.25 mile radius of Site 12. The depth to groundwater is anticipated to vary from approximately 500 feet bgs at the top of the cliffline to approximately 265 to 455 feet bgs along the lower portions of the site. Based on the site location and topography, the prevailing groundwater flow direction would be generally north, toward the Pacific Ocean (Figure 1-6). The site is located downgradient of the aquifer recharge zone and will not impact current or future groundwater production wells within the aquifer recharge zone. The freshwater lens is relatively thin beneath the site, and becomes even thinner and more brackish as it approaches the nearby Pacific Ocean. The thinness of the lens downgradient of the site and the unsuitability of the land for development preclude it from being used as a source of potable water.

The exposure pathways considered for the highly unlikely future resident adult and child scenario are incidental soil ingestion and dermal exposures to surface soil, and inhalation of surface soil particles in air. The evaluation of the residential scenario is included to provide a basis for any further risk management needs at the site. It is assumed that future residents could be exposed to subsurface soil, which could be disturbed during digging or excavation activities and brought to the surface. Therefore, as a conservative measure, residents are also evaluated for incidental ingestion of, dermal contact with, and inhalation of subsurface soil particles. The exposure pathways considered for current and future occasional users/trespassers are incidental ingestion of, dermal contact with, and inhalation of airborne particulates of surface soil. The CSM for Site 12 is presented in Figure 4-16. An exposure pathway analysis is presented in Table 4-1.

4.7 Site 12 COPCs

4.7.1 Area A

A total of 30 surface soil samples, including three duplicate samples, were collected from Area A during January and February 2000 to characterize and evaluate the risks to human health and the environment posed by the site (Figure 4-2). Based on these analytical results, antimony, arsenic, barium, cadmium, copper, cyanide, lead, manganese, mercury (inorganic), molybdenum, thallium, zinc, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-c,d)pyrene, DDE, DDT, and dieldrin were identified as COPCs in surface soil at Area A as they exceeded the residential PRGs and BTVs (for metals).

A total of 10 subsurface soil samples (including one duplicate) were collected during the February and July 2000 events so that buried waste materials could be evaluated (Figure 4-3). Based on these analytical results, beryllium, cobalt, cyanide, lead, benzo(a)anthracene,

benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-c,d)pyrene, and DDE were identified as COPCs in subsurface soil at Area A as they exceeded the residential PRGs and BTVs (for metals).

4.7.2 Area B

A total of 76 surface soil samples, including six duplicate samples, were collected from Area B during December 1999 and July 2000 to characterize and evaluate the risks to human health and the environment posed by the site (Figure 4-5). Based on these analytical results, aluminum, antimony, arsenic, cadmium, chromium (total), copper, lead, thallium, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, fluoranthene, indeno(1,2,3-c,d)pyrene, and pyrene were identified as COPCs in surface soil at Area B as they exceeded the residential PRGs and BTVs (for metals).

A total of 29 subsurface soil samples (including three duplicates) were collected during the January through February 2000 sampling event so that buried waste materials could be evaluated (Figure 4-6). Based on these analytical results, aluminum, cadmium, chromium (total), lead, thallium, vanadium, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-c,d)pyrene were identified as COPCs in subsurface soil at Area B as they exceeded the residential PRGs and BTVs (for metals).

4.7.3 Area C

A total of three surface soil samples were collected from Area C in June 2000 to characterize and evaluate the risks to human health and the environment posed by the site (Figure 4-8). Based on these analytical results cadmium and lead were identified as COPCs in surface soil at Area C as they exceeded the residential PRGs and BTVs (for metals).

One subsurface soil sample was collected in June 2000 so that buried waste materials could be evaluated (Figure 4-8). Based on these analytical results no compounds were identified as COPCs in subsurface soil at Area C as they did not exceed the residential PRGs and BTVs (for metals).

4.7.4 Area D

A total of three surface soil samples were collected from Area D in June 2000 to characterize and evaluate the risks to human health and the environment posed by the site (Figure 4-10). Based on these analytical results, cadmium was identified as a COPC in surface soil at Area D as they exceeded the residential PRGs and BTVs (for metals).

One subsurface soil sample was collected in June 2000 so that buried waste materials could be evaluated (Figure 4-10). Based on these analytical results, no compounds were identified as COPCs in subsurface soil at Area D as they did not exceed the residential PRGs and BTVs.

4.7.5 Area E

A total of 43 surface soil samples, including four duplicate samples, were collected from Area E during two sampling events (from December 1999 through January 2000 and June 2000) to characterize and evaluate the risks to human health and the environment posed by the site (Figure 4-12). Based on these analytical results, cadmium, copper, lead, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-c,d)pyrene, and DDT were identified as COPCs in surface soil at Area E as they exceeded the residential PRGs and BTVs (for metals).

A total of 11 subsurface soil samples (including two duplicates) were collected during a January/February 2000 sampling event so that buried waste materials could be evaluated (Figure 4-13). Based on these analytical results, cadmium and thallium were identified as COPCs in subsurface soil at Area E as they exceeded the residential PRGs and BTVs (for metals).

4.7.6 Area F

A total of eight surface soil samples, including one duplicate, were collected from Area F during two sampling events (January and June 2000) to characterize and evaluate the risks to human health and the environment posed by the site (Figure 4-8). Based on these analytical results cadmium and nickel were identified as COPCs in surface soil at Area F as they exceeded the residential PRGs and BTVs (for metals).

4.8 Current and Potential Future Site and Resource Users

Currently there are no people working or living on or near the site. The site is not fenced and can be accessed, even though the steep slopes make access difficult. The slope and areas downgradient of the site are designated as part of the Guam National Wildlife Overlay (USFWS, 1995). Due to the steep terrain, the proximity to active runways, and the presence of the Guam National Wildlife Overlay, Andersen AFB future land reuse plans do not include future commercial or residential reuse of Site 12. Present and future receptors at the site include occasional users/trespassers. Future onsite resident adults and children were evaluated as receptors as a conservative, baseline measure.

4.9 Summary of Site Risks

A HHRA and an ERA were performed for Site 12 to evaluate whether the COPCs identified in surface and subsurface soil pose potential unacceptable risks to human health or the environment. The HHRA and ERA identified the COPCs, exposure concentrations, exposure duration, and exposure pathways and estimated the risks to human health and the environment if no action were taken. COPCs that are determined to pose unacceptable risks to human health or the environment are designated as COCs. A comprehensive HHRA and ERA for Site 12 are presented in RI/FS (EA, 2006). In accordance with USEPA Guidance (USEPA, 1999a), the HHRA and ERA are presented in terms of COCs, only.

4.9.1 Baseline HHRA for Site 12

The baseline HHRA estimates what risks the site poses if no action were taken. It provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action. This section of the ROD summarizes the results of the baseline HHRA for this site. The HHRA methodology is detailed in Appendix D.3 of RI/FS (EA, 2006) and, in general, involves a four-step process: (1) hazard identification, (2) toxicity assessment, (3) exposure assessment, and (4) risk characterization.

4.9.1.1 Identification of COCs for HHRA at Site 12

The range of detected concentrations (maximum and minimum) and the frequency of detection for each COC identified in surface and subsurface soils at Areas A, B, E, and F of Site 12 are included in Tables 4-2 through 4-7. No COCs were identified in surface and subsurface soils at Areas C and D of Site 12.

The EPC for each COC is a statistically derived concentration based on the soil sample results that is used to calculate the risk associated with each COC. The EPCs for COCs in surface and subsurface soils for Site 12 are included in Tables 4-2 and 4-7.

For the RME scenario, the EPC for each COC is estimated using the arithmetic mean and the 95UCLM. The 95UCLM represents a high value for an EPC so there is 95 percent confidence that all other values will be below the 95UCLM value. The 95UCLM is used as the EPC in the exposure assessment for the RME assumptions. However, if the 95UCLM is greater than the maximum detected concentration, the maximum detected concentration value is used as the EPC and is listed in the table instead of the 95UCLM value.

4.9.1.2 Exposure Assessment for HHRA at Site 12

An exposure assessment is conducted to estimate the magnitude of actual and/or potential human exposures. In the exposure assessment, average and maximum estimates of potential exposure are developed in accordance with USEPA guidance for both current and potential future land-use assumptions. Current maximum exposure estimates are used to determine whether a potential health hazard exists based on current conditions. Future maximum potential exposure estimates are used to provide an understanding of potential future exposures and health hazards and include a qualitative estimate of the likelihood of such exposures occurring. Conducting an exposure assessment involves analyzing releases of COCs; identifying all potential pathways of exposure; estimating average and maximum potential exposure point concentrations for specific pathways based both on environmental monitoring data and predictive chemical modeling results; and estimating potential chronic daily intakes for specific pathways. The results of this assessment are pathway-specific estimates of intakes for current and potential future exposures to individual COCs.

Potential Receptor Populations

Due to occasional use by adult trespassers, occasional users/trespassers are identified as potential receptors at the Site. Due to the proximity to the active runways and the presence of the Guam National Wildlife Overlay (USFWS, 1995), Andersen AFB future land reuse plans do not

include future residential reuse of Site 12. It is not expected that residential exposures are likely to occur at the site in the future. However, at the request of USEPA Region 9, future onsite resident adults and children were evaluated as receptors, as a conservative measure.

Chemical Release Source

As illustrated in the CSM (Figure 4-16), COCs detected in the heterogeneous wastes at Site 12 may have adsorbed onto surface and subsurface soil particles. COCs may also have been released into the air as a result of disturbance of impacted soils (e.g., by wind and other climatic factors).

Media of Concern

Media of concern include surface soil, subsurface soil, and air as environmental transport media for the suspension of COC-impacted surface and subsurface soil particles present at Site 12. Groundwater was not considered as a medium of concern. The site is located downgradient of the aquifer recharge zone and will not impact current or future groundwater production wells within the aquifer recharge zones. The freshwater lens is relatively thin beneath the site, and becomes even thinner and more brackish as it approaches the nearby Pacific Ocean. The thinness of the lens downgradient of the site and the unsuitability for developing the land preclude it from being used as a source of potable water.

Exposure Pathways

The following exposure pathways are included in the CSM (Figure 4-16) and are considered to be complete for Site 12:

- Incidental ingestion of surface soil during residential activities (i.e., gardening)
- Incidental ingestion of surface soil during trespassing activities
- Dermal contact with surface soil during residential activities (i.e., gardening)
- Dermal contact with surface soil during trespassing activities
- Incidental ingestion of subsurface soil during residential activities (i.e., gardening)
- Dermal contact with subsurface soil during residential activities (i.e., gardening)
- Inhalation of suspended surface soil particles during residential activities (i.e., gardening)
- Inhalation of suspended surface soil particles during trespassing activities
- Inhalation of suspended subsurface soil particles during residential activities (i.e., gardening)

The final step in the exposure assessment is to estimate COC intakes for each of the pathways considered in the assessment. In this exposure assessment, two different measures of intake are provided depending on the nature of the effect being evaluated. When evaluating longer-term exposures to chemicals that produce adverse non-carcinogenic effects, intakes are averaged over the period of exposure (i.e., the averaging time) (USEPA, 1989a). This measure of intake is

referred to as the ADI and is a less-than-lifetime exposure. For chemicals that produce carcinogenic effects, intakes are averaged over an entire lifetime and are referred to as the LADI (USEPA, 1989a).

The detailed exposure duration, exposure time, incidental ingestion rates of contaminated soil, inhalation rates of contaminated dust, and dermal exposure assumptions for resident adults, resident children, occasional users and trespassers under RME and CT scenarios are presented in Appendix D.3 of the RI/FS.

4.9.1.3 Toxicity Assessment for HHRA at Site 12

The toxicity assessment considers the types of potential adverse health affects associated with exposures to COCs. The toxicity assessment relies on existing toxicity information developed based on dose-response for specific COCs. Using this dose-response relationship, specific toxicity values are derived by USEPA that can be used to estimate the incidence of potentially adverse effects occurring in humans at different exposure levels. The USEPA-derived toxicity values for COCs are called RfDs for non-carcinogens and SFs for potential carcinogens.

The USEPA IRIS database was used for RfDs of non-carcinogenic COCs. If RfDs for COCs were not available from IRIS, the USEPA HEAST were used as a secondary data source. If RfDs for COCs were not available from IRIS or HEAST for one route of exposure but existed for another route, the existing value was examined for technical applicability to the alternate route and subsequently used, if appropriate. The primary non-carcinogenic target organs for aluminum, antimony, cadmium, copper, manganese, DDT, and dieldrin are the skin, blood, kidneys, gastro-intestinal system, nervous system, and liver.

Unlike non-carcinogens, carcinogens are generally assumed to have no threshold, that is, there is presumed to be no level of exposure below which carcinogenic effects will not manifest themselves. This “non-threshold” concept supports the idea that there are small, finite probabilities of inducing a carcinogenic response associated with every level of exposure to a potential carcinogen. The primary carcinogenic target organs for arsenic, cadmium, benzo(a)pyrene, and benzo(k)fluoranthene are the skin, lungs, and forestomach. The weight-of-evidence classification system assigns a letter or alphanumeric (A through E) to each potential carcinogen that reflects an assessment of its potential to be a human carcinogen:

- A = a known human carcinogen
- B1 = a probable human carcinogen, based on sufficient animal data and limited human data
- B2 = a probable human carcinogen based on sufficient animal data and inadequate or no human data
- C = a possible human carcinogen
- D = not classifiable as to human carcinogenicity
- E = evidence of noncarcinogenicity for humans

Only compounds that have a weight-of-evidence classification of C or above are considered to have carcinogenic potential in this risk assessment.

Additionally, there are no toxicity values available for lead. According to the USEPA, lead is classified as a B4-probable human carcinogen. However, there is no USEPA value for use as a slope factor in quantifying cancer risks. In the absence of any USEPA-published toxicity values for lead, it is currently not possible to perform a quantitative risk estimate for lead exposures using standard USEPA methodology. The current USEPA guidance sets forth an interim soil cleanup level for total lead at 400 mg/kg (USEPA, 1989b), which is considered "protective for direct contact at residential settings." Infants and young children are the populations most vulnerable to effects from exposure to lead.

4.9.1.4 HHRA Characterization for Site 12

Carcinogenic risk was estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to a potential carcinogen at the site. The numerical estimate of excess lifetime cancer risk was calculated by multiplying the LADI by the risk per unit dose (the slope factor), as shown in the following equation:

$$Risk = LADI \times SF$$

where: Risk = A unitless probability (e.g., 2×10^{-5}) of an individual's developing cancer
LADI = Lifetime average daily intake (mg/kg/day)
SF = Cancer slope factor $(mg/kg/day)^{-1}$

Because the SF is the statistical 95th percent UCL on the dose-response slope, this method provides a conservative, upper-bound estimate of risk.

Cancer risks were estimated for current and future occasional users and for potential future residents. These risks are probabilities that usually are expressed in scientific notation (e.g., 1×10^{-6}). An excess lifetime cancer risk of 1×10^{-6} indicates that an individual experiencing the reasonable maximum exposure estimate has a 1 in 1,000,000 chance of developing cancer as a result of site-related exposure. This is referred to as an "excess lifetime cancer risk" because it would be in addition to the risks of cancer individuals face from other causes such as smoking or exposure to too much sun. The chance of an individual's developing cancer from all other causes has been estimated to be as high as one in three. USEPA's generally acceptable risk range for site-related exposures is 10^{-4} to 10^{-6}.

The potential human health risks associated with exposures to non-carcinogenic COCs at Site 12 were estimated by comparing ADIs with established RfDs, as per USEPA guidance (USEPA, 1989a) derived for a similar exposure period. An RfD represents a level that an individual may be exposed to that is not expected to cause any deleterious effect. The ratio of exposure to toxicity is called a HQ. An HQ<1 indicates that a receptor's dose of a single contaminant is less than the RfD, and that toxic non-carcinogenic effects from that chemical are unlikely. The HI is generated by adding the HQs for all COCs that affect the same target organ (e.g., liver) or that act through the same mechanism of action within a medium or across all media to which a given individual may reasonably be exposed. An HI<1 indicates that, based on the sum of all HQ's from different contaminants and exposure routes, toxic non-carcinogenic effects from all

contaminants are unlikely. An HI >1 indicates that site-related exposures may present a risk to human health.

The HQ is calculated as follows:

$$HQ = \frac{ADI}{RfD}$$

where: HQ = Hazard quotient; ratio of average daily intake level to acceptable daily intake level (unitless)
ADI = Estimated average daily intake (mg/kg/day)
RfD = Reference dose (mg/kg/day)

ADI and RfD are expressed in the same units and represent the same exposure period (i.e., chronic, subchronic, or short-term).

4.9.1.4.1 Surface and Subsurface Soil Exposures at Site 12

Risk characterization is the final step of the HHRA process. In this step, the toxicity values were combined with the estimated chemical intakes for the receptor populations to quantitatively estimate both carcinogenic risks and risks for non-carcinogens. Risks were estimated for the following receptor populations:

- Future resident adults and children
- Occasional users/trespassers

The detailed exposure and risk calculations are presented in Appendix D.3 of the RI/FS. The results of the scenarios for which unacceptable health risks were calculated from exposure to COC in surface and subsurface soil at Site 12 follow.

4.9.1.4.1.1 Area A

Surface Soil Risk Results

Non-cancer HIs exceeded 1.0 for resident adults and children (Tables 4-8 and 4-9, respectively). Adult residential exposures to COCs in surface soil and air at Site 12 result in an HI that exceeds USEPA's risk target of 1.0. Using RME conditions, the total HI was 2.9 for resident adults. Therefore, there are concerns for adverse effects from exposures to non-carcinogens in surface soil for resident adults at Area A. Exposures to COCs in surface soil and air at Area A among resident children, under the specified exposure conditions, result in an HI that exceeds 1.0 under RME conditions. Under RME conditions the HI was 22.3. The COCs with cumulative HIs exceeding 1.0 were antimony (HI = 5.0), arsenic (HI = 4.8), copper (HI = 2.0), manganese (HI = 5.1), and DDT (HI = 3.3) under RME conditions.

Cumulative cancer risks across all pathways marginally exceeded USEPA's acceptable risk range of 10^{-6} to 10^{-4} for future residents (adults and children) (Table 4-8). Under RME conditions, the cumulative cancer risk was 1.7×10^{-4}. The COCs with cumulative risks to

resident adults/children exceeding USEPA's risk goal of 10^{-6} were arsenic (1.1×10^{-4}), benzo(a)pyrene (1.7×10^{-6}), DDE(1.6×10^{-5}), DDT (2.7×10^{-5}), and dieldrin (1.7×10^{-5}), under RME conditions. The COCs with cumulative risks to occasional users/trepassers exceeding USEPA's risk goal of 10^{-6} were arsenic (8.9×10^{-6}), DDE(1.3×10^{-6}), DDT (2.4×10^{-6}), and dieldrin (2.0×10^{-6}), under RME conditions.

Subsurface Soil Risk Results

No unacceptable risk to human health was calculated for exposure of resident adults and children to COC-impacted subsurface soil at Site 12 Area A.

4.9.1.4.1.2 Area B

Surface Soil Risk Results

Non-cancer HIs exceeded 1.0 for resident adults and children (Tables 4-10 and 4-11), respectively). Adult residential exposures to COCs in surface soil and air at Site 12 Area B result in an HI that exceeds USEPA's risk target of 1.0. However, there were no COCs with cumulative HIs exceeding 1.0. When HIs were summed across target organs there were no target organs with HIs exceeding 1.0. Therefore, there are no concerns for adverse effects from exposures to non-carcinogens in surface soil for resident adults at Area B. Exposures to COCs in surface soil and air at Area B among resident children, under the specified exposure conditions, result in an HI that exceeds 1.0 under RME conditions. Under RME conditions the HI was 10.9. The COCs with cumulative HIs exceeding 1.0 were aluminum (HI = 2.1), antimony (HI = 1.5), arsenic (HI = 1.9), chromium (HI = 2.4), and manganese (HI = 2.4).

Cumulative cancer risks across all pathways exceeded USEPA's acceptable risk range of 10^{-6} to 10^{-4} for future residents (adults and children) (Table 4-10). Under RME conditions the cumulative cancer risk was 3.0×10^{-3}. The COCs with cumulative risks exceeding USEPA's risk goal of 10^{-6} were arsenic (4.4×10^{-5}), chromium (1.4×10^{-5}), benz(a)anthracene (1.8×10^{-4}), benzo(a)pyrene (2.0×10^{-3}), benzo(b)fluoranthene (1.8×10^{-4}), benzo(k)fluoranthene (9.6×10^{-6}), dibenz(a,h)anthracene (3.4×10^{-4}), and indeno(1,2,3-c,d)pyrene (2.1×10^{-4}), under RME conditions.

Excess lifetime cancer risks to occasional users/trespassers resulting from exposure to COCs in surface soil and ambient air at Area B exceeded USEPA's risk range of 10^{-6} to 10^{-4} (Table 4-12). The total excess lifetime cancer risk was 3.7×10^{-4} under RME conditions. The COCs with cumulative risks exceeding USEPA's risk goal of 10^{-6} were arsenic (3.6×10^{-6}), benz(a)anthracene (2.2×10^{-5}), benzo(a)pyrene (2.5×10^{-4}), benzo(b)fluoranthene (2.4×10^{-5}), benzo(k)fluoranthene (1.2×10^{-6}), dibenz(a,h)anthracene (4.3×10^{-5}), and indeno(1,2,3-c,d)pyrene (2.6×10^{-5}), under RME conditions.

Subsurface Soil Risk Results

HIs exceeded USEPA's risk target of 1.0 for resident adults and children (Tables 4-13 and 4-14). Exposure to COCs in subsurface soil and air among resident adults resulted in an estimated HI of 1.9 under RME conditions. There were no COCs or target organs with HIs exceeding 1.0, indicating no concern for adverse non-cancer health effects for resident adults exposed to

subsurface soil. Exposure to COCs in subsurface soil and air at Area B among resident children resulted in an estimated HI of 12 under RME conditions. Cumulative HIs exceeded 1.0 for aluminum (HI = 3.3), chromium (HI = 4.1), and manganese (HI = 4.0).

Excess lifetime cancer risks to future residents (adults/children) from exposures to COCs in subsurface soil exceeded USEPA's acceptable risk range of 10^{-6} to 10^{-4} (Table 4-13). The total excess lifetime cancer risk was 8.9×10^{-4} under RME conditions. The COCs with cumulative risks exceeding USEPA's risk goal of 10^{-6} were benz(a)anthracene (4.1×10^{-5}), benzo(a)pyrene (5.3×10^{-4}), benzo(b)fluoranthene (5.5×10^{-5}), benzo(k)fluoranthene (2.7×10^{-6}), dibenz(a,h)anthracene (1.4×10^{-4}), and indeno(1,2,3-c,d)pyrene (9.3×10^{-5}), under RME conditions.

4.9.1.4.1.3 Area C

Surface Soil Risk Results

No unacceptable risk to human health was calculated for exposure of resident adults and children or occasional users/trespassers to COC-impacted surface soil at Area C.

Subsurface Soil Risk Results

There were no COCs identified in subsurface soil at Area C.

4.9.1.4.1.4 Area D

Surface Soil Risk Results

No unacceptable risk to human health was calculated for exposure of resident adults and children or occasional users/trespassers to COC-impacted surface soil at Area D.

Subsurface Soil Risk Results

There were no COCs identified in subsurface soil at Area D.

4.9.1.4.1.5 Area E

Surface Soil Risk Results

No unacceptable risk to human health was calculated for exposure of resident adults and children or occasional users/trespassers to COC-impacted surface soil at Area E.

Subsurface Soil Risk Results

No unacceptable risk to human health was calculated for exposure of resident adults and children to COC-impacted surface soil at Area E.

4.9.1.4.1.6 Area F

Surface Soil Risk Results

Non-cancer HIs exceeded 1.0 for resident adults and children (Tables 4-15 and 4-16). Adult residential exposures to COCs in surface soil and air at Site 12 Area F result in an HI that exceeds USEPA's risk target of 1.0. Using RME, the total HI was 4.1 for resident adults. Cadmium was the only COC with a cumulative HI exceeding 1.0 (HI = 3.9) under RME conditions. Exposures to COCs in surface soil and air at Area F among resident children, under the specified exposure conditions, result in an HI that exceeds 1.0 under RME conditions. Under RME conditions the HI was 39. The only COCs with a cumulative HI exceeding 1.0 were cadmium (HI = 37) and nickel (HI = 1.8).

4.9.1.4.2 HHRA Results for Lead in Surface and Subsurface Soils at Site 12

Human health risks associated with exposures to lead were not calculated the same as either cancer or non-caner risks. Risks related to lead were based on studies of adverse effects on children, based on blood lead levels, and are discussed in the following sections. Lead was detected in surface and/or subsurface soil in samples collected from Site 12 Areas A, B, C, and E.

4.9.1.4.2.1 Area A Lead Risk Results

Surface Soil Lead Risk Results

Resident Children

Lead was detected in surface soil samples at Area A at concentrations greater than the screening level of 400 mg/kg. The mean lead concentration was 9,860 mg/kg. The maximum detected concentration of lead in surface soils at Area A was 147,000 mg/kg.

Based on LEAD99D model outputs, the predicted mean blood lead concentration for children hypothetically residing at Site 12 Area A is greater than the 10 μg/dL "level of concern" when all data are included in the mean lead concentration. Therefore, under future residential conditions whereby children could be exposed to Area A surface soil, potential related adverse health effects would be a concern and remediation would be necessary.

Subsurface Soil Lead Risk Results

Resident Children

Lead was detected in Area A subsurface soil at concentrations greater than the residential soil lead guideline of 400 mg/kg. The mean soil lead concentration in subsurface soil was 969 mg/kg and the maximum detected concentration was 6,240 mg/kg.

Based on the LEAD99D model outputs, the population of children potentially exposed to subsurface soil lead under residential exposure conditions is predicted to have a mean blood lead level of 10.8 μg/dL. This would result in 48 percent of the exposed children's blood lead levels exceeding the level of concern (10 μg /dL) at Area A. Therefore, under future residential

conditions whereby children could be exposed to Area A subsurface soil, potential related adverse health effects would be a concern and remediation would be necessary.

4.9.1.4.2.2 Area B Lead Risk Results

Surface Soil Lead Risk Results

Resident Children

Lead was detected in surface soil samples at Area B at concentrations greater than the screening level of 400 mg/kg. The mean lead concentration was 5,910 mg/kg. The maximum detected concentration of lead in surface soils at Area B was 122,000 mg/kg.

Based on LEAD99D model outputs, the predicted mean blood lead concentration for children hypothetically residing at Site 12 is greater than the 10 μg/dL "level of concern" when all data are included in the mean lead concentration at Site 12. Therefore, under future residential conditions whereby children could be exposed to Area B subsurface soil, potential related adverse health effects would be a concern and remediation would be necessary.

Subsurface Soil Lead Risk Results

Resident Children

Lead was detected in Area B subsurface soil at concentrations greater than the residential soil lead guideline of 400 mg/kg. The mean soil lead concentration in subsurface soil was 271 mg/kg and the maximum detected concentration was 1,210 mg/kg.

Based on the LEAD99D model outputs, the population of children potentially exposed to Area B subsurface soil lead under residential exposure conditions is predicted to have a mean blood lead level of 4.6 μg/dL. This would result in more than 95 percent of the exposed population predicted to have blood lead levels below the 10 μg/dL level of concern. Therefore, under future residential conditions whereby children could be exposed to Area B subsurface soil, potential related adverse health effects would be a concern and remediation would be necessary.

4.9.1.4.2.3 Area C Lead Risk Results

Surface Soil

Resident Children

Lead was detected in Area C surface soil at concentrations greater than the screening level of 400 mg/kg. The mean soil lead concentration in surface soil was 174 mg/kg and the maximum detected concentration was 494 mg/kg.

Based on the LEAD99D model outputs, the population of children potentially exposed to Area C surface soil lead under residential exposure conditions is predicted to have a mean blood lead level of 3.1 μg/dL. This would result in more than 99 percent of the exposed population

predicted to have blood lead levels below the 10 μg/dL level of concern. Therefore, under future residential conditions whereby children could be exposed to Area E surface soil, there are no related concerns for potential adverse health effects.

4.9.1.4.2.4 Area E Lead Risk Results

Surface Soil

Resident Children

Lead was detected in Area E surface soil at concentrations greater than the screening level of 400 mg/kg. The mean soil lead concentration in surface soil was 191 mg/kg and the maximum detected concentration was 1,720 mg/kg.

Based on the LEAD99D model outputs, the population of children potentially exposed to Area E surface soil lead under residential exposure conditions is predicted to have a mean blood lead level of 3.2 μg/dL. This would result in more than 99 percent of the exposed population predicted to have blood lead levels below the 10 μg/dL level of concern. Therefore, under future residential conditions whereby children could be exposed to Area E surface soil, there are no related concerns for potential adverse health effects.

4.9.1.4.2.5 Basis for Action Statement

Based on the identified unacceptable human health risks under a future residential scenario, as summarized in Sections 4.9.1.4.1.1 through 4.9.1.4.2.4, the response action selected in this ROD is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

4.9.1.5 HHRA Uncertainties for Site 12

There are numerous uncertainties involved in the HHRA process. These are discussed briefly in the following sections.

4.9.1.5.1 Sampling and Analysis

The sampling plan can have a significant impact on the results obtained in calculating human health risks at a site. To the extent that samples are collected in areas that are expected to be contaminated (biased sampling), the EPC used in calculating risk exposures and risks is likely to overestimate the actual concentration encountered at the site from random exposure across the site. This sampling bias will generally result in an overestimate of exposures and risks at a site. The soil sampling at Site 12 incorporated a combination of random and biased samples. As the majority of soil samples collected at Site 12 are biased toward potentially contaminated areas, the detected concentrations and calculated health risks would tend to be overestimated.

4.9.1.5.2 Chemical Fate and Transport Modeling

Section 2.7.1.5.2 presents information about Chemical Fate and Transport Modeling; this information is common to Chapters 2, 3, and 4 (Decision Summaries for Sites 6, 9, and 12, respectively).

4.9.1.5.3 Toxicity Assessment

Section 2.7.1.5.3 presents information about Toxicity Assessment; this information is common to Chapters 2, 3, and 4 (Decision Summaries for Sites 6, 9, and 12, respectively).

4.9.1.5.4 Analysis of Exposure Assessment

An analysis of uncertainties is an important aspect of the exposure assessment. It provides the risk assessor and reviewer with information relevant to the individual uncertainties associated with exposure factor assumptions and their potential impact on the final assessment.

Uncertainties of Receptors of Concern

Under current use conditions at Site 12, the only receptors are occasional users/trespassers; however, residents are considered as future receptors. The results of this HHRA indicate that there are unacceptable risks to occasional users/trespassers and future residential receptors at Area B.

The USAF has evaluated risks to potential future residents at the site, although there are no plans for residential development. It was only under these most conservative assumptions that any risks were identified that exceeded USEPA's risk targets. This is an unlikely future use scenario and should be considered to present the possibility of adverse health effects at the site only in the unlikely event that residential development takes place at Site 12.

Uncertainties of Exposure Factors

Section 2.7.1.5.4 presents information about Uncertainties of Exposure Factors; this information is common to Chapters 2, 3, and 4 (Decision Summaries for Sites 6, 9, and 12, respectively).

4.9.1.5.5 Risk Characterization

Section 2.7.1.5.5 presents information about Risk Characterization; this information is common to Chapters 2, 3, and 4 (Decision Summaries for Sites 6, 9, and 12, respectively).

4.9.1.5.6 Deriving Cleanup Goals

Under current use conditions at the site, the only receptors are occasional users/trespassers. There are no unacceptable risks to this receptor at Site 12. Therefore, there are no cleanup goals required and no remedial action necessary to be protective of current use receptors at the site.

The 10^{-6} RGs presented in this HHRA are based on the very unlikely future residential use of Site 12. This is a very conservative approach because residential use of the site is not expected in the future. However, as a conservative approach to potential remedial options at the site, baseline cleanup values were derived for potential future residents at the site. Risk-based

cleanup values were derived for future residents to correspond to a non-cancer HI = 1.0. Risk-based cleanup values were derived for carcinogens, which correspond to three levels of potential cancer risk (10^{-6}, 10^{-5}, and 10^{-4}). These values correlate to three distinct cancer risk values, which are included in USEPA's "acceptable risk range" of 10^{-6} to 10^{-4}. The decision as to which risk level is appropriate for cleanup is a site-specific risk management decision, which is made in the FS stage of the RI/FS process.

4.9.2 Baseline ERA for Site 12

The purpose of the ERA was to determine the likelihood that adverse ecological effects may occur as a result of exposure to COCs. In addition to the DSI, an ecological (flora and fauna) survey was conducted at Site 12. Each of the three major habitat types are described below, including wildlife observed within each habitat type. The entire Site 12 is considered to be habitat for the Mariana fruit bat, an endangered species, and the bats were observed flying above several of the areas. Because the habitats and nature of contamination differ in each of the six areas, habitat surveys and risk evaluations were conducted within each of the six areas, and are discussed below.

Major Habitat Types, Area A

Area A is the westernmost portion of Site 12 (Figures 1-6 and 4-1). The area is situated almost entirely along the northern cliffline and is comprised largely of fill material: soil, solid asphalt and concrete pieces, coral boulders, drums, aircraft parts, electrical parts, construction debris, and municipal-type trash. A fill area composed of soil and debris extends down the slope approximately 200 feet and is approximately 200 feet wide.

The January 2000 ecological assessment identified approximately 20 percent of Area A as mixed shrub habitat. A mixture of vines and herbs (0 to 3 feet tall), shrubs (3 to 10 feet tall), and small trees (10 to 30 feet tall) dominate this habitat. The dominant flora in the habitat include vines (*Convolulace* sp.), herbs [eupatorium (*Chromolaena odorata*), Canadian horseweed (*Conyza canadensis*), and false verbena (*Sida* sp.)], small trees [paipai (*Guamia mariannae*), Indian mulberry (*Morinda citrifolia*), limeberry (*Triphasia trifolia*)], and larger trees [inkberry (*Cestrum* sp.), mapunyao (*Agalia mariannensis*), and sea-hibiscus (*Hibiscus tiliaceus*)].

Limestone forest habitat covers approximately 80 percent of Area A. A mixture of vines and herbs (0 to 3 feet tall), small trees (3 to 10 feet tall), and larger trees (10 to 30 feet tall) dominate this habitat. The dominant flora in the habitat include vines [*Convolulace* sp. and false rattan (*Flagellaria indica*)], herbs [eupatorium (*Chromolaena odorata*), fern (*Pteris tripartia*), and beggar's tick (*Bidens pilosa*)], the small tree paipai (*Guamia mariannae*), and larger trees [mapunyao (*Agalia mariannensis*), inkberry (*Cestrum species*), banyan (*Ficus prolixa*), paipai (*Guamia mariannae*), and sea-hibiscus (*Hibiscus tiliaceus*)]. *Tabernaemontana rotensis*, the native, rare tree proposed for listing on the GESL, was observed in the limestone forest habitat of Area A and along the cliffline between Areas A and B.

Based on site observations of game trails, scat, skeletal remains, and actual sightings, animals are prevalent across both habitats at Area A, including sambar deer (*Cervus mariannus*) and feral pigs (*Sus scrofa*). Some bird species observed transiting this habitat were the black drongo

(Dicrurus macrocerus), black francolin *(Francolinus francolinus*), Eurasian tree sparrow *(Passer montanus),* and Philippine turtle-dove *(Streptopeia bitorquata).*

Major Habitat Types, Area B

Area B is located east of Area A (Figures 1-6 and 4-4). Approximately half of Area B is situated along the cliffline, and the other half is located on the top, grassy portion of the plateau. The slope below the cliffline has concentrated areas of fill: soil and limestone boulders, drums, aircraft parts, electrical parts, 50-caliber bullets, construction debris, and municipal trash.

Mixed shrub habitat covers approximately 50 percent of Area B. A mixture of sedges, vines, and herbs (0 to 3 feet tall), shrubs (3 to 10 feet tall), and small trees (10 to 30 feet tall) dominate this habitat. The dominant species are sedges (*Cyperaceae* sp.), vines [*Convolulace* sp. and climbing hempvine (*Mikania scandens*)], herbs [eupatorium (*Chromolaena odorata*) and Canadian horseweed (*Conyza canadensis*)], shrubs (*Wikstroemia elliptica*), and small trees [mapunyao (*Agalia mariannensis*), paipai (*Guamia mariannae*), sea-hibiscus (*Hibiscus tiliaceus*), and the lipstick tree (*Ochrosia mariannensis*)].

Limestone forest habitat covers approximately 50 percent of Area B. A mixture of vines and herbs (0 to 3 feet tall), small trees (3 to 10 feet tall), and larger trees (10 to 30+ feet tall) dominate this habitat. The dominant species include vines (*Convolulace* sp.), herbs [eupatorium (*Chromolaena odorata*) and giant brake (*Pteris tripartita*)], ferns, small trees [paipai (*Guamia mariannae*) and inkberry (*Cestrum* sp.)], and larger trees [mapunyao (*Agalia mariannensis*), alum (*Melanolepis multiglandulosa*), sea-hibiscus (*Hibiscus tiliaceus*), chopak (*Pisonia grandis*), false elder (*Premna obtusifolia*), and pengua (*Macaranga thompsonii*)]. *Tabernaemontana rotensis* was also identified in the limestone forest habitat of Area B.

Based on site observations of game trails, scat, skeletal remains, and actual sightings, animals are prevalent across the entire habitat of Area B, including sambar deer (*Cervus mariannus*), feral pigs (*Sus scrofa*), and feral dogs *(Canis familiaris).* Some bird species observed transiting this habitat were the black drongo *(Dicrurus macrocerus),* black francolin *(Francolinus francolinus*), common sandpiper *(Actitus hypoleucos),* Eurasian tree sparrow *(Passer montanus),* Philippine turtle-dove *(Streptopeia bitorquata),* ruddy turnstone *(Arenaria interpres),* and white tern *(Gygis alba).* The brown tree snake *(Bioga irregularis)* was observed in traps near the site. Hermit crabs (*Coenobita* sp.) were also observed in the limestone forest portion of the site.

Major Habitat Types, Area C

Area C is a small area located below the cliffline east of Area B (Figures 1-7 and 4-7). Area C contains small amounts of municipal-type trash and limestone boulders. Limestone forest habitat represents 100 percent of Area C. A mixture of grasses, vines, and herbs (0 to 3 feet tall), small trees (3 to 10 feet tall), and larger trees (10 to 30+ feet tall) dominate this habitat. The only grass identified was *Pulitrias almora*, with dominant vines [*Convolulace* sp. and climbing hempvine (*Mikania scandens*)], herbs [groundflower (*Catharanthus roseus*) and giant brake (*Pteris tripartita*)], small trees [Indian mulberry (*Morinda citrifolia*), limeberry (*Triphasia trifolia*), and *Widstroemia biflora*], and larger trees [mapunyao (*Agalia mariannensis*), paipai (*Guamia mariannae*), alum (*Melanolepis multiglandulosa*), and pengua (*Macaranga thompsonii*)]. The

Tabernaemontana rotensis, a rare tree proposed for the GESL, was identified scattered along the cliffline between Areas A through E.

Based on site observations of game trails, scat, skeletal remains, and actual sightings, animals are prevalent across the habitat, including sambar deer (*Cervus mariannus*), feral pigs (*Sus scrofa*), and feral dogs *(Canis familiaris).* Bird species observed transiting this habitat were the black drongo *(Dicrurus macrocerus),* black francolin *(Francolinus francolinus*), common sandpiper *(Actitus hypoleucos),* Eurasian tree sparrow *(Passer montanus),* and the Philippine turtle-dove *(Streptopeia bitorquata).* The brown tree snake *(Bioga irregularis)* was observed in traps near the site. Hermit crabs *(Coenobita* sp.*)* were also observed in the limestone forest portion of the site.

Major Habitat Types, Area D

Area D is located east of Area C along the cliffline, and is similar to Area C (Figures 1-6 and 4-9). Limestone forest habitat represents 100 percent of Area D. A mixture of grasses, vines, and herbs (0 to 3 feet tall), small trees (3 to 10 feet tall), and larger trees (10 to 30+ feet tall) dominate this habitat. The only grass identified was *Pulitrias almora*, with dominant vines (*Convolulace* sp.), herbs [eupatorium (*Chromolaena odorata*), giant brake (*Pteris tripartita*), and limestone forest fern (*Tectaria crenata*)], small trees [*Wikstroemia elliptica*, limeberry (*Triphasia trifolia*), inkberry (*Cestrum* sp.)], and larger trees [mapunyao (*Agalia mariannensis*), paipai (*Guamia mariannae*), alum (*Melanolepis multiglandulosa*), chopak (*Pisonia grandis*), *Neisosperma oppositifolia*, and pengua (*Macaranga thompsonii*)].

Fauna observations at Area D are the same as for Area C (above).

Major Habitat Types, Area E

Area E is located east of Area D, along the cliffline (Figures 1-6 and 4-11). Approximately 5 acres of the area are located along the steep hillside and are comprised of fill material: soil and limestone boulders, drums, aircraft parts, various construction and mechanical equipment, and municipal trash.

Mixed shrub habitat covers approximately 40 percent of the area. A mixture of sedges, grasses, vines, and herbs (0 to 3 feet tall), shrubs (3 to 10 feet tall), and small trees (10 to 30 feet tall) dominate this habitat. The dominant grass in the area is wildcane (*Saccharum spontaneum*), with vines [climbing hempvine (*Mikania scandens*) and *Convolulace* sp.], herbs [eupatorium (*Chromolaena odorata*), Canadian horseweed (*Conyza canadensis*), balsam-apple (*Momordica charantia*), false verbena (*Sida* sp.), and beggar's tick (*Bidens pilosa*)], shrubs [Indian mulberry (*Morinda citrifolia*) and *Wikstroemia elliptica*, and limeberry (*Triphasia trifolia*)], and small trees [mapunyao (*Agalia mariannensis*), paipai (*Guamia mariannae*), sea-hibiscus (*Hibiscus tiliaceus*), lipstick tree (*Ochrosia mariannensis*), and tangantangan (*Leucaena leucocephala*)].

Limestone forest habitat covers approximately 60 percent of the area. A mixture of vines and herbs (0 to 3 feet tall) and larger trees (10 to 30+ feet tall) dominate this habitat. The dominant species were vines (*Convolulace* sp.), herbs [eupatorium (*Chromolaena odorata*) and giant brake (*Pteris tripartita*)], small trees [*Wikstroemia elliptica* and inkberry (*Cestrum species*)], and larger trees [mapunyao (*Agalia mariannensis*), alum (*Melanolepis multiglandulosa*), sea-hibiscus

(*Hibiscus tiliaceus*), paipai (*Guamia mariannae*), and chopak (*Pisonia grandis*)]. *Tabernaemontana rotensis* was identified scattered along the cliffline in Area E.

Based on site observations of game trails, scat, skeletal remains, and actual sightings, animals are prevalent across the habitat, including sambar deer (*Cervus mariannus*), feral pigs (*Sus scrofa*), and feral dogs *(Canis familiaris).* The endangered Mariana fruit bat *(Pteropus mariannus)* was observed flying over the limestone forest habitats of Area E. Bird species observed transiting this habitat were the black drongo *(Dicrurus macrocerus),* black francolin *(Francolinus francolinus*), yellow bittern *(Ixobrychus sinensis),* common sandpiper *(Actitus hypoleucos),* Eurasian tree sparrow *(Passer montanus),* Philippine turtle-dove *(Streptopeia bitorquata),* and white tern *(Gygis alba).* The brown tree snake *(Bioga irregularis)* was observed in traps near the site. Hermit crabs *(Coenobita* sp.*)* and monitor lizards *(Varanus indicus)* were also observed in the limestone forest portion of the site.

Major Habitat Types, Area F

Area F is located at the base of a 170-foot vertical cliff east of Area E (Figures 1-6 and 4-14). Large amounts of debris are piled at the base of the cliff, including drums, NiCd batteries, aircraft parts, mechanical equipment, construction debris, vehicle parts, office equipment, and municipal trash. Limestone forest habitat represents 100 percent of Area F. The area is surrounded by undisturbed limestone forest. A mixture of vines and herbs (0 to 3 feet tall) and larger trees (10 to 30+ feet tall) dominate this habitat. The dominant flora at Area F include vines (*Convolulace* sp.), herbs [eupatorium (*Chromolaena odorata*) and giant brake (*Pteris tripartita*)], shrubs [limeberry (*Triphasia trifolia*), inkberry (*Cestrum species*), and *Wikstroemia elliptica*], and trees [mapunyao (*Agalia mariannensis*), paipai (*Guamia mariannae*), sea-hibiscus (*Hibiscus tiliaceus*), ifit (*Intsia bijuga*), pengua (*Macaranga thompsonii*), alum (*Melanolepis multiglandulosa*), lipstick tree (*Ochrosia mariannensis*), and chopak (*Pisonia grandis*)].

Based on site observations of game trails, scat, skeletal remains, and actual sightings, animals are prevalent across the habitat, including sambar deer (*Cervus mariannus*), feral pigs (*Sus scrofa*), and feral dogs *(Canis familiaris).* The Mariana fruit bat *(Pteropus mariannus)* was observed flying over Area F. Bird species observed transiting this habitat were the black drongo *(Dicrurus macrocerus),* black francolin *(Francolinus francolinus),* brown noddy *(Anous stolidus),* Eurasian tree sparrow *(Passer montanus),* Philippine turtle-dove *(Streptopeia bitorquata),* and white tern *(Gygis alba).*

Based on flora and fauna of Site 12, the CSM for the ERA at Site 12 is presented in Figure 4-17. The CSM is based on simple direct contact and food-web models. The secondary source of COC exposure is surface soil. This exposure may occur through direct contact with or ingestion of surface soil, or by ingestion of plant or animal tissue that has been exposed to surface soil. Exposure pathways and routes include:

- Direct Contact with Surface Soil—This exposure route is important for uptake of COCs by plants and for soil invertebrates. Most vertebrates, when foraging, may have the potential to be exposed to COCs via dermal contact. However, the dermal exposure pathway is not believed to be important for birds, mammals, or reptiles because of the lack of contact with exposed soils. Many factors limit direct contact with exposed soils

including the extensive ground cover by vegetation, the arboreal nature of most native species, and the protection from dermal contact by scales, feathers, or hair (USEPA, 2000c). Any incidental surface contamination of scales, feathers, or hair that is subsequently ingested during grooming is accounted for in the incidental soil ingestion pathway.

- Ingestion of Food (i.e., plants and biota that have taken up constituents from soil)—Terrestrial herbivores and predators that forage in the terrestrial habitats may ingest plants or animal prey that have bioaccumulated COCs from surface soils.
- Incidental Ingestion of Surface Soils—Herbivores and predators that forage in the terrestrial habitats may incidentally ingest some surface soil with their food or during other activities such as grooming.

On the basis of this evaluation, there are complete exposure pathways to surface soil in ecological habitats potentially impacted by releases of COCs. From this environmental medium, some COCs could bioconcentrate in plants and prey animals that may be eaten by other consumers.

The selection of assessment endpoints must be based on the fundamental knowledge of the local ecology. Assessment endpoints typically relate to an effect on a population or community. Survival of Mariana fruit bats is an example of a population level assessment endpoint. Community level assessment endpoints could include the primary productivity of the limestone forest habitat. Examples of endpoints representing guilds of species are useful in that they convey information beyond the indicator species identified in the endpoint itself. An assessment endpoint involving a community index may provide more information about a site than an analysis of one species. Consequently, it is important to note that confirmation of the deleterious effects at the community level is an inherent confirmation that population level effects are occurring (Hartwell, 1997).

Based on ecological survey at Site 12 the following ecological receptors were considered in the ERA:

- Soil-invertebrate communities (i.e., earthworm) and plant communities
- Native terrestrial birds represented by the Mariana crow and the yellow bittern
- Mariana fruit bat

For the purposes of this ERA, it is assumed that no future actions are expected at Site 12 that would change the potential use of the area by ecological receptors. The ERA methodology involves a four-step process: (1) identification of potential COCs, (2) exposure assessment, (3) toxicity assessment, and (4) risk characterization.

4.9.2.1 Identification of COCs for ERA at Site 12

To identify COCs for the ERA at Site 12, the maximum detected concentration for each chemical in surface soil was compared to the higher of (1) conservative toxicologically based screening criteria, or (2) BTVs for the Base for inorganic constituents (ICF, 1998). A constituent was

excluded as a COC if the maximum detected concentration at Site 12 was lower than the screening value, or the constituent was an essential nutrient. Ecological screening values and their sources are shown in Table 4-17.

The results of COC screening are shown in Table 4-18 for Site 12. The screening values were based on conservative threshold of ecological risk as recommended by the Dutch National Institute of Public Health and Environmental Protection (Dutch, 1994, 1995, and 1997).

4.9.2.2 Exposure Assessment for ERA at Site 12

Exposure refers to the degree of contact between ecological receptors at a site and the COCs. Based on the CSM described in Section 4.10.2 of this ROD, it is assumed that ecological receptors at Site 12 are exposed to COCs in surface soil either through direct contact, via dietary food web, or both.

Only validated samples were used in the calculation of a representative concentration. "U"-qualified, or non-detect samples were included in the calculations as one-half of the detection limit. For duplicate samples, the maximum value of the duplicate sample concentrations was used in the calculations. The data for each COC were tested for normality or lognormality using the Shapiro-Wilks W-test (Shapiro and Wilks, 1965). If the data fit neither or both the normal and lognormal distribution according to the Shapiro-Wilks test, a lognormal distribution was assumed consistent with USEPA guidance (USEPA, 1992a). For data fitting a normal distribution, the arithmetic mean was considered to be the most appropriate representative concentration. If the data fit a lognormal distribution, or a lognormal distribution was assumed because the data fit neither type of distribution, the lognormal mean of the constituent data was used as the representative concentration consistent with USEPA guidance.

The following assumptions are made for arriving at each COC exposure concentration:

- COCs are assumed to be 100 percent bioavailable. That is, whether by direct contact or via food-web ingestion, all of the COCs are available for absorption and expression of toxic effects, which is highly unlikely considering the soil chemistry at Site 12.

- The area use factor for the Mariana crow, yellow bittern, and Mariana fruit bat receptors is assumed to be 1.0. This means that 100 percent of the Mariana crow, yellow bittern, and Mariana fruit bat food comes from Site 12.

4.9.2.3 Toxicity Assessment for ERA at Site 12

Toxicity assessment is based on studies that determine the lowest concentrations of contaminants that may cause adverse effects on ecological receptors. In this ERA, toxicity assessments were completed for soil-invertebrate communities (earthworm), plant communities, native terrestrial birds represented by the Mariana crow and the yellow bittern, and Mariana fruit bat relative to COCs in surface soils at Site 12.

Earthworms

Many of the earthworm TRVs are from LOAEL chronic effects data based on laboratory studies of earthworms (ICF, 1998). In the absence of sufficient data, NOAEL data were used for chronic effects to derive earthworm TRVs.

Plants

Risks to plants, as with invertebrates, are expressed relative to concentrations observed in soil. Plant toxicity data were based on growth effects from Ecological Soil Screening Levels.

Avian Species and Mariana Fruit Bat

Food-web risks for avian species and the Mariana fruit bat are expressed relative to a dose of chemical (mg/kg-bw/day) taken up by the organism from food and soil. USEPA (1997b) guidance specifies that a screening ecotoxicity value should be "equivalent to a documented or best conservatively estimated chronic NOAEL." Literature-reported wildlife NOAEL and LOAEL TRVs were used as TRVs for food-web risks.

4.9.2.4 ERA Characterization for Site 12

The ERA was characterized based on calculation of a HQ or an EQ:

Ecological Quotient = Representative Concentration / TRV

Hazard Quotient = Representative Dose / Toxicity Reference Value

If the representative soil concentration is less than the TRV, then the HQ or EQ will be less than 1.0. In this circumstance, no adverse ecological risk is expected for the exposed ecological receptors. If the representative soil concentration is greater than the TRV, then the HQ or EQ will be greater than 1.0, and adverse ecological risk is expected for the exposed ecological receptors. A summary of the recommended ERA cleanup values is presented in the following text and table.

RGs and Recommended Cleanup Values For Receptors of Concern at Site 12 (mg/kg)						
Analyte	Terrestrial Vegetation RG	Soil Invertebrates RG	Mariana Crow RG	Yellow Bittern RG	Mariana Fruit Bat RG	Background Threshold Value
Cadmium	**29**	110	NA	NA	NA	6.5
Copper	NA	61	NA	NA	NA	**72**
Lead	NA	6,630	**900**	4,300	3,300	166
Nickel	30	200	NA	NA	NA	**243**
Zinc	190	**120**	NA	NA	NA	111
4,4'-DDE	NA	**61**	NA	NA	NA	NA
4,4'-DDT	NA	**11**	NA	NA	NA	NA
Total DDT	NA	NA	**1.5**	15	NA	NA

Note – The recommended ecological cleanup value is presented as shaded and **bolded** value. The cleanup value is derived by comparing the lowest RG for each COC to the BTV. The higher of these two is then selected as the recommended cleanup value.

4.9.2.4.1 ERA Results for Site 12

Area A

Eleven metals and three pesticides were identified as COCs at Area A. Copper, lead, zinc, pentachlorophenol, DDE, DDT, and total DDT represent risk to identified ecological receptors at Area A (Table 4-20). High lead concentrations were observed in sample S-204 (15 percent). High concentrations of pentachlorophenol, DDE, DDT, and zinc were observed in sample S-064 (10, 64, 112 mg/kg and 1.6 percent, respectively). High copper risks were identified for soil invertebrates and plants, with the highest concentration at 1.2 percent in S-062. The remaining identified COCs had acceptable risks. A tabular presentation of ecological RGs and cleanup levels is presented in Table 4-21. A short discussion of each derivation of ecological RGs and cleanup values for Area A follows.

Copper—Copper was identified as a COC to soil invertebrates in Area A. The recommended ecological cleanup value of 72 mg/kg is based on the BTV, which exceeds the ecological RG for soil invertebrates (61 mg/kg).

Lead—Lead was identified as a COC (soil invertebrates, plants, Mariana crow, yellow bittern, and Mariana fruit bat) in Area A. An ecological cleanup value (166 mg/kg), based on a comparison of the BTV to the ecological RG for terrestrial vegetation (50 mg/kg) results in a cleanup level of 166 mg/kg. However, as is discussed in the following sections, using the terrestrial vegetation as a criterion for establishing the cleanup goal is overly conservative. A comparison of the BTV for lead to the RGs for other ecological receptors results in a cleanup value of 900 mg/kg that would be protective of soil invertebrates, the Mariana crow, the yellow bittern, and the Mariana fruit bat.

DDE—This pesticide was identified as a COC for soil invertebrates in Area A. The RG of 61 mg/kg is a cleanup value that would be protective of these organisms.

DDT—This pesticide was identified as a COC for soil invertebrates in Area A. The RG of 11 mg/kg is a cleanup value that would be protective of these organisms.

Total DDT—Total DDT was identified as a COC for the Mariana crow and yellow bittern in Area A. The ecological RG of 1.5 mg/kg is based on protecting the endangered Mariana crow. Clearly, the individual DDT RGs (DDE and DDT) would result in total DDT values that greatly exceed the total DDT RG referenced here. Consequently, the total DDT RG should drive remedial efforts.

Zinc—Zinc was identified as a COC for soil invertebrates and plants in Area A. Many of the higher zinc concentrations are co-located with the higher lead concentrations. A comparison of the BTV (111 mg/kg) to the ecological RG for terrestrial vegetation (190 mg/kg) and soil invertebrates (120 mg/kg) results in a cleanup level of 120 mg/kg. However, as is discussed in the following sections, using these ecological receptors as criteria for establishing an ecological

cleanup goal is overly conservative. Current zinc concentrations in surface soil at Area A pose no risk to the Mariana crow, the yellow bittern, and the Mariana fruit bat. Also, the removal of lead-contaminated soils will reduce the risks related to zinc to levels that would be protective of these ecological receptors.

Area B

Eleven metals and three organic chemicals were identified as COCs in Area B. Following risk assessment procedures, and taking into account naturally occurring metals on Guam, lead was found to present risk to plants, the Mariana crow, and yellow bittern (Table 4-20). Total PAH was found to represent risk to earthworms, plants, and the Mariana fruit bat, although the levels of these risks were small (Table 4-20). The other identified COCs were found to have *de minimus* levels of risk for ecological receptors. Lead concentrations were very high at sample location S-151 (12 percent) and total PAH concentrations were high at sample S-174 (2,000 mg/kg). As with Area A, remediation of the sample areas with high lead, zinc, and total PAH concentrations may be required to reduce ecological risks at Area B. A tabular presentation of ecological RGs and cleanup levels is presented in Table 4-21. A short discussion of each derivation of ecological RGs and cleanup values for Area B follows.

Lead—Lead was identified as a COC to terrestrial plants, the Mariana crow, and the yellow bittern in Area B. An ecological cleanup value, based on a comparison of the BTV (166 mg/kg) to the ecological RG for terrestrial vegetation (50 mg/kg) results in a cleanup level of 166 mg/kg. However, as is discussed in the following sections, using the terrestrial vegetation as a criterion for establishing the ecological cleanup goal is overly conservative. A comparison of the BTV for lead to the RGs for other ROCs results in a cleanup value of 900 mg/kg that would be protective of the Mariana crow and the yellow bittern (Table 4-21).

Zinc—Zinc was identified as a COC for soil invertebrates and plants in Area B. Many of the higher zinc concentrations are co-located with the higher lead concentrations. A comparison of the BTV (111 mg/kg) to the ecological RG for terrestrial vegetation (190 mg/kg) and soil invertebrates (120 mg/kg) results in a cleanup level of 120 mg/kg. However, as is discussed in the following sections, using these ecological receptors as criteria for establishing an ecological cleanup goal is overly conservative. Current zinc concentrations in surface soil at Area A pose no risk to the Mariana crow, the yellow bittern, and the Mariana fruit bat. Also, the removal of lead-contaminated soils will reduce the risks related to zinc to levels that would be protective of these ecological receptors.

Area C

Area C is a small area (less than 1 acre), with only two designated COCs, cadmium and lead. Following ERA procedures, acceptable risk levels for cadmium were found for the ecological receptors. Lead was found to represent small levels of risk for plants, Mariana crow, and yellow bittern (8.0, 1.8, and 4.0, respectively, Table 4-20). Because of the small size of the site, the relatively small level of risks, and the conservative uncertainty built into the risk assessment process, no further action is required at Area C.

Area D

Area D is another small site located along the cliffline east of Area C. Two COCs were identified at Area D (cadmium and zinc). Following risk assessment procedures, acceptable risk levels for cadmium were found for the ecological receptors. Zinc was found to represent small levels of risk for soil invertebrates and plants (1.9 and 1.2, respectively, Table 4-20). Because of the small size of the site, the relatively small level of risks, and the conservative uncertainty built into the risk assessment process, no further action is required at Area D.

Area E

Area E is one of the larger sites (9 acres) located east of Area D. Most of the area is cliffline, on which waste material has been disposed of. Seven COCs were identified at Area E (beryllium, cadmium, copper, lead, manganese, zinc, and total DDT). The endangered Mariana fruit bat was observed flying above Area E. Following the ERA, and considering the naturally occurring metal concentrations found at Andersen AFB, potential lead risks were found for plants, the Mariana crow, and the yellow bittern (Table 4-20). The levels of risk found for lead are small (plants, 4.0; Mariana crow, 1.5; yellow bittern, 3.5). Due to the conservative uncertainty associated with the ERA, no further action is required for Area E.

Area F

A tabular presentation of ecological RGs and cleanup levels is provided in Table 4-21. A short discussion of each derivation of ecological RGs and cleanup values for Area F follows.

Area F is a very small area located at the base of the cliff east of Area E. As with Area E, the Mariana fruit bat was observed at this site. NiCd batteries had been disposed of at this location. Only three COCs were identified at Area F (cadmium, lead, and nickel). After taking natural lead concentrations at Andersen AFB into account, risks to the ecological receptors were found to be acceptable for this metal. However, nickel and cadmium were found to present at unacceptable levels of risk to soil invertebrates and plants (Table 4-20). Sample location S-074 had concentrations of both these metals (cadmium 2,640 mg/kg and nickel 2,780 mg/kg) that were responsible for these high levels of risk. Removal of the NiCd batteries and nearby soils may be required to reduce ecological risks at Area F.

Cadmium—Cadmium was identified as a COC for soil invertebrates and plants in Area F. An ecological cleanup value, based on a comparison of the BTV (6.5 mg/kg) to the ecological RG for terrestrial vegetation (29 mg/kg), results in a cleanup level of 29 mg/kg. However, as is discussed in the following sections, using the terrestrial vegetation as a criterion for establishing the ecological cleanup goal is overly conservative. A comparison of the BTV for cadmium to the RGs for other ecological receptors results in a cleanup value of 110 mg/kg that would be protective of soil invertebrates (Table 4-21).

Nickel—Nickel was identified as a COC for soil invertebrates and plants in Area F. The BTV of 242 mg/kg is proposed as a cleanup value that would be protective of these organisms (Table 4-21).

4.9.2.4.2 ERA Uncertainties for Site 12

Ecological risk characterization includes analysis of uncertainty (USEPA, 1997a). Uncertainty is distinguished from variability, and arises from lack of knowledge about factors associated with the study. Sources of uncertainty include the process of selecting COCs, assumptions made in establishing the CSM, the adequacy of ecological characterization of the site, estimates of toxicity to receptors, and selection of model parameters. There are a number of factors that contribute to uncertainty in the ecological risk characterization for Site 12 described above.

4.9.2.4.2.1 Non-Random Sampling

While ecological receptors are likely to be found anywhere around the six areas at Site 12, environmental media at known or suspected waste sites are typically sampled in a non-random fashion. That is, sampling points are chosen to best characterize known or suspected areas of contamination. Peripheral and nearby areas are undersampled, if at all, and thus the average exposure of ecological receptors is biased high and exposure concentrations used in the risk assessment are conservative. For example, it was suspected that NiCd batteries had been disposed of at Area F, and certain samples were taken from locations where this was suspected. This resulted in the relatively high nickel and cadmium concentrations found in this area, and the resultant risks to some ecological receptors. This is an example of sampling to characterize suspected areas of contamination (USEPA, 1988), even though this area represents a small proportion of the entire area at Site 12.

4.9.2.4.2.2 COC Selection

COCs for the Site 12 ERA were selected by comparison of maximum concentrations for the measured analytes with conservative, toxicologically based concentrations expected to represent no adverse effect levels. In addition, because the geology of Andersen AFB is unique (represented by highly weathered limestone), reference background concentrations of metals were also used to identify COCs. The use of conservative toxicity values relative to maximum concentrations represents a very conservative screening process. Because plants and animals on Andersen AFB have acclimated to high metal concentrations such as aluminum or manganese, the use of representative background concentrations represents a more realistic COC selection mechanism.

4.9.2.4.2.3 Receptor of Concern Selection

Section 2.7.2.4.2.3 presents information about Receptor of Concern Selection; this information is common to Chapters 2, 3, and 4 (Decision Summaries for Sites 6, 9, and 12, respectively).

4.9.2.4.2.4 Exposure Pathway

Section 2.7.2.4.2.4 presents information about Exposure Pathways; this information is common to Chapters 2, 3, and 4 (Decision Summaries for Sites 6, 9, and 12, respectively).

4.9.2.4.2.5 Exposure Assumptions

Section 2.7.2.4.2.5 presents information about Exposure Assumptions; this information is common to Chapters 2, 3, and 4 (Decision Summaries for Sites 6, 9, and 12, respectively).

4.9.2.4.2.6 Toxicity Reference Values

Toxicological data used in the risk characterization represents significant uncertainty. Because there are no known data on the effects of chemical constituents on the Mariana crow, yellow bittern, or Mariana fruit bat, toxicological data for surrogate species were used, and this adds uncertainty. This uncertainty is to some extent controlled by choosing the lowest available screening values, consistent with USEPA (1997a) guidance to "be consistently conservative in selecting literature values…"

Consistent with ORNL procedures (Sample et al., 1996), an allometric (weight difference) conversion was performed to modify the toxicity value from the test species to the Mariana fruit bat. This is due to the finding that smaller animals, such as rats and mice that are commonly used as test species in toxicity tests, have higher metabolic rates, and detoxify contaminants faster than larger animals. Studies have shown that the approximate conversion is body weight to the 1/4th power. Alternatively, similar studies have shown that this is not true for avian species, thus the measured NOAEL or LOAEL has been directly used for the TRV for avian receptors.

In several instances, there were missing TRVs for various ROCs. This included earthworms (antimony, thallium, carbazole, and dibenzofuran), plants (carbazole, DDD, DDE, DDT, and dieldrin), avian receptors (antimony, beryllium, thallium, carbazole, dibenzofuran, pentachlorophenol, and total PAH), and mammals (carbazole and dibenzofuran). In those instances, concentrations found at the areas in Site 12 were compared with Andersen AFB background, and in most cases, site concentrations used to estimate risk were lower than background concentrations. In these circumstances, the biota would have been expected to adapt to the unique geological conditions of Guam, and risks to these receptors from these contaminants should be acceptable.

4.9.2.4.2.7 Cumulative Hazard Indices

Section 2.7.2.4.2.7 provides information about Cumulative Hazard Indices; this information is common to Chapters 2, 3, and 4 (Decision Summaries for Sites 6, 9, and 12, respectively).

4.9.2.4.2.8 Population Level Effects

The goal of an ERA is to protect the populations of organisms living on or near the site of concern. When the potential presence of threatened and endangered species is found, such as the Mariana fruit bat at Areas E and F, Site 12, these receptors deserve a special level of protection, protecting each individual organism. However, for most organisms, the protection of the populations remains the goal. Toxic endpoints used for plants tend to be individual, such as reduced weight or shoot length. Toxic endpoints for earthworms, mammals, and birds are those that could have an impact on the population, such as reproduction. In addition, for this ERA, concentrations of COCs in soil were represented by means, which are more reflective of what the populations of organisms are likely to be exposed to at the site.

4.10 Remedial Action Objectives

Site 12 has been divided into six areas: Areas A, B, C, D, E, and F. The HHRA and ERA determined that there is no significant risk to human or ecological receptors in Areas C, D, and E and no RAOs were established for those three areas. Therefore, no action is required for Areas C, D, and E. The COCs identified in Areas A, B, and F were determined to represent potential unacceptable risks to both human and ecological receptors.

The 10^{-6} RGs presented in the RI/FS are based on the very unlikely future residential use of Site 12. This is a very conservative approach because Site 12 and adjacent areas are not currently used for residential purposes due to the steep terrain, the proximity to active runways, and the presence of the Guam National Wildlife Overlay (below the cliffline). In addition, future land use plans for Site 12 exclude residential reuse. However, as a conservative approach to potential remedial options at the site, baseline cleanup values were derived for potential future residents at the site. Risk-based cleanup values were derived for future residents to correspond to a non-cancer HI = 1.0. Risk-based cleanup values were derived for carcinogens, which correspond to three levels of potential cancer risk (10^{-6}, 10^{-5}, and 10^{-4}). These values correlate to three distinct cancer risk values, which are included in USEPA's "acceptable risk range" of 10^{-6} to 10^{-4}. The decision as to which risk level is appropriate for cleanup is a site-specific risk management decision. Future site use was considered in developing RGs during the RI/FS process.

Remedial activities should not cause more ecological harm than a no-action alternative. Much of the habitat in Areas A, B, and F is native limestone forest. Native limestone forest should not be destroyed in the remediation process unless obvious signs of ecological stress are present (such as a lack of vegetation) or biota is in danger of immediate toxicity or lethality. The limestone forest habitats show no obvious signs of vegetative stress, and numerous animals were observed in these locations. Therefore, no remedial actions will be performed in these forest areas. The mixed shrub habitats within Areas A and B were damaged during the disposal of materials in the late 1940s, and have not fully revegetated. As the mixed shrub habitats are still in the process of recovery, remedial efforts in these habitat areas were considered.

RAOs are medium-specific or site-specific remediation goals for protecting the human health and the environment. Based on HHRA results at Area A, antimony, arsenic, copper, lead, manganese, benzo(a)pyrene, DDE, DDT, and dieldrin were determined to be surface soil COCs (Table 4-22). Based on ERA results at Area A, copper, lead, DDE, and DDT were determined to be surface soil COCs (Table 4-22). Based on HHRA results at Area A, lead was determined to be a subsurface soil COC (Table 4-22).

Based on HHRA results at Area B, antimony, arsenic, chromium, lead, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene were determined to be surface soil COCs (Table 4-23). Based on ERA results at Area B, chromium, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene were determined to be surface soil COCs (Table 4-23). Based on HHRA results at Area B lead was determined to be a subsurface soil COC (Table 4-23).

Based on HHRA and ERA results at Area F, nickel and cadmium are the surface soil COCs (Table 4-24).

As no unacceptable risks to human health or the environment were identified at Areas C, D, and E, no RAOs were developed for those areas (i.e., no action is required for Areas C, D, and E). Based on the results of the HHRA and ERA, the following RAOs were developed for the areas at Site 12 where unacceptable risks were identified (i.e., Areas A, B, and F):

Area A

- Prevent future residential exposure to non-cancer risks in surface soil from antimony, arsenic, copper, and manganese at concentrations greater than their respective RGs (BTVs).

- Prevent future residential risks to exposures to lead in surface and subsurface soil at concentrations greater than the USEPA Region 9 residential PRG of 400 mg/kg.

- Prevent future residential exposure to cancer risks in surface soil from benzo(a)pyrene, DDE, DDT, and dieldrin at concentrations greater than their respective RGs calculated to a 10^{-5} cancer risk. Prevent future residential exposure to cancer risks in surface soil from arsenic at concentrations greater than the RG (BTV).

- Prevent future occasional user/trespasser exposure to lead in surface soil at concentrations greater than the USEPA Region 9 industrial PRG of 800 mg/kg.

- Prevent future occasional user/trespasser exposure to cancer risks in surface soil from DDE, DDT, and dieldrin at concentrations greater than their RGs calculated to a 10^{-5} cancer risk. Prevent future occasional user/trespasser exposure to cancer risks in surface soil from arsenic at concentrations greater than the RG (BTV).

- Mitigate ecological risks associated with copper (soil invertebrates), lead (Mariana crow), and DDE and DDT (Mariana crow and soil invertebrates) in surface soil at concentrations greater than 72, 900, 61, and 11 mg/kg, respectively (ERA cleanup values).

Area B

- Prevent future residential exposure to non-cancer risks in surface soil from antimony, arsenic, and chromium and in subsurface soil from chromium at concentrations greater than the respective RGs (BTVs).

- Prevent future residential exposure to lead in surface soil at concentrations greater than the USEPA Region 9 residential PRG of 400 mg/kg.

- Prevent future residential exposure to benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-c,d)pyrene in surface and subsurface soil at concentrations greater their respective RGs calculated to a 10^{-5} cancer risk. In addition, prevent future residential exposure to arsenic (surface soil) and

chromium (surface and subsurface soil) at concentrations greater than their respective RGs (BTVs).

- Prevent future occasional user/trespasser exposure to benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-c,d)pyrene in surface soil at concentrations greater than their respective RGs calculated to a 10^{-5} cancer risk. Prevent future occasional user/trespasser exposure to arsenic in surface soil at concentrations greater than the respective RG (BTV).

- Mitigate ecological risks associated with lead (Mariana crow) greater than 900 mg/kg in surface soil.

Area F

- Prevent future residential exposure to cadmium and nickel in surface soil at concentrations greater than the RGs (ERA cleanup value and BTV, respectively).

- Mitigate ecological risks associated with nickel and cadmium (terrestrial plants and soil invertebrates) in surface soil at concentrations greater than 242 and 29 mg/kg, respectively.

4.11 Description of Alternatives

Using USEPA guidelines (40 CFR 300.430(e)(7)) for screening remediation technologies, 33 remedial technologies for soil were considered for use at Site 12. Many of these were eliminated from further consideration because they were not feasible for the physical and chemical properties of the Site 12 COCs and/or the unique environmental setting of Site 12. For instance, many of the COCs at Site 12 are metals. Most biological treatment technologies (e.g., bioventing, enhanced bioremediation, composting, and landfarming) are ineffective in reducing metals concentrations to levels that would not pose a risk to human health or the environment. Similarly, treatment technologies such as vapor extraction and solar denitrification are not designed to treat metals and, therefore, are not feasible at Site 12. The remaining remedial technologies that were potentially feasible for the mitigation of Site 12 risks were screened according to their effectiveness, implementability, and, to a lesser extent, cost. Remedial technologies retained from the screening process were grouped into remedial alternatives that were further screened based on their effectiveness, implementability, and cost. Based on the remedial technology and alternative screenings, the following remedial alternatives were retained for detailed analysis at Site 12:

- No Action
- Institutional Controls
- Soil Removal (two variations were evaluated).

Each of these remedial alternatives is summarized below. A more complete, detailed presentation of each alternative is presented in Chapter 4 of the FS (EA, 2006). A summary of the comparative analysis of these alternatives and a further description of the Selected Remedy for Site 12 are presented in Sections 4.12 and 4.14, respectively, of this ROD.

4.11.1 *No Action* Alternative

Pursuant to Section 300.430(e)(6) of the revised NCP, a "No Action" alternative is required to be developed to provide a baseline against which the other remedial alternatives are to be compared. By definition under the NCP and EPA guidance, the No Action alternative includes no remedial actions or institutional controls. COC-impacted soil, other debris, and the identified human and ecological risks, therefore, would remain at the site.

No costs are associated with this alternative.

4.11.2 *Institutional Controls* Alternative

The *Institutional Controls* alternative includes the following components to achieve the RAOs for Site 12:

- LUCs – The USAF would implement LUCs through amendments to the BCP to ensure the continued protection of human health and the environment. The full scope of the LUCs will be presented in a LUCMP to be developed by the USAF in coordination with the USEPA and Guam EPA, subsequent to completing the ROD. The LUCs will be applied to the extent of Site 12 Areas with COCs exceeding RGs. Conceptually, the LUCs would include (1) a prohibition on the redevelopment or disturbance of the soil without prior approvals from the USAF, the USEPA, and the Guam EPA; (2) a prohibition on the residential redevelopment (3) limitations and controls on any future excavation/maintenance activities at the site (e.g., worker requirements, soil management, waste disposal); and (4) a requirement for intrusive activities to be first reviewed and approved by the Andersen AFB Civil Engineer Squadron. The LUCMP will include additional provisions such as (1) requirements for periodic (e.g., annual) inspections of the site conditions and use to ensure compliance with the LUCs; (2) periodic (e.g., annual) LUC-compliance reporting requirements to the USEPA and Guam EPA; (3) protocols for property lease or transfer (note: currently, there are no plans for property lease or transfer); and (4) protocols for notification and correction of any LUC non-compliant events. The LUCs would remain in effect for as long as the site conditions are not suitable for unrestricted use and unlimited exposure. A detailed discussion of the LUC objectives, the LUCs, and the actions the USAF will be required to ensure proper implementation of LUCs at Site 12 is provided in Table A-3 (Appendix A).

- Five-year reviews – Following successful implementation of the above actions, the site would be suitable for continued use as open space, but would not be suitable for unrestricted use and unlimited exposure because COCs above RGs would remain onsite. Therefore, the USAF, in conjunction with the USEPA and Guam EPA, would conduct 5-year reviews to ensure that the remedial alternative remains effective in the future for the continued protection of human health and the environment. The reviews would focus on the site conditions, the current and planned future site use, the results of any nearby monitoring programs (e.g., the Basewide Long-term Groundwater Monitoring Program), evaluations of ecological conditions and/or risks in the areas of impacted soil below the

cliffline, and the LUC-compliance reports. The 5-year reviews would be conducted until the site was deemed suitable for unrestricted use.

Following implementation of the *Institutional Controls* alternative, the site would be rendered suitable for continued use by Andersen AFB. Although soil COCs would remain onsite, the *Institutional Controls* alternative would protect human health by preventing unacceptable exposures to COCs. The alternative would not protect the environment, as ecological receptors would still have access to contaminated soil.

The 30-year present worth cost of implementing the *Institutional Controls* alternative for Site 12 is estimated to be $183,500 (Table 4-25). Approximately $33,400 are for capital costs related to installing fence and $150,100 are for long-term costs related to O&M and periodic site reviews.

4.11.3 Soil Removal Alternatives

The following two variations on the Soil Removal Alternative were evaluated for Areas A, B, and F:

- *Soil Removal Protective of Residential and Ecological Receptors* (Section 4.11.3.1)
- *Soil Removal Protective of Ecological Receptors with Institutional Controls* (Section 4.11.3.2)

The application of the two soil removal variations at Areas A, B, and F with respect to RGs and soil volumes is as follows:

Area A

Using the *Soil Removal Protective of Residential and Ecological Receptors* alternative, the total volume of soil to be removed from Area A would be approximately 1,820 bcy (Table 4-26). The conditions at Area A indicate that surface soil would be excavated to a depth of no greater than 2 feet bgs. The thickness of subsurface soil to be removed at this area would be approximately an additional 1 foot. The excavation would be backfilled with 1-foot-thick layer of clean fill, to the degree that site conditions (slope) allow and be seeded for revegetation. Figure 4-18 shows the areas where surface soils would be removed to protect residential and ecological receptors. Several areas with lead, manganese, and arsenic concentrations exceeding the RGs, located in the native limestone forest, will not be removed because the physical stress related to removing the chemical stressors would create more harmful than beneficial impacts to the habitat. Figure 4-19 shows the areas where subsurface soils would be removed to protect residents and ecological receptors.

Using the *Soil Removal Protective of Ecological Receptors with Institutional Controls* alternative, the total volume of soil to be removed from Area A would be approximately 860 bcy (Table 4-26). Surface soil would be excavated to a depth of no greater than 2 feet bgs. Subsurface soil to be removed would be approximately an additional 1 foot. The excavation would be backfilled with 1-foot-thick layer of clean fill, to the degree that site conditions (slope) allow and be seeded for revegetation. Figure 4-20 shows the areas where surface soils would be

removed to protect ecological receptors. One area with lead concentrations exceeding the RGs, located in the native limestone forest, will not be removed

Area A had high lead concentrations (particularly sample S204), and a more localized area of DDT and DDE contamination. The area of DDT contamination (samples S062, S064, S215, and S217) is located in the mixed shrub habitat area that is being considered for remedial activities. In addition to the high DDT and DDE concentrations, this area also has elevated PAH, copper, arsenic, and lead concentrations. An area of elevated lead and arsenic concentrations (samples S072 and S210) lies within the limestone forest habitat and was not included in the cleanup area.

The removal of lead- and DDT-contaminated soil to achieve the RGs under both *Soil Removal Protective of Residential and Ecological Receptors* and *Soil Removal Protective of Ecological Receptors with Institutional Controls* alternatives would also result in the removal of co-located copper- and arsenic-contaminated soil (Peer Review, 2004).

The HQs calculated for the Mariana crow and Mariana fruit bat were based on NOAEL toxicity values because these are endangered species, while HQs for the yellow bittern were based on LOAEL toxicity values for protection of populations of this non-endangered bird. Acceptable risks were observed for the Mariana fruit bat and yellow bittern, and low HQs were observed using NOAEL levels for the Mariana crow. LOAEL-based HQs for the Mariana crow were both below 1.0. The Mariana crow, Mariana fruit bat, and yellow bittern are less likely to utilize the habitat of Area A as they are more likely to inhabit areas of Andersen AFB where there is an active brown tree snake trapping and eradication program. Consequently, the potential for the Mariana crow to reside and obtain 100 percent of its food at Area A is very unlikely.

The plant HQs for lead and arsenic were 44 and 1.1, respectively. Plant toxicity values are extremely conservative, and tend to overestimate risks to plants. The presence of limestone forest over 80 percent of Area A is evidence that vegetation in Area A has not been impacted by metals. The area of mixed shrub habitat is primarily the result of the physical stress created by boulders and fill material dumped down the slope. Plant populations at Area A are not expected to be negatively impacted by lead or arsenic.

HQs for soil invertebrates would fall below 1.0 following removal of the lead and the DDT hot spots, with the exception of arsenic with a HQ of 1.7. As with plants, this low hazard would not result in adverse effects on soil invertebrate populations.

Area B

Using the *Soil Removal Protective of Residential and Ecological Receptors* alternative, a total of approximately 9,080 bcy of soil would be removed (Table 4-27). Surface soil would be excavated to a depth of no greater than 2 feet bgs. In general, the thickness of subsurface soil to be removed would be approximately 1 foot. The excavation would be backfilled with 1-foot-thick layer of clean fill, to the degree that site conditions (slope) allow and be seeded for revegetation. Figure 4-21 shows the areas where surface soils would be removed. Several areas with PAH concentrations exceeding the RGs, located in the native limestone forest, would not be removed.

Figure 4-22 shows the areas where subsurface soils would be removed to protect residential and ecological receptors.

Area B consists of approximately 50 percent mixed shrub habitat (along the top of the cliffline) and 50 percent limestone forest (along and below the cliffline). A large area along the cliffline, on the western edge of the site, contains elevated antimony, arsenic, and PAH concentrations that would pose risks to human receptors, but minimal risks to ecological receptors. Lead poses a potential risk to human and ecological receptors along the eastern edge of the site, along the cliffline, and above the cliffline. Two soil samples with high lead concentrations (S215 and S156) were collected within the limestone forest habitat, and were not included in the cleanup area.

Using the *Soil Removal Protective of Ecological Receptors with Institutional Controls* alternative, approximately 1,150 bcy of soil would be removed (Table 4-27). With this alternative, surface soil would be excavated to a depth of no greater than 2 feet bgs and no subsurface soil would be removed. The excavation would be backfilled with 1-foot-thick layer of clean fill, to the degree that site conditions (slope) allow and be seeded for revegetation. Figure 4-23 shows the areas where surface soils would be removed to protect ecological receptors. One area with lead concentrations exceeding the RGs, located in the native limestone forest, would not be removed.

Considering that remediation actions would require working along the cliffline and ecological risk HQs are not very high, there is a case for supporting no further action along the cliffline at Area B. However, the area of lead contamination, particularly above the cliffline, should be remediated.

Area F

Area F is located at the base of a cliff. The recommended cleanup is restricted to a small area where NiCd batteries were disposed of and a small area with intact and remnant drums. A small nickel and cadmium "hot spot" is surround where the NiCd batteries were disposed of. As a result, a small area of nickel- and cadmium-contaminated soil is recommended for removal.

Using either the *Soil Removal Protective of Residential and Ecological Receptors* alternative or the *Soil Removal Protective of Ecological Receptors with Institutional Controls* alternative, the total volume of soil to be removed would be the same, approximately 100 bcy (Table 4-28). The recommended cleanup areas for both alternatives are identical, as the RGs derived for both alternatives are identical. Surface soil would be excavated to a depth of no greater than 2 feet bgs. The excavation would be backfilled with 1-foot-thick layer of clean fill, to the degree that site conditions (slope) allow and be seeded for revegetation.

There are no COCs in subsurface soils that pose any potential risk to ecological or human receptors. Figure 4-23 shows the areas of the cadmium cleanup and drum removal. Also, due to the presence of limestone forest habitat at Area F, and the difficulty associated with any remedial action at Area F, a low-impact remedial action is recommended.

4.11.3.1 *Soil Removal Protective of Residential and Ecological Receptors* Alternative

The *Soil Removal Protective of Residential and Ecological Receptors* alternative consists of the following components to achieve RAOs for Site 12:

- Excavation and Offsite Disposal – Soil with COC concentrations exceeding the residential and ecological RGs would be excavated from each impacted area. Soil removal volumes are estimated by assuming a 2-foot excavation depth for surface soils. No subsurface soils (soils deeper than 2 feet bgs) would be removed. The COCs in the soil at this site are metals and pesticides, which are relatively immobile and not expected to migrate to groundwater. Soil removal activities on the flat areas would proceed using an excavator or other appropriate equipment. Excavated soil would be stockpiled in a designated area. Based on the concentrations of metals in subsurface soil samples collected at the site, some soil may potentially be hazardous waste. Composite soil samples should be collected from the fill debris piles and analyzed for hazardous waste characteristics utilizing TCLP for metals. Pending waste characterization, the debris fill would be either disposed of at the CU or transported off island for disposal as hazardous waste. Lead-contaminated soil may need to be mixed with TSP prior to disposal at the CU. Soil below the RGs would be used as backfill, and the backfilled areas would be compacted and revegetated. Upon completion of soil removal activities, solid decontamination wastes such as personal protective equipment would be disposed of as solid waste.

Following completion of the removal, the site would be rendered suitable for unrestricted use and no long-term O&M or reviews would be required.

The cost of the *Soil Removal Protective of Residential and Ecological Receptors* alternative is estimated to be $2,142,200 in capital costs. There are no associated long-term costs. The costs for this alternative at Areas A, B, and F are $570,100, $1,402,900, and $169,200, respectively (Tables 4-29, 4-30, and 4-31).

4.11.3.2 *Soil Removal Protective of Ecological Receptors with Institutional Controls* Alternative

The *Soil Removal Protective of Ecological Receptors with Institutional Controls* alternative consists of the following components to achieve RAOs for Site 12:

- Excavation and Offsite Disposal – Soil with COC concentrations exceeding the RGs for the selected scenario will be excavated from each impacted area. Soil removal volumes were estimated by assuming a 2-foot excavation depth for surface soils. No subsurface soils (soils deeper than 2 feet bgs) will be removed. The COCs in the soil at this site are metals and pesticides, which are relatively immobile and not expected to migrate to groundwater. Soil removal activities on the flat areas will proceed using an excavator or other appropriate equipment. Excavated soil will be stockpiled in a designated area. Based on the concentrations of metals in subsurface soil samples collected at the site, some soil may potentially be hazardous waste. Composite soil samples will be collected from the fill

debris piles and analyzed for hazardous waste characteristics utilizing TCLP for metals. Pending waste characterization, the debris fill will be either disposed of at the CU or transported off-island for disposal as hazardous waste. Lead-contaminated soil may need to be mixed with TSP (i.e., stabilized) prior to disposal at the CU. Soil below the RGs will be used as backfill, and the backfilled areas will be compacted and revegetated. Upon completion of soil removal activities, solid decontamination wastes such as personal protective equipment will be disposed of as solid waste.

- LUCs – Institutional Controls would be required at Areas A and B to limit access or ensure that subsurface fill material is not disturbed. The USAF will implement LUCs through amendments to the BCP. The full scope of the LUCs will be presented in a LUCMP to be developed by the USAF in coordination with the USEPA and Guam EPA, subsequent to completing the ROD. Conceptually, the LUCs would include (1) a prohibition on the redevelopment or disturbance of the soil without prior approvals from the USAF, the USEPA, and the Guam EPA; (2) a prohibition on the residential redevelopment (3) limitations and controls on any future excavation/maintenance activities at the site (e.g., worker requirements, soil management, waste disposal); and (4) a requirement for intrusive activities to be first reviewed and approved by the Andersen AFB Civil Engineer Squadron. The LUCMP would include additional provisions such as (1) requirements for periodic (e.g., annual) inspections of the site conditions and use to ensure compliance with the LUCs; (2) periodic (e.g., annual) LUC-compliance reporting requirements to the USEPA and Guam EPA; (3) protocols for property lease or transfer (note: currently, there are no plans for property lease or transfer); and (4) protocols for notification and correction of any LUC non-compliant events. The LUCs would remain in effect for as long as the site conditions are not suitable for unrestricted use and unlimited exposure. A detailed discussion of the LUC objectives, the LUCs, and the actions the USAF will be required to ensure proper implementation of LUCs at Site 12 is provided in Table A-3 (Appendix A).

- Five-year reviews – Following successful implementation of the above actions, the site would be suitable for continued use as open space, but would not be suitable for unrestricted use and unlimited exposure because COCs above RGs would remain onsite. Therefore, the USAF, in conjunction with the USEPA and Guam EPA, would conduct 5-year reviews to ensure that the remedial alternative remains effective in the future for the continued protection of human health and the environment. The reviews would focus on the site conditions, the current and planned future site use, the results of any nearby monitoring programs (e.g., the Basewide Long-term Groundwater Monitoring Program), evaluations of ecological conditions and/or risks in the areas of impacted soil below the cliffline, and the LUC-compliance reports. The 5-year reviews would be conducted until the site was deemed suitable for unrestricted use.

The total 30-year present worth cost of the *Soil Removal Protective of Ecological Receptors with Institutional Controls* alternative is estimated to be $1,324,200. The costs for this alternative at Areas A, B, and F are $507,600, $647,400, and $169,200, respectively (Tables 4-32, 4-33, and 4-34).

4.12 Comparative Analysis of Alternatives

Evaluation criteria for comparison of remedial alternatives are based on CERCLA statutory requirements, earlier program initiatives promulgated in the 20 November 1985 NCP, and site-specific experience gained in the Superfund program. A total of nine criteria are developed for comparing the merits of each remedial alternative, as follows:

- Overall Protection of Human Health and the Environment
- Compliance with ARARs
- Short-Term Effectiveness
- Long-Term Effectiveness and Permanence
- Reduction of Mobility, Toxicity, or Volume Through Treatment
- Implementability
- Cost
- Territorial (Guam) Acceptance
- Community Acceptance

The first two criteria are threshold factors that must be met by each alternative. The next five criteria are the primary balancing factors upon which the comparison of remedial alternatives is based. The last two criteria are modifying factors and are applied to ensure that the final cleanup alternative would meet public acceptance. The final step is a cost analysis for a few feasible remedial alternatives before presenting the final cleanup alternative for public review and comment.

The above-mentioned nine criteria will be presented each in the following sections and a comparison of the alternatives for Site 12 Areas A, B, and F will be made in decreasing order from the most to least advantageous alternative.

4.12.1 Overall Protection of Human Health and the Environment

This threshold criterion provides an overall assessment of human health and environmental protection based on how specific site remedial alternatives would achieve protection over time, how site risks associated with each COC would be reduced, and how each COC source would be eliminated, reduced, or controlled.

The *Soil Removal Protective of Residential and Ecological Receptors* alternative would be the most protective of human health and the environment because it would remove COC-impacted soil and would render the site suitable for unrestricted use.

The *Soil Removal Protective of Ecological Receptors with Institutional Controls* alternative adequately meets the criteria for overall protection of human health and the environment both short-term and long-term from unacceptable risks posed by COCs. By excavating and removing the COC-impacted soil, the source would be removed and the exposure pathways identified in the risk assessment, direct dermal contact, incidental ingestion of soil, and inhalation of soil particulates, would be controlled for both human and ecological receptors.

The *Institutional Controls* alternative would be protective of residents and occasional users/trespassers by reducing the exposure time (average daily dose) from the identified COC-exposure pathways. This alternative, however, would not be protective of ecological receptors.

The *No Action* alternative would not adequately meet the criteria for overall protection of human health and the environment, both short- and long-term, from unacceptable risks posed by COCs. Since it does not meet the most important of the criteria, it will not be fully evaluated under the other eight criteria.

4.12.2 Compliance with ARARs

This threshold criterion evaluates a remedial alternative's compliance with the federal and territorial (Guam) ARARs as defined in CERCLA Section 121. The applicable ARARs are those legally enforceable federal and territorial (Guam) requirements that specifically address hazardous substances, pollutants, removal actions, locations, or other circumstances found at the impacted areas. The ARARs and TBCs for Site 12 are provided in Table 4-35 and 4-36.

The *Soil Removal Protective of Residential and Ecological Receptors* alternative meets each of its respective ARARs.

The *Soil Removal Protective of Ecological Receptors with Institutional Controls* alternative meets each of its respective ARARs.

The *Institutional Controls* alternative would also meet the ARARs by eliminating the exposure pathways.

The *No Action* alternative would not meet the ARARs with regard to protection of human health and the environment.

4.12.3 Short-Term Effectiveness

This balancing criterion addresses the impact of the remedial action during the construction and start-up phase. Factors evaluated include protection of workers during the remedial actions, environmental impacts resulting from the implementation of the remedial action, and the time required to implement the remedial alternative at the site.

The *Institutional Controls* alternative would require nominal excavation to install fence posts for a chain-link fence. Workers may have slight exposure to COCs from incidental inhalation or ingestion of dust particles during excavation activities (fence posts), though these activities should be minimal as the fence would be constructed outside of the impacted area. Workers would wear appropriate protective clothing (disposable chemical resistant gloves, safety glasses, and possibly dust particulate filter masks) to prevent exposure. Dust suppression techniques would be applied, as conditions require.

During the construction phase of the *Soil Removal Protective of Ecological Receptors with Institutional Controls* alternative, there is a potential for COC exposure to construction workers.

With regard to COCs, workers may be exposed to COCs by incidental inhalation of soil particulates. Although the short-term exposure period would not likely exceed acceptable risk levels, engineering controls such as dust suppression would be implemented to control dust emissions, or when necessary, workers would be protected against dust emission by wearing dust particulate masks. Additionally, standard work clothing and gloves would be used to prevent dermal contact and incidental ingestion of COC-impacted soils. Furthermore, standard practices such as washing hands and face, and no eating or smoking at the site would be implemented to minimize the risk of incidental ingestion of soil. There is slightly more COC exposure potential for remediation workers under the *Soil Removal Protective of Residential and Ecological Receptors* alternative due to the greater soil volume to be excavated.

The Contractor shall also comply with federal and territorial requirements for any task involving the transport of hazardous wastes and/or contaminated materials to off-site treatment, storage, and/or disposal facilities. This includes 40 CFR 260, 49 CFR 172, 173, 178, 179, and other applicable federal and territorial transportation regulations.

The *No Action* alternative would not be effective in the short-term because RAOs would not be achieved.

4.12.4 Long-Term Effectiveness and Permanence

This balancing criterion addresses the effectiveness of each remedial alternative over the life of the remedial action. It also assesses the results of the remedial action in terms of the risk remaining after the response objectives have been met. Particularly, the effectiveness of the controls is applied to manage the risk posed by the residual COCs in the impacted areas at the site.

Once the COC-impacted soils are excavated and removed under the *Soil Removal Protective of Ecological Receptors with Institutional Controls* alternative, Areas A, B, and F will not pose unacceptable risks to ecological receptors. Removing these contaminated soils also reduces exposure concentrations of the COCs to human receptors. However, some residual COC concentrations would still exceed the RGs at Areas A and B, and as such they would need to be managed with *Institutional Controls* to be protective of the unlikely scenario of future residential receptors.

Both the *Soil Removal Protective of Residential and Ecological Receptors* alternative and the *Soil Removal Protective of Ecological Receptors with Institutional Controls* alternative would have the same result at Area F: approximately 100 bcy of soil would be removed from a small nickel and cadmium "hot spot." Following completion of the removal, Area F would be rendered suitable for unrestricted use.

Under the *Soil Removal Protective of Residential and Ecological Receptors* alternative residual COC concentrations would be reduced to levels that would allow unrestricted use.

The *Institutional Controls* alternative would not reduce the volume or treat the COCs; therefore, residual risks would remain. As long as the *Institutional Controls* are maintained, there would

be no complete exposure pathway for human receptors, however the *Institutional Controls* alternative would not reduce exposures or overall risks to ecological receptors. The COCs would not be highly mobile and would unlikely migrate to groundwater. Some vegetation will be impacted during the installation of the perimeter fence, but the impacted vegetation is expected to recover soon after the completion of fence installation.

The *No Action* alternative would not be effective for addressing human receptor risk of exposure to COCs. There would be no controls for this alternative to manage the risks posed by the COCs in soil.

4.12.5 Reduction of Toxicity, Mobility, or Volume Through Treatment

This balancing criterion assesses how each alternative would reduce the principal threats of the total mass of COCs, to provide irreversible reduction in COC mobility, and/or to reduce the total volume of impacted media. Factors of this criterion that are evaluated include the treatment process, the amount of COCs destroyed or treated, the degree of reduction in toxicity, mobility, or volume expected, and the type and quantity of untreated COC residuals.

The *Soil Removal Protective of Ecological Receptors with Institutional Controls* alternative eliminates the source of COCs. This alternative eliminates potential risks to ecological receptors at the site, and reduces (but does not eliminate) potential risks to human receptors. The *Soil Removal Protective of Residential and Ecological Receptors* alternative removes a greater volume of soil in order to mitigate human health risks as well. These alternatives will not directly reduce the mobility, toxicity, or volume of COCs, as the COCs are simply relocated from one location to another (although the volume of COC-impacted soil remaining onsite would be greatly reduced). However, some RCRA hazardous COC-impacted soils may be treated with TSP, if necessary, to reduce the mobility of contaminants (i.e., lead) prior to disposal. Any soil treatment will comply with the RCRA Land Disposal Restrictions as specified in 40 CFR 268.49. Before transporting any COC-impacted soil to the CU, the COC-impacted soils will be characterized using the TCLP analyses. The COC-impacted soils that are classified as hazardous based on TCLP analyses will be sent off-island to a licensed hazardous waste disposal facility. Soils that are deemed hazardous by virtue of contamination by specific metals (e.g. lead) that are amenable to treatment would be treated with TSP to render them non-hazardous. The COC-impacted soils that are classified as non-hazardous waste based on TCLP analyses will be disposed at the CU.

The *Institutional Controls* and *No Action* alternatives would not reduce the toxicity, mobility, or volume of waste through treatment.

4.12.6 Implementability

This balancing criterion assesses the technical and administrative feasibility of implementing a remedial action and the availability of various services and materials required during implementation. Factors of technical feasibility include construction and operational difficulties, reliability of technology, ease of undertaking additional remedial actions, and the ability to monitor the effectiveness of the remedy.

The *No Action* alternative can be an acceptable remedial alternative under the appropriate site conditions. The technical feasibility to implement the *No Action* alternative is simple, as there are no remedial components specified. However, in an administrative sense, the *No Action* alternative is not implementable because the threshold criteria are not met.

The *Soil Removal* alternatives are a proven and effective means for mitigating site risks. The technology is feasible to implement as the required equipment and services are readily available. The difficulties with this alternative include the mixed volume of COC-impacted soils that need to be excavated selectively from steep, highly vegetated terrain and then transported off-site for disposal. As the site is located in rough terrain, it is possible that the quantity of soil that needs to be removed may expand as the work effort gets underway and confirmatory samples are collected. Multiple mobilizations may be required to transport any soil determined to be hazardous off-island for disposal. Off-island transportation of waste would be more difficult to implement than using the Andersen AFB CU for final disposal.

4.12.7 Territorial (Guam) Acceptance

This modifying criterion accounts for the technical and administrative issues concerning the Territory of Guam regarding each of the remedial alternatives. This factor includes the remedial actions that the territory would support, oppose, or would be concerned about. The territorial acceptance was evaluated based on comments received from Guam EPA's representatives during public meetings regarding IRP sites at Andersen AFB.

The Guam EPA has reviewed the RI/FS and Proposed Plan and concurs with the USAF's and the USEPA's co-selected remedial alternative, *Soil Removal Protective of Ecological Receptors with Institutional Controls*. In accordance with NCP regulations, this ROD report has been made available to the public for a 30-day review and comment period, per 40 CFR 400.435. A notification of availability to review the draft final report has been published in the local newspaper, the *Pacific Daily News*. The comments from USEPA and Guam EPA have been addressed and the ROD revised accordingly. The date of availability for review was presented in the *Pacific Daily News*. Responses have been submitted to Guam EPA or forwarded to Andersen AFB.

4.12.8 Community Acceptance

This modifying criterion was evaluated based on comments received from community representatives during Public Meeting and the Public Comment Period. During the Public Comment Period there were no significant comments regarding the *Soil Removal Protective of Ecological Receptors with Institutional Controls* as a preferred alternative. The USAF has responded to the comments and concerns that were received during the Public Meeting and Public Comment Period for this ROD (see Sections 5 and 6).

4.12.9 Cost

This balancing criterion assesses the projected cost for the final list of alternatives at the

conclusion of the cleanup alternatives screening process. Present worth analysis allows remedial actions to be compared on the basis of a single cost representing an amount that, if invested in the base year and disbursed as needed, would be sufficient to cover the costs associated with the remedial action over its planned life. When applicable, for purposes of comparison, an assumed operating performance period of 30 years was used in calculating the present worth of the final remedial alternatives. The remedial costs included capital costs and annual O&M costs. Capital costs consist of both direct and indirect costs. Direct costs include expenditures for the equipment, labor, and materials necessary to install removal actions. Indirect costs include expenditures for engineering, financial, and other services required when installing a remedial alternative at a site. Annual O&M costs include auxiliary monitoring, materials and energy required to install remedial actions, disposal of residue, purchased services, administrative costs, insurance, taxes, license costs, maintenance reserve and contingency funds, rehabilitation costs, and costs for periodic site reviews.

There are no costs associated with the *No Action* alternative.

The total cost for the *Soil Removal Protective of Ecological Receptors with Institutional Controls* alternative at Areas A, B, and F are estimated at $1,324,200 (Tables 4-32, 4-33, and 4-34) which includes both capital and long-term costs.

The total cost of the *Soil Removal Protective of Residential and Ecological Receptors* alternative is estimated to be $2,142,200 (Tables 4-29, 4-30, and 4-31) as associated with capital costs and no long-term costs.

The *Institutional Controls* alternative has mostly long-term costs associated with periodic reviews estimated at $183,500 (Table 4-25).

4.13 Principal Threat Posed by Waste

According to USEPA guidelines, treatment alternatives must be used to address the principal threats posed by any site whenever practicable. In general, the term “principal threat wastes” includes the following (USEPA, 1999b):

- Liquid source material, such as waste contained in drums, lagoons or tanks, and free product in the subsurface containing COCs
- Mobile source material, such as surface soil or subsurface soil containing high concentrations of COCs that are mobile due to wind entrainment, volatilization, surface runoff, or subsurface transport
- Highly-toxic source materials, such as buried drums containing non-liquid wastes, buried tanks containing non-liquid wastes, or soils containing significant concentrations of highly toxic materials

Wastes that are generally considered as “non-principal threat” include the following (USEPA, 1999b):

- Non-mobile contaminated source material of low to moderate toxicity, such as surface soil containing COCs that generally are relatively immobile in air and groundwater in the specific environmental setting
- Low toxicity source materials, such as surface soil and subsurface soil with concentrations of COCs not greatly above reference dose levels or that present an excess cancer risk near acceptable risk range

Nevertheless the human health risks and environmental risks associated with COC-impacted soils justify a remedial action to protect the environment. As such, the *Soil Removal Protective of Ecological Receptors with Institutional Controls* alternative was selected to remove the non-principal threats associated with COC-impacted soils at Site 12. Removing the non-principal threats eliminates the exposure pathway that poses potential risks to ecological receptors and reduces potential risks to human receptors.

4.14 Selected Remedy

The USAF and USEPA Region 9, with concurrence from the Guam EPA, co-selected the *Soil Removal Protective of Ecological Receptors with Institutional Controls* alternative for Areas A, B, and F. No Action is proposed for Site 12 Areas C, D, and E.

4.14.1 Summary of the Rationale for the Selected Remedy

No Action is required at Areas C, D, and E because the HHRA and ERA determined that there is no significant risk to human or ecological receptors in those areas.

The *Soil Removal Protective of Ecological Receptors with Institutional Controls* alternative was selected for Areas A, B, and F as it provided the best balance of considerations under the nine evaluation criteria and is the most cost-effective alternative for the continued use of the site by the USAF. Future residential (or commercial) development at Site 12 is extremely unlikely.

This alternative would mitigate human health and ecological risks through the removal of some COC-impacted soil, LUCs, and periodic site reviews. For this alternative, the contaminants, except those in the native limestone forest, would be removed and minimal restrictions on future land use would be required. Although some technical effort will be required, the alternative requires minimal administrative effort. This alternative will be acceptable to the GovGuam and the local community.

The slope portion of the site is designated as part of the Guam National Wildlife Overlay (USFWS, 1995). The site is proximal to the active runways and the WSA, which have exclusion zones, and most of the site consists of steep terrain that is not appropriate for construction.

4.14.2 Detailed Description of the Selected Remedy

The *Soil Removal Protective of Ecological Receptors with Institutional Controls* alternative consists of excavating and disposing of impacted soil/fill in areas exceeding the ecological RGs. In addition, institutional controls will be required to restrict exposure of future residential

receptors to remaining contamination. Periodic site reviews will be conducted by the USAF to ensure the long-term effectiveness of this alternative for protecting human health and the environment.

Soil with COC concentrations exceeding the RGs for the selected alternative would be excavated from each impacted area. Soil removal volumes are estimated by assuming a 2-foot excavation depth for surface soils plus an additional 2-foot excavation of underlying subsurface soils. No subsurface soils (soils deeper than 2 feet bgs) would be removed under this remedial alternative. The COCs in the soil at this site are metals, pesticides, and PAHs, which are relatively immobile and not expected to migrate to groundwater.

Soil removal activities on the flat areas would proceed using an excavator or other appropriate equipment. Excavated soil would be stockpiled in a designated area. Based on the concentrations of metals in subsurface soil samples collected at the site, some soil may potentially be hazardous waste. Composite soil samples should be collected from the fill debris piles and analyzed for hazardous waste characteristics utilizing TCLP for metals. Pending waste characterization, the debris fill would be either disposed of at the CU or transported off island for disposal as hazardous waste. Lead-contaminated soil may need to be mixed with TSP prior to disposal at the CU. Soil below the RGs would be used as backfill, and the backfilled areas would be compacted and revegetated.

Upon completion of soil removal activities, solid decontamination wastes such as personal protective equipment would be disposed of as solid waste.

A detailed description of the actions the USAF is required to perform to properly implement LUCs at Site 12 Areas A and B is provided in Table A-3 (Appendix A). LUCs will not be required upon completion of the soil removal at Area F. Table A-3 provides a summary of: (1) site risks relevant to the selected remedy, (2) a description of the property including current and anticipated future property ownership, land use, and restrictions, (3) a description of onsite structures, (4) a description of LUC objectives, (5) a list of applicable engineering and institutional controls and other specific measures that are required to implement LUCs consistent with the selected remedy, (6) monitoring and reporting requirements, and (7) specific corrective actions to address non-compliant LUC events.

No Action is proposed for Areas C, D, and E because the HHRA and ERA determined that there is no significant risk to human or ecological receptors in those areas.

4.14.3 Summary of the Estimated Remedy Costs

The total 30-year present worth cost of the *Soil Removal Protective of Ecological Receptors with Institutional Controls* alternative is estimated to be $1,324,200. This cost is associated with the initial capital costs primarily for the soil excavations as well as long-term O&M costs for the periodic site reviews and LUC maintenance. The individual costs at Areas A, B, and F are $507,600, $647,400, and $169,200, respectively (Tables 4-32, 4-33, and 4-34). The excavation activities at Site 12 are currently scheduled for 2007.

There are no costs associated with the No Action decision for Areas C, D, and E.

4.14.4 Expected Outcome of the Selected Remedy

The *Soil Removal Protective of Ecological Receptors with Institutional Controls* alternative will help achieve RAOs at Areas A, B, and F by reducing volumes of non-principal threats such as COC-impacted soils within 2-3 years. This will allow for continued use of those sites by the USAF. LUCs will be in-place and maintained by the USAF to mitigate the residual risks to human health. The full recovery of revegetation may extend beyond the completion of the cleanup. Nevertheless, the environmental restoration will enhance the value of Site 12 and neighboring properties.

With the No Action decision for Areas C, D, and E, those areas will be suitable for unrestricted use and unlimited exposure.

4.15 Statutory Determination

According to USEPA guidelines (USEPA, 1999b), the lead agency must select remedies that are protective of human health and the environment, comply with ARARs, are cost effective, and utilize permanent solutions and alternative treatment or resource recovery technologies to the maximum extent practicable. Additionally, a preference is given for remedies that permanently and significantly reduce the volume, toxicity, or mobility of hazardous waste materials.
The selected remedies (*Soil Removal Protective of Ecological Receptors with Institutional Controls* in Areas A, B, and F) are protective of human health and the environment, comply with Federal and Territory of Guam requirements that are applicable or relevant and appropriate to the remedial action, are cost-effective, and utilize permanent solutions and alternative treatment technologies to the maximum extent practicable.

Using the preferred *Soil Removal Protective of Ecological Receptors with Institutional Controls* alternative, much of the source of the solid waste debris and COC-impacted soils will be removed from Areas A, B, and F at Site 12, thereby eliminating the exposure pathways for ecological receptors and reducing potential risks to human health. The alternative also includes LUCs and periodic site reviews to ensure the long-term protection of human health from residual COCs. The *Soil Removal Protective of Ecological Receptors with Institutional Controls* alternative is a permanent solution that reduces the potential for offsite migration of COCs or migration of COCs from the subsurface to groundwater. Due to the steep slopes at Site 12, the implementation of the *Soil Removal Protective of Ecological Receptors with Institutional Controls* alternative may have technical challenges. Because the *Soil Removal Protective of Ecological Receptors with Institutional Controls* alternative will result in hazardous substances, pollutants, or contaminants remaining on site above levels that allow for unlimited use and unrestricted exposure, LUCs and five-year reviews will be required for this remedial action.

Because no significant risks to human health or the environment were identified for Areas C, D, and E, the No Action decision for those areas is a permanent solution which is protective of human health and the environment and complies with ARARs.

4.15.1 Overall Protection of Human Health and the Environment

The *Soil Removal Protective of Ecological Receptors with Institutional Controls* alternative will be protective of human health and the environment at Areas A, B, and F. It will eliminate unacceptable exposures to COCs by ecological receptors by the removal action and would prevent exposure to future residential receptors by preventing residential development on or adjacent to the site. The removal of most, but not all, of the COC-impacted soil would also be beneficial to human receptors.

The No Action decision for Areas C, D, and E is protective of human health and the environment because no significant risks were identified in those areas.

4.15.2 Compliance with ARARs

The *Soil Removal Protective of Ecological Receptors with Institutional Controls* alternative meets its respective ARARs. With respect to natural habitat, some vegetation and trees will be impacted by the *Soil Removal Protective of Ecological Receptors with Institutional Controls* alternative. However, the revegetation plan at the end of the cleanup project is expected to restore and improve the ecological habitat at the site.

Some archeological sites were documented near Site 12 (USAF, 1988). The Urunao Beach Complex and the Falcona Beach Complex have been identified as archeological areas on the northwestern portion of Guam (Ogden, 1996). The area has been identified as a culturally valuable archeological site and was listed on the Guam Register of Historic Sites in July 1974 (Reinman, 1977). The Falcona Beach Complex lies approximately 1,000 feet west of Site 12. No archeological site has been identified at Site 12. However, should any archeological objects be discovered during the excavation, the excavation activities will be terminated and the integrity of the archeological objects will be preserved. The excavation activities will not be continued at Site 12 until an archaeological survey can determine that it would be safe to continue cleanup activities. Archeological efforts will be coordinated with the Guam's historical preservation authorities and in accordance with the National Historic Preservation Act, 16 U.S.C. Section 470 and the Archaeological and Historic Preservation Act, 16 USC Section 469a-1.

The No Action decision for Areas C, D, and E complies with ARARs because no significant risks were identified in those areas and no response action is required.

4.15.3 Cost Effectiveness

According to USEPA guidelines (USEPA, 1999b), a remedy is cost effective if the cost is proportional to its overall effectiveness in protecting human health and the environment. The *Soil Removal Protective of Ecological Receptors with Institutional Controls* alternative permanently protects human health and the environment at Areas A, B, and F. The present worth cost estimate for performing soil removal protective of ecological receptors at Area A is $507,600, including $413,400 in capital costs (Table 4-32). The cost estimate for performing soil removal protective of ecological receptors at Area B is $647,400, including $553,200 in capital costs (Tables 4-33). The cost estimate for performing soil removal protective of

ecological receptors at Area F is $169,200 (Table 4-34). There should be no long-term costs associated with the cleanup at Area F as it is also protective of human receptors and implementation of institutional controls will not be required.

The No Action decision for Areas C, D, and E is cost-effective because no significant risks were identified in those areas and no response action is required.

4.15.4 Utilization of Permanent Solution

Under the *Soil Removal Protective of Ecological Receptors with Institutional Controls* alternative for Areas A, B, and F, much of the COC-impacted soils will be permanently removed from Site 12; however, there will be residual contamination at Areas A and B which will be addressed by the LUCs and periodic site reviews.

The No Action decision for Areas C, D, and E is a permanent solution because no significant risks were identified in those areas and no response action is required.

4.15.5 Preference for Treatment as a Principal Element

Although COCs are not "treated" under the *Soil Removal Protective of Ecological Receptors with Institutional Controls* alternative for Areas A, B, and F, much of the COC-impacted soil will be removed from the site and properly disposed at either the Andersen CU or an off-island hazardous waste disposal facility. Should the volume of COC-impacted soil be of concern when excavating surface and subsurface soils, the COC-impacted soils may be treated by TSP, which has been used successfully to treat and immobilize metals in soils.

No treatment is required under the No Action decision for Areas C, D, and E because no significant risks were identified in those areas and no response action is required.

4.15.6 Five-Year Review Requirement

In accordance with 42 USC §9621(c) and 40 CFR 300.430(f)(5)(iii)(C), five-year review(s) of this ROD will be necessary because residual COCs will be left in Areas A and B at concentrations which do not allow for unrestricted use and unlimited exposure.

4.16 Documentation of Significant Changes

On 29 March 2006, the Proposed Plan for the Sites 6, 9, and 12 was released to the public for review and comments, with a Public Comment Period extending from 30 March to 29 April 2006. A public meeting was held in the Holiday Resort in Tumon on 6 April 2006 to present the Proposed Plan to the public.

The same alternatives that are presented in this ROD for Site 12 (*Soil Removal Protective of Ecological Receptors with Institutional Controls* for Areas A, B, and F and No Action for Areas C, D, and E) were also presented in Proposed Plan and the public meeting as the preferred alternatives. The USAF, USEPA Region 9, and Guam EPA have agreed that *Soil Removal*

Protective of Ecological Receptors with Institutional Controls is the preferred alternative to clean up Areas A, B, and F at Site 12 and that No Action is appropriate for Areas C, D, and E at Site 12. Therefore, there are no significant changes to the remedy as originally identified in the March 2006 Proposed Plan.

TABLE 4-1. SELECTION OF EXPOSURE PATHWAYS, SITE 12, ANDERSEN AFB, GUAM.

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	OnSite/ OffSite	Type Of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current	Groundwater	Groundwater	Tap Water	Commercial Worker	Adult	Ingestion	Onsite	None	No exposure pathway.
	Surface Soil	Surface Soil	Site 12	Trespasser/Occasional User	Adult	Ingestion	Onsite	Quant	Trespasser may visit the area.
						Dermal	Onsite	Quant	Trespasser may visit the area.
				Commercial Worker	Adult	Ingestion	Onsite	None	No workers are present at site.
						Dermal	Onsite	None	No workers are present at site.
		Air	Site 12	Trespasser/Occasional User	Adult	Inhalation	Onsite	Quant	Trespasser may visit the area.
				Commercial Worker	Adult	Inhalation	Onsite	None	No workers are present at site.
		Animal tissue	Wild Deer Meat	Hunter	Adult	Ingestion	Onsite	Quant	Risks evaluated on a facility-wide basis; no hunting allowed at site.
					Child	Ingestion	Onsite	Quant	Risks evaluated on a facility-wide basis; no hunting allowed at site.
		Animal tissue	Wild Pig Meat	Hunter	Adult	Ingestion	Onsite	Quant	Risks evaluated on a facility-wide basis; no hunting allowed at site.
					Child	Ingestion	Onsite	Quant	Risks evaluated on a facility-wide basis; no hunting allowed at site.
	Subsurface Soil	Subsurface Soil	Site 12	Utility Worker	Adult	Ingestion	Onsite	None	No utilities are present at site.
						Dermal	Onsite	None	No utilities are present at site.
		Air	Site 12	Utility Worker	Adult	Inhalation	Onsite	None	No utilities are present at site.
	Sediment	Sediment	Site 12	Trespasser/Occasional User	Adult	Ingestion	Onsite	None	No sediment at site.
	Surface Water	Surface Water	Site 12	Trespasser/Occasional User	Adult	Dermal	Onsite	None	No surface water at site.
Future	Groundwater	Groundwater	Tap Water	Resident	Adult	Ingestion	Onsite	None	No exposure pathway.
					Child	Ingestion	Onsite	None	No exposure pathway.
				Trespasser/Occasional User	Adult	Ingestion	Onsite	None	No exposure pathway.
	Surface Soil	Surface Soil	Site 12	Resident	Adult	Ingestion	Onsite	Quant	Residential exposures extremely unlikely; considered as conservative baseline.
						Dermal	Onsite	Quant	Residential exposures extremely unlikely; considered as conservative baseline.
					Child	Ingestion	Onsite	Quant	Residential exposures extremely unlikely; considered as conservative baseline.
						Dermal	Onsite	Quant	Residential exposures extremely unlikely; considered as conservative baseline.
				Trespasser/Occasional User	Adult	Ingestion	Onsite	Quant	Most likely future recptor population
						Dermal	Onsite	Quant	Most likely future recptor population
		Air	Site 12	Resident	Adult	Inhalation	Onsite	Quant	Residential exposures extremely unlikely; considered as conservative baseline.
					Child	Inhalation	Onsite	Quant	Residential exposures extremely unlikely; considered as conservative baseline.
				Trespasser/Occasional User	Adult	Inhalation	Onsite	Quant	Residential exposures extremely unlikely; considered as conservative baseline.
	Subsurface Soil	Subsurface Soil	Site 12	Resident	Adult	Ingestion	Onsite	Quant	Residential exposures extremely unlikely; considered as conservative baseline.
						Dermal	Onsite	Quant	Residential exposures extremely unlikely; considered as conservative baseline.
					Child	Ingestion	Onsite	Quant	Residential exposures extremely unlikely; considered as conservative baseline.
						Dermal	Onsite	Quant	Residential exposures extremely unlikely; considered as conservative baseline.
				Construction Worker	Adult	Ingestion	Onsite	None	Construction unlikely; resident exposure to subsurface soils considered as conservative baseline
						Dermal	Onsite	None	Construction unlikely; resident exposure to subsurface soils considered as conservative baseline
		Air	Site 12	Resident	Adult	Inhalation	Onsite	Quant	Residential exposures extremely unlikely; considered as conservative baseline.
					Child	Inhalation	Onsite	Quant	Residential exposures extremely unlikely; considered as conservative baseline.
				Construction Worker	Adult	Inhalation	Onsite	None	Construction unlikely; resident exposure to subsurface soils considered as conservative baseline.
	Sediment	Sediment	Site 12	Resident	Adult	Ingestion	Onsite	None	No sediment at site.
	Surface Water	Surface Water	Site 12	Resident	Child	Ingestion	Onsite	None	No surface water at site.

TABLE 4-2. SUMMARY OF CONTAMINANTS OF CONCERN AND MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATIONS FOR SURFACE SOIL, SITE 12, AREA A, ANDERSEN AFB, GUAM.

Scenario Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil

Exposure Point	COC	Concentration Detected		Units	BTV	Residential PRG	Industrial PRG	Frequency of Detection	EPC	Statistical Measure
		Min	Max							
Site 12A	Antimony	2.1	446	ppm	63	31	**410**	17/17	155	95% UCL-T
	Arsenic	1.7	207	ppm	**62**	0.39	1.6	14/17	98	95% UCL-T
	Copper	7.8	12,800	ppm	72.2	3,100	**41,000**	21/21	5,762	95% UCL-T
	Lead	39.1	147,000	ppm	166	400	**800**	28/28	62,733	95% UCL-T
	Manganese	603	7,310	ppm	5,500	1,800	**19,000**	19/19	4,316	95% UCL-T
	Benzo[a]pyrene	0.00611	1.6	ppm	NA	0.062	**0.21**	21/22	0.24	95% UCL-T
	DDE	0.0011	64.13	ppm	NA	1.7	**7.0**	19/20	64	Max [1]
	DDT	0.0016	111.8	ppm	NA	1.7	**7.0**	19/20	112	Max [1]
	Dieldrin	0.00026	9.431	ppm	NA	0.03	**0.11**	7/20	1.23	95% UCL-T

Key
Bold/Shaded: Higher of BTV & Industrial PRG (USEPA, 2004)
BTV: Background Threshold Value
COC: Contaminant of concern
EPC: Exposure point concentration
Max: Maximum concentration
Min: Minimum concentration
NA: Not applicable
ppm: Parts per million
PRG: USEPA Region 9 Preliminary Remediation Goal
USEPA: U.S. Environmental Protection Agency
95% UCL-T: 95% Upper Confidence Limit of Log-transformed Data
1: 95% UCL exceeds maximum detected concentration. Therefore, maximum concentration used for EPC.

The table presents the COCs and EPC for each of the COCs detected in surface soil (i.e., the concentration that was used to estimate the exposure and risk from each COC in the surface soil). The table includes the range of concentrations detected for each COC, as well as the frequency of detection (i.e., the number of times the chemical was detected in the samples collected at the surface site), the EPC, and how the EPC was derived. The table indicates that manganese was the most frequently detected COC in soil at the site. The 95%UCL of Log-transformed Data was used as the EPC for each of the COC except DDE and DDT, for which the maximum concentration was used as the default EPC because the 95% UCL exceeded the maximum detected concentration for these two COC.

TABLE 4-3. SUMMARY OF CONTAMINANTS OF CONCERN AND MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATIONS FOR SUBSURFACE SOIL, SITE 12, AREA A, ANDERSEN AFB, GUAM.

Scenario Timeframe: Current/Future
Medium: Subsurface Soil
Exposure Medium: Subsurface Soil

	COC	Concentration Detected		Units	BTV	Residential PRG	Industrial PRG	Frequency of Detection	EPC	Statistical Measure
		Min	Max							
Site 12A	Lead	20.1	6240	ppm	166	400	**800**	10/10	6,240	Max [1]
	Benz[a]anthracene	0.0033	1.7	ppm	NA	0.62	**2.1**	8/10	1.65	95% UCL-T
	Benzo[a]pyrene	0.0022	1.4	ppm	NA	0.062	**0.21**	9/10	1.4	Max [1]
	DDE	0.0012	4.384	ppm	NA	1.7	**7.0**	9/9	4.384	Max [1]

Key
Bold/Shaded: Higher of BTV & Industrial PRG (USEPA, 2004)
BTV: Background Threshold Value
COC: Contaminant of concern
EPC: Exposure point concentration
Max: Maximum concentration
Min: Minimum concentration
NA: Not applicable
ppm: Parts per million
PRG: USEPA Region 9 Preliminary Remediation Goal
USEPA: U.S. Environmental Protection Agency
95% UCL-T: 95% Upper Confidence Limit of Log-transformed Data
1: 95% UCL exceeds maximum detected concentration. Therefore, maximum concentration used for EPC.

The table presents the COCs and EPC for each of the COCs detected in subsurface soil (i.e., the concentration that was used to estimate the exposure and risk from each COC in the surface soil). The table includes the range of concentrations detected for each COC, as well as the frequency of detection (i.e., the number of times the chemical was detected in the samples collected at the surface site), the EPC, and how the EPC was derived. The table indicates that lead was the most frequently detected COC in soil at the site. The 95%UCL of Log-transformed Data was used as the EPC for benzo(a)anthracene. However, because the 95% UCL exceeded the maximum detected concentration for lead, benzo(a)pyrene, and DDE, the maximum concentration was used as the default EPC for these COC.

TABLE 4-4. SUMMARY OF CONTAMINANTS OF CONCERN AND MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATIONS FOR SURFACE SOIL, SITE 12, AREA B, ANDERSEN AFB, GUAM.

Scenario Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil

Exposure Point	COC	Concentration Detected		Units	BTV	Residential PRG	Industrial PRG	Frequency of Detection	EPC	Statistical Measure
		Min	Max							
Site 12B	Aluminum	2,870	221,000	ppm	**173,500**	76,000	100,000	43/43	112,012	95% UCL-T
	Antimony	0.47	4,790	ppm	63	31	**410**	38/38	48	95% UCL-T
	Arsenic	1.8	908	ppm	**62**	0.39	1.6	32/38	40	95% UCL-T
	Chromium, Total	24.8	1,310	ppm	**1,080**	210	450	39/39	555	95% UCL-T
	Lead	12.6	122,000	ppm	166	400	**800**	49/49	6,004	95% UCL-T
	Benz[a]anthracene	0.00175	260	ppm	NA	0.62	**2.1**	63/63	260	Max [1]
	Benzo[a]pyrene	0.00241	290	ppm	NA	0.062	**0.21**	63/63	290	Max [1]
	Benzo[b]fluoranthene	0.00545	270	ppm	NA	0.62	**2.1**	62/63	270	Max [1]
	Benzo[k]fluoranthene	0.00222	140	ppm	NA	6.2	**21**	63/63	140	Max [1]
	Dibenz[a,h]anthracene	0.0028	50	ppm	NA	0.062	**0.21**	29/57	50	Max [1]
	Indeno[1,2,3-c,d]pyrene	0.00407	300	ppm	NA	0.62	**2.1**	63/63	300	Max [1]

Key
Bold/Shaded: Higher of BTV & Industrial PRG (USEPA, 2004)
BTV: Background Threshold Value
COC: Contaminant of concern
EPC: Exposure point concentration
Max: Maximum concentration
Min: Minimum concentration
NA: Not applicable
ppm: Parts per million
PRG: USEPA Region 9 Preliminary Remediation Goal
USEPA: U.S. Environmental Protection Agency
95% UCL-T: 95% Upper Confidence Limit of Log-transformed Data
1: 95% UCL exceeds maximum detected concentration. Therefore, maximum concentration used for EPC.

The table presents the COCs and EPC for each of the COCs detected in surface soil (i.e., the concentration that was used to estimate the exposure and risk from each COC in the surface soil). The table includes the range of concentrations detected for each COC, as well as the frequency of detection (i.e., the number of times the chemical was detected in the samples collected at the surface site), the EPC, and how the EPC was derived. The table indicates that benz(a)anthracene, benzo(a)pyrene, benzo(k)fluoranthene, and indeno(1,2,3-C,D)pyrene were the most frequently detected COC in soil at the site. The 95%UCL of Log-transformed Data was used as the EPC for aluminum, antimony, arsenic, total chromium, and lead. However, because the 95% UCL exceeded the maximum detected concentrations for benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-C,D)pyrene, the maximum concentration was used as the default EPC for each of these COC.

TABLE 4-5. SUMMARY OF CONTAMINANTS OF CONCERN AND MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATIONS FOR SUBSURFACE SOIL, SITE 12, AREA B, ANDERSEN AFB, GUAM.

Scenario Timeframe: Current/Future
Medium: Subsurface Soil
Exposure Medium: Subsurface Soil

Exposure Point	COC	Concentration Detected		Units	BTV	Residential PRG	Industrial PRG	Frequency of Detection	EPC	Statistical Measure
		Min	Max							
Site 12B	Aluminum	24,200	272,000	ppm	**173,500**	76,000	100,000	12/12	173,080	95% UCL-T
	Chromium, Total	99.3	1,460	ppm	**1,080**	210	450	12/12	971	95% UCL-T
	Lead	33.7	1,210	ppm	166	400	**800**	15/15	545	95% UCL-T
	Benz[a]anthracene	0.00112	59	ppm	NA	0.62	**2.1**	23/26	59	Max [1]
	Benzo[a]pyrene	0.00101	77	ppm	NA	0.062	**0.21**	25/26	77	Max [1]
	Benzo[b]fluoranthene	0.00177	80	ppm	NA	0.62	**2.1**	25/26	80	Max [1]
	Benzo[k]fluoranthene	0.00049	39	ppm	NA	6.2	**21**	25/26	39	Max [1]
	Dibenz[a,h]anthracene	0.004	20	ppm	NA	0.062	**0.21**	14/26	20	Max [1]
	Indeno[1,2,3-c,d]pyrene	0.00312	135.91	ppm	NA	0.62	**2.1**	25/26	135.91	Max [1]

Key
Bold/Shaded: Higher of BTV & Industrial PRG (USEPA, 2004)
BTV: Background Threshold Value
COC: Contaminant of concern
EPC: Exposure point concentration
Max: Maximum concentration
Min: Minimum concentration
NA: Not applicable
ppm: Parts per million
PRG: USEPA Region 9 Preliminary Remediation Goal
USEPA: U.S. Environmental Protection Agency
95% UCL-T: 95% Upper Confidence Limit of Log-transformed Data
1: 95% UCL exceeds maximum detected concentration. Therefore, maximum concentration used for EPC.

The table presents the COCs and EPC for each of the COCs detected in subsurface soil (i.e., the concentration that was used to estimate the exposure and risk from each COC in the surface soil). The table includes the range of concentrations detected for each COC, as well as the frequency of detection (i.e., the number of times the chemical was detected in the samples collected at the surface site), the EPC, and how the EPC was derived. The table indicates that benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-c,d)pyrene were the most frequently detected COC in soil at the site. The 95%UCL of Log-transformed Data was used as the EPC for aluminum, total chromium, and lead. However, because the 95% UCL exceeded the maximum detected concentrations for benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-c,d)pyrene, the maximum concentration was used as the default EPC for these COC.

TABLE 4-6. SUMMARY OF CONTAMINANTS OF CONCERN AND MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATIONS FOR SURFACE SOIL, SITE 12, AREA E, ANDERSEN AFB, GUAM.

Scenario Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil

Site 12E	COC	Concentration Detected		Units	BTV	Residential PRG	Industrial PRG	Frequency of Detection	EPC	Statistical Measure
		Min	Max							
	Manganese	427	3,490	ppm	5,500	1,800	**19,000**	20/20	2,358	95% UCL-N

Key
Bold/Shaded: Higher of BTV & Industrial PRG (USEPA, 2004)
BTV: Background Threshold Value
COC: Contaminant of concern
EPC: Exposure point concentration
Max: Maximum concentration
Min: Minimum concentration
ppm: Parts per million
PRG: USEPA Region 9 Preliminary Remediation Goal
USEPA: U.S. Environmental Protection Agency
95% UCL-N: 95% Upper Confidence Limit of Normal Data

The table presents the COC and EPC for the COC detected in surface soil (i.e., the concentration that was used to estimate the exposure and risk from the COC in the surface soil). The table includes the range of concentrations detected for the COC, as well as the frequency of detection (i.e., the number of times the chemical was detected in the samples collected at the surface site), the EPC, and how the EPC was derived. The 95%UCL of Normal Data was used as the EPC for the COC.

TABLE 4-7. SUMMARY OF CONTAMINANTS OF CONCERN AND MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATIONS FOR SURFACE SOIL, SITE 12, AREA F, ANDERSEN AFB, GUAM.

Scenario Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil

Exposure Point	COC	Concentration Detected		Units	BTV	Residential PRG	Industrial PRG	Frequency of Detection	EPC	Statistical Measure
		Min	Max							
Site 12F	Cadmium	11	2,640	ppm	6.5	37	**450**	6/6	2,640	Max [1]
	Nickel	4.9	2,780	ppm	242.4	1,600	**20,000**	4/4	2,780	Max [1]

Key
Bold/Shaded: Higher of BTV & Industrial PRG (USEPA, 2004)
BTV: Background Threshold Value
COC: Contaminant of concern
EPC: Exposure point concentration
Max: Maximum concentration
Min: Minimum concentration
NA: Not applicable
ppm: Parts per million
PRG: USEPA Region 9 Preliminary Remediation Goal
USEPA: U.S. Environmental Protection Agency
1: 95% UCL exceeds maximum detected concentration. Therefore, maximum concentration used for EPC.

The table presents the COCs and EPC for each of the COCs detected in surface soil (i.e., the concentration that will be used to estimate the exposure and risk from each COC in the surface soil). The table includes the range of concentrations detected for each COC, as well as the frequency of detection (i.e., the number of times the chemical was detected in the samples collected at the surface site), the EPC, and how the EPC was derived. The table indicates that cadmium is the most frequently detected COC in soil at the site. Because the 95% UCL exceeds maximum detected concentration for both cadmium and nickel, the maximum concentration was used as the default EPC.

TABLE 4-8. SUMMARY OF SURFACE SOIL HHRA RESULTS FOR FUTURE RESIDENT ADULT UNDER REASONABLE MAXIMUM EXPOSURE, SITE 12, AREA A, ANDERSEN AFB, GUAM.

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk (1)				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Site 12A	ANTIMONY	--	--	--	--	ANTIMONY	blood	5.3E-01	--	--	5.3E-01
			ARSENIC	9.8E-05	--	9.3E-06	1.07E-04	ARSENIC		4.5E-01	--	5.4E-02	5.04E-01
			BARIUM	--	--	--	--	BARIUM		1.5E-02	--	--	1.5E-02
			CADMIUM	--	--	--	--	CADMIUM	kidney	4.2E-02	--	3.3E-03	4.53E-02
			COPPER	--	--	--	--	COPPER	GI System	2.1E-01	--	--	2.1E-01
			CYANIDE	--	--	--	--	CYANIDE		1.1E-04	--	--	1.1E-04
			LEAD	--	--	--	--	LEAD		--	--	--	--
			MANGANESE	--	--	--	--	MANGANESE	Nervous System	2.5E-01	--	--	2.5E-01
			MERCURY (INORGANIC)	--	--	--	--	MERCURY (INORGANIC)		9.7E-03	--	--	9.7E-03
			MOLYBDENUM	--	--	--	--	MOLYBDENUM		4.7E-03	--	--	4.7E-03
			THALLIUM	--	--	--	--	THALLIUM		3.0E-02	--	--	3.0E-02
			ZINC	--	--	--	--	ZINC		7.4E-02	--	--	7.4E-02
			BENZ[A]ANTHRACENE	7.4E-08	--	3.0E-08	1.04E-07	BENZ[A]ANTHRACENE		--	--	--	--
			BENZO[A]PYRENE	1.2E-06	--	4.9E-07	1.69E-06	BENZO[A]PYRENE		--	--	--	--
			BENZO[B]FLUORANTHENE	1.5E-07	--	6.3E-08	2.13E-07	BENZO[B]FLUORANTHENE		--	--	--	--
			DIBENZ[A,H]ANTHRACENE	3.9E-07	--	1.6E-07	5.5E-07	DIBENZ[A,H]ANTHRACENE		--	--	--	--
			INDENO[1,2,3-C,D]PYRENE	4.2E-07	--	1.7E-07	5.9E-07	INDENO[1,2,3-C,D]PYRENE		--	--	--	--
			DDE	1.5E-05	--	1.4E-06	1.64E-05	DDE		--	--	--	--
			DDT	2.5E-05	--	2.4E-06	2.74E-05	DDT	liver	3.1E-01	--	3.7E-02	3.47E-01
			DIELDRIN	1.3E-05	--	4.2E-06	1.72E-05	DIELDRIN	liver	3.4E-02	--	1.3E-02	4.7E-02
			PENTACHLOROPHENOL	2.3E-07	--	1.8E-07	4.1E-07	PENTACHLOROPHENOL		1.3E-04	--	1.3E-04	2.6E-04
			(Total)	1.53E-04	--	1.84E-05	1.72E-04	(Total)		1.96E+00	--	1.07E-01	2.07E+00
	Air	Site 12A	ANTIMONY	--	--	--	--	ANTIMONY		--	--	--	--
			ARSENIC	--	8.9E-07	--	8.9E-07	ARSENIC		--	--	--	--
			BARIUM	--	--	--	--	BARIUM		--	1.3E-02	--	1.3E-02
			CADMIUM	--	1.2E-07	--	1.2E-07	CADMIUM		--	--	--	--
			COPPER	--	--	--	--	COPPER		--	--	--	--
			CYANIDE	--	--	--	--	CYANIDE		--	--	--	--
			LEAD	--	--	--	--	LEAD		--	--	--	--
			MANGANESE	--	--	--	--	MANGANESE	Nervous System	--	7.8E-01	--	7.8E-01
			MERCURY (INORGANIC)	--	--	--	--	MERCURY (INORGANIC)		--	6.3E-05	--	6.3E-05
			MOLYBDENUM	--	--	--	--	MOLYBDENUM		--	--	--	--
			THALLIUM	--	--	--	--	THALLIUM		--	--	--	--
			ZINC	--	--	--	--	ZINC		--	--	--	--
			BENZ[A]ANTHRACENE	--	2.8E-11	--	2.8E-11	BENZ[A]ANTHRACENE		--	--	--	--
			BENZO[A]PYRENE	--	4.5E-10	--	4.5E-10	BENZO[A]PYRENE		--	--	--	--
			BENZO[B]FLUORANTHENE	--	5.9E-11	--	5.9E-11	BENZO[B]FLUORANTHENE		--	--	--	--
			DIBENZ[A,H]ANTHRACENE	--	1.5E-10	--	1.5E-10	DIBENZ[A,H]ANTHRACENE		--	--	--	--
			INDENO[1,2,3-C,D]PYRENE	--	1.6E-10	--	1.6E-10	INDENO[1,2,3-C,D]PYRENE		--	--	--	--
			DDE	--	1.3E-08	--	1.3E-08	DDE		--	--	--	--
			DDT	--	2.3E-08	--	2.3E-08	DDT		--	--	--	--
			DIELDRIN	--	1.2E-08	--	1.2E-08	DIELDRIN		--	6.2E-05	--	6.2E-05
			PENTACHLOROPHENOL	--	2.1E-10	--	2.1E-10	PENTACHLOROPHENOL		--	2.4E-07	--	2.4E-07
			(Total)	--	1.06E-06	--	1.06E-06	(Total)		--	7.93E-01	--	7.93E-01
						Total Risk Across Medium	1.73E-04					Total Hazard Index Across All Media and All Exposure Routes	2.86E+00

(1) Carcinogenic risks are combined for Resident Adults and Children.

Total blood HI =	5.3E-01
Total kidney HI =	4.53E-02
Total GI System HI =	2.1E-01
Total Nervous System HI =	1.03E+00
Total liver HI =	3.94E-01

TABLE 4-9. SUMMARY OF SURFACE SOIL HHRA RESULTS FOR FUTURE RESIDENT CHILDREN UNDER REASONABLE MAXIMUM EXPOSURE, SITE 12, AREA A, ANDERSEN AFB, GUAM.

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk (1)				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Site 12A	ANTIMONY	--	--	--	--	ANTIMONY	blood	5.0E+00	--	--	5.0E+00
			ARSENIC	--	--	--	--	ARSENIC		4.2E+00	--	5.5E-01	4.75E+00
			BARIUM	--	--	--	--	BARIUM		1.4E-01	--	--	1.4E-01
			CADMIUM	--	--	--	--	CADMIUM	kidney	3.9E-01	--	3.4E-02	4.24E-01
			COPPER	--	--	--	--	COPPER	GI System	2.0E+00	--	--	2.0E+00
			CYANIDE	--	--	--	--	CYANIDE		1.1E-03	--	--	1.1E-03
			LEAD	--	--	--	--	LEAD		--	--	--	--
			MANGANESE	--	--	--	--	MANGANESE	Nervous System	2.3E+00	--	--	2.3E+00
			MERCURY (INORGANIC)	--	--	--	--	MERCURY (INORGANIC)		9.0E-02	--	--	9.0E-02
			MOLYBDENUM	--	--	--	--	MOLYBDENUM		4.3E-02	--	--	4.3E-02
			THALLIUM	--	--	--	--	THALLIUM		2.8E-01	--	--	2.8E-01
			ZINC	--	--	--	--	ZINC		6.9E-01	--	--	6.9E-01
			BENZ[A]ANTHRACENE	--	--	--	--	BENZ[A]ANTHRACENE		--	--	--	--
			BENZO[A]PYRENE	--	--	--	--	BENZO[A]PYRENE		--	--	--	--
			BENZO[B]FLUORANTHENE	--	--	--	--	BENZO[B]FLUORANTHENE		--	--	--	--
			DIBENZ[A,H]ANTHRACENE	--	--	--	--	DIBENZ[A,H]ANTHRACENE		--	--	--	--
			INDENO[1,2,3-C,D]PYRENE	--	--	--	--	INDENO[1,2,3-C,D]PYRENE		--	--	--	--
			DDE	--	--	--	--	DDE		--	--	--	--
			DDT	--	--	--	--	DDT	liver	2.9E+00	--	3.7E-01	3.27E+00
			DIELDRIN	--	--	--	--	DIELDRIN	liver	3.1E-01	--	1.4E-01	4.5E-01
			PENTACHLOROPHENOL	--	--	--	--	PENTACHLOROPHENOL		1.2E-03	--	1.3E-03	2.5E-03
			(Total)	--	--	--	--	(Total)		1.83E+01	--	1.10E+00	1.94E+01
	Air	Site 12A	ANTIMONY	--	--	--	--	ANTIMONY		--	--	--	--
			ARSENIC	--	--	--	--	ARSENIC		--	--	--	--
			BARIUM	--	--	--	--	BARIUM		--	4.7E-02	--	4.7E-02
			CADMIUM	--	--	--	--	CADMIUM		--	--	--	--
			COPPER	--	--	--	--	COPPER		--	--	--	--
			CYANIDE	--	--	--	--	CYANIDE		--	--	--	--
			LEAD	--	--	--	--	LEAD		--	--	--	--
			MANGANESE	--	--	--	--	MANGANESE	Nervous System	--	2.8E+00	--	2.8E+00
			MERCURY (INORGANIC)	--	--	--	--	MERCURY (INORGANIC)		--	2.2E-04	--	2.2E-04
			MOLYBDENUM	--	--	--	--	MOLYBDENUM		--	--	--	--
			THALLIUM	--	--	--	--	THALLIUM		--	--	--	--
			ZINC	--	--	--	--	ZINC		--	--	--	--
			BENZ[A]ANTHRACENE	--	--	--	--	BENZ[A]ANTHRACENE		--	--	--	--
			BENZO[A]PYRENE	--	--	--	--	BENZO[A]PYRENE		--	--	--	--
			BENZO[B]FLUORANTHENE	--	--	--	--	BENZO[B]FLUORANTHENE		--	--	--	--
			DIBENZ[A,H]ANTHRACENE	--	--	--	--	DIBENZ[A,H]ANTHRACENE		--	--	--	--
			INDENO[1,2,3-C,D]PYRENE	--	--	--	--	INDENO[1,2,3-C,D]PYRENE		--	--	--	--
			DDE	--	--	--	--	DDE		--	--	--	--
			DDT	--	--	--	--	DDT		--	--	--	--
			DIELDRIN	--	--	--	--	DIELDRIN		--	2.2E-04	--	2.2E-04
			PENTACHLOROPHENOL	--	--	--	--	PENTACHLOROPHENOL		--	8.5E-07	--	8.5E-07
			(Total)	--	--	--	--	(Total)		--	2.85E+00	--	2.85E+00
						Total Risk Across Medium	--					Total Hazard Index Across All Media and All Exposure Routes	2.23E+01

(1) Carcinogenic risks are combined for Resident Adults and Children and are shown on Table 4-8.

Total blood HI =	5.0E+00
Total kidney HI =	4.24E-01
Total GI System HI =	2.0E+00
Total Nervous System HI =	5.10E+00
Total liver HI =	3.72E+00

TABLE 4-10. SUMMARY OF SURFACE SOIL HHRA RESULTS FOR FUTURE RESIDENT ADULT UNDER REASONABLE MAXIMUM EXPOSURE, SITE 12, AREA B, ANDERSEN AFB, GUAM.

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk (1)				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Site 12B	ALUMINUM	--	--	--	--	ALUMINUM	skin	1.5E-01	--	--	1.5E-01
			ANTIMONY	--	--	--	--	ANTIMONY	blood	1.6E-01	--	--	1.6E-01
			ARSENIC	4.0E-05	--	3.8E-06	4.38E-05	ARSENIC		1.8E-01	--	2.2E-02	2.02E-01
			CADMIUM	--	--	--	--	CADMIUM	kidney	8.6E-03	--	6.9E-04	9.29E-03
			CHROMIUM, TOTAL	--	--	--	--	CHROMIUM, TOTAL		2.5E-01	--	--	2.5E-01
			COPPER	--	--	--	--	COPPER	GI System	3.7E-03	--	--	3.7E-03
			LEAD	--	--	--	--	LEAD		--	--	--	--
			MANGANESE	--	--	--	--	MANGANESE	Nervous System	1.2E-01	--	--	1.2E-01
			THALLIUM	--	--	--	--	THALLIUM		1.6E-02	--	--	1.6E-02
			BENZ[A]ANTHRACENE	1.3E-04	--	5.2E-05	1.82E-04	BENZ[A]ANTHRACENE		--	--	--	--
			BENZO[A]PYRENE	1.4E-03	--	5.8E-04	1.98E-03	BENZO[A]PYRENE		--	--	--	--
			BENZO[B]FLUORANTHENE	1.3E-04	--	5.4E-05	1.84E-04	BENZO[B]FLUORANTHENE		--	--	--	--
			BENZO[K]FLUORANTHENE	6.8E-06	--	2.8E-06	9.6E-06	BENZO[K]FLUORANTHENE		--	--	--	--
			CHRYSENE	6.8E-07	--	2.8E-07	9.6E-07	CHRYSENE		--	--	--	--
			DIBENZ[A,H]ANTHRACENE	2.4E-04	--	1.0E-04	3.4E-04	DIBENZ[A,H]ANTHRACENE		--	--	--	--
			FLUORANTHENE	--	--	--	--	FLUORANTHENE		8.9E-03	--	4.6E-03	1.35E-02
			INDENO[1,2,3-C,D]PYRENE	1.5E-04	--	6.0E-05	2.1E-04	INDENO[1,2,3-C,D]PYRENE		--	--	--	--
			PYRENE	--	--	--	--	PYRENE		1.1E-02	--	5.7E-03	1.67E-02
			(Total)	2.10E-03	--	8.53E-04	2.95E-03	(Total)		9.08E-01	--	3.30E-02	9.41E-01
	Air	Site 12B	ALUMINUM	--	--	--	--	ALUMINUM		--	2.0E-01	--	2.0E-01
			ANTIMONY	--	--	--	--	ANTIMONY		--	--	--	--
			ARSENIC	--	3.7E-07	--	3.7E-07	ARSENIC		--	--	--	--
			CADMIUM	--	2.4E-08	--	2.4E-08	CADMIUM		--	--	--	--
			CHROMIUM, TOTAL	--	1.4E-05	--	1.4E-05	CHROMIUM, TOTAL		--	--	--	--
			COPPER	--	--	--	--	COPPER		--	--	--	--
			LEAD	--	--	--	--	LEAD		--	--	--	--
			MANGANESE	--	--	--	--	MANGANESE	Nervous System	--	3.8E-01	--	3.8E-01
			THALLIUM	--	--	--	--	THALLIUM		--	--	--	--
			BENZ[A]ANTHRACENE	--	4.9E-08	--	4.9E-08	BENZ[A]ANTHRACENE		--	--	--	--
			BENZO[A]PYRENE	--	5.4E-07	--	5.4E-07	BENZO[A]PYRENE		--	--	--	--
			BENZO[B]FLUORANTHENE	--	5.0E-08	--	5.0E-08	BENZO[B]FLUORANTHENE		--	--	--	--
			BENZO[K]FLUORANTHENE	--	2.6E-09	--	2.6E-09	BENZO[K]FLUORANTHENE		--	--	--	--
			CHRYSENE	--	2.6E-10	--	2.6E-10	CHRYSENE		--	--	--	--
			DIBENZ[A,H]ANTHRACENE	--	9.3E-08	--	9.3E-08	DIBENZ[A,H]ANTHRACENE		--	--	--	--
			FLUORANTHENE	--	--	--	--	FLUORANTHENE		--	1.7E-05	--	1.7E-05
			INDENO[1,2,3-C,D]PYRENE	--	5.6E-08	--	5.6E-08	INDENO[1,2,3-C,D]PYRENE		--	--	--	--
			PYRENE	--	--	--	--	PYRENE		--	2.0E-05	--	2.0E-05
			(Total)	--	1.52E-05	--	1.52E-05	(Total)		--	5.80E-01	--	5.80E-01
						Total Risk Across Medium	2.97E-03					Total Hazard Index Across All Media and All Exposure Routes	1.52E+00

(1) Carcinogenic risks are combined for Resident Adults and Children.

Total skin HI =	1.5E-01
Total blood HI =	1.6E-01
Total kidney HI =	9.29E-03
Total GI System HI =	3.7E-03
Total Nervous System HI =	5.00E-01

TABLE 4-11. SUMMARY OF SURFACE SOIL HHRA RESULTS FOR FUTURE RESIDENT CHILDREN UNDER REASONABLE MAXIMUM EXPOSURE, SITE 12, AREA B, ANDERSEN AFB, GUAM.

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk (1)				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Site 12B	ALUMINUM	--	--	--	--	ALUMINUM	skin	1.4E+00	--	--	1.4E+00
			ANTIMONY	--	--	--	--	ANTIMONY	blood	1.5E+00	--	--	1.5E+00
			ARSENIC	--	--	--	--	ARSENIC		1.7E+00	--	2.2E-01	1.92E+00
			CADMIUM	--	--	--	--	CADMIUM	kidney	8.0E-02	--	7.0E-03	8.7E-02
			CHROMIUM, TOTAL	--	--	--	--	CHROMIUM, TOTAL		2.4E+00	--	--	2.4E+00
			COPPER	--	--	--	--	COPPER	GI System	3.4E-02	--	--	3.4E-02
			LEAD	--	--	--	--	LEAD		--	--	--	--
			MANGANESE	--	--	--	--	MANGANESE	Nervous System	1.1E+00	--	--	1.1E+00
			THALLIUM	--	--	--	--	THALLIUM		1.5E-01	--	--	1.5E-01
			BENZ[A]ANTHRACENE	--	--	--	--	BENZ[A]ANTHRACENE		--	--	--	--
			BENZO[A]PYRENE	--	--	--	--	BENZO[A]PYRENE		--	--	--	--
			BENZO[B]FLUORANTHENE	--	--	--	--	BENZO[B]FLUORANTHENE		--	--	--	--
			BENZO[K]FLUORANTHENE	--	--	--	--	BENZO[K]FLUORANTHENE		--	--	--	--
			CHRYSENE	--	--	--	--	CHRYSENE		--	--	--	--
			DIBENZ[A,H]ANTHRACENE	--	--	--	--	DIBENZ[A,H]ANTHRACENE		--	--	--	--
			FLUORANTHENE	--	--	--	--	FLUORANTHENE		8.3E-02	--	4.7E-02	1.3E-01
			INDENO[1,2,3-C,D]PYRENE	--	--	--	--	INDENO[1,2,3-C,D]PYRENE		--	--	--	--
			PYRENE	--	--	--	--	PYRENE		1.0E-01	--	5.8E-02	1.58E-01
			(Total)	--	--	--	--	(Total)		8.55E+00	--	3.32E-01	8.88E+00
	Air	Site 12B	ALUMINUM	--	--	--	--	ALUMINUM		--	7.1E-01	--	7.1E-01
			ANTIMONY	--	--	--	--	ANTIMONY		--	--	--	--
			ARSENIC	--	--	--	--	ARSENIC		--	--	--	--
			CADMIUM	--	--	--	--	CADMIUM		--	--	--	--
			CHROMIUM, TOTAL	--	--	--	--	CHROMIUM, TOTAL		--	--	--	--
			COPPER	--	--	--	--	COPPER		--	--	--	--
			LEAD	--	--	--	--	LEAD		--	--	--	--
			MANGANESE	--	--	--	--	MANGANESE	Nervous System	--	1.3E+00	--	1.3E+00
			THALLIUM	--	--	--	--	THALLIUM		--	--	--	--
			BENZ[A]ANTHRACENE	--	--	--	--	BENZ[A]ANTHRACENE		--	--	--	--
			BENZO[A]PYRENE	--	--	--	--	BENZO[A]PYRENE		--	--	--	--
			BENZO[B]FLUORANTHENE	--	--	--	--	BENZO[B]FLUORANTHENE		--	--	--	--
			BENZO[K]FLUORANTHENE	--	--	--	--	BENZO[K]FLUORANTHENE		--	--	--	--
			CHRYSENE	--	--	--	--	CHRYSENE		--	--	--	--
			DIBENZ[A,H]ANTHRACENE	--	--	--	--	DIBENZ[A,H]ANTHRACENE		--	--	--	--
			FLUORANTHENE	--	--	--	--	FLUORANTHENE		--	5.8E-05	--	5.8E-05
			INDENO[1,2,3-C,D]PYRENE	--	--	--	--	INDENO[1,2,3-C,D]PYRENE		--	--	--	--
			PYRENE	--	--	--	--	PYRENE		--	7.1E-05	--	7.1E-05
			(Total)	--	--	--	--	(Total)		--	2.01E+00	--	2.01E+00
						Total Risk Across Medium	--					Total Hazard Index Across All Media and All Exposure Routes	1.09E+01

(1) Carcinogenic risks are combined for Resident Adults and Children and are shown on Table 4-10.

Total skin HI =	1.4E+00
Total blood HI =	1.5E+00
Total kidney HI =	8.7E-02
Total GI System HI =	3.4E-02
Total Nervous System HI =	2.40E+00

TABLE 4-12. SUMMARY OF SURFACE SOIL HHRA RESULTS FOR OCCASIONAL USER/TRESPASSER UNDER REASONABLE MAXIMUM EXPOSURE, SITE 12, AREA B, ANDERSEN AFB, GUAM.

Scenario Timeframe: Current/Future
Receptor Population: Trespasser/Occasional User
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Site 12B	ALUMINUM	--	--	--	--	ALUMINUM	skin	1.1E-02	--	--	1.1E-02
			ANTIMONY	--	--	--	--	ANTIMONY	blood	1.2E-02	--	--	1.2E-02
			ARSENIC	2.6E-06	--	1.0E-06	3.6E-06	ARSENIC		1.4E-02	--	5.4E-03	1.94E-02
			CADMIUM	--	--	--	--	CADMIUM	kidney	6.4E-04	--	1.7E-04	8.1E-04
			CHROMIUM, TOTAL	--	--	--	--	CHROMIUM, TOTAL		1.9E-02	--	--	1.9E-02
			COPPER	--	--	--	--	COPPER	GI System	2.7E-04	--	--	2.7E-04
			LEAD	--	--	--	--	LEAD		--	--	--	--
			MANGANESE	--	--	--	--	MANGANESE	Nervous System	8.8E-03	--	--	8.8E-03
			THALLIUM	--	--	--	--	THALLIUM		1.2E-03	--	--	1.2E-03
			BENZ[A]ANTHRACENE	8.3E-06	--	1.4E-05	2.23E-05	BENZ[A]ANTHRACENE		--	--	--	--
			BENZO[A]PYRENE	9.2E-05	--	1.6E-04	2.52E-04	BENZO[A]PYRENE		--	--	--	--
			BENZO[B]FLUORANTHENE	8.6E-06	--	1.5E-05	2.36E-05	BENZO[B]FLUORANTHENE		--	--	--	--
			BENZO[K]FLUORANTHENE	4.5E-07	--	7.6E-07	1.21E-06	BENZO[K]FLUORANTHENE		--	--	--	--
			CHRYSENE	4.5E-08	--	7.6E-08	1.21E-07	CHRYSENE		--	--	--	--
			DIBENZ[A,H]ANTHRACENE	1.6E-05	--	2.7E-05	4.3E-05	DIBENZ[A,H]ANTHRACENE		--	--	--	--
			FLUORANTHENE	--	--	--	--	FLUORANTHENE		6.6E-04	--	1.1E-03	1.76E-03
			INDENO[1,2,3-C,D]PYRENE	9.6E-06	--	1.6E-05	2.56E-05	INDENO[1,2,3-C,D]PYRENE		--	--	--	--
			PYRENE	--	--	--	--	PYRENE		8.1E-04	--	1.4E-03	2.21E-03
			(Total)	1.38E-04	--	2.34E-04	3.71E-04	(Total)		6.84E-02	--	8.07E-03	7.65E-02
	Air	Site 12B	ALUMINUM	--	--	--	--	ALUMINUM		--	2.5E-03	--	2.5E-03
			ANTIMONY	--	--	--	--	ANTIMONY		--	--	--	--
			ARSENIC	--	8.2E-09	--	8.2E-09	ARSENIC		--	--	--	--
			CADMIUM	--	5.3E-10	--	5.3E-10	CADMIUM		--	--	--	--
			CHROMIUM, TOTAL	--	3.1E-07	--	3.1E-07	CHROMIUM, TOTAL		--	--	--	--
			COPPER	--	--	--	--	COPPER		--	--	--	--
			LEAD	--	--	--	--	LEAD		--	--	--	--
			MANGANESE	--	--	--	--	MANGANESE	Nervous System	--	4.7E-03	--	4.7E-03
			THALLIUM	--	--	--	--	THALLIUM		--	--	--	--
			BENZ[A]ANTHRACENE	--	1.1E-09	--	1.1E-09	BENZ[A]ANTHRACENE		--	--	--	--
			BENZO[A]PYRENE	--	1.2E-08	--	1.2E-08	BENZO[A]PYRENE		--	--	--	--
			BENZO[B]FLUORANTHENE	--	1.1E-09	--	1.1E-09	BENZO[B]FLUORANTHENE		--	--	--	--
			BENZO[K]FLUORANTHENE	--	5.8E-11	--	5.8E-11	BENZO[K]FLUORANTHENE		--	--	--	--
			CHRYSENE	--	5.8E-12	--	5.8E-12	CHRYSENE		--	--	--	--
			DIBENZ[A,H]ANTHRACENE	--	2.1E-09	--	2.1E-09	DIBENZ[A,H]ANTHRACENE		--	--	--	--
			FLUORANTHENE	--	--	--	--	FLUORANTHENE		--	2.0E-07	--	2.0E-07
			INDENO[1,2,3-C,D]PYRENE	--	1.3E-09	--	1.3E-09	INDENO[1,2,3-C,D]PYRENE		--	--	--	--
			PYRENE	--	--	--	--	PYRENE		--	2.5E-07	--	2.5E-07
			(Total)	--	3.36E-07	--	3.36E-07	(Total)		--	7.20E-03	--	7.20E-03
						Total Risk Across Medium	3.72E-04					Total Hazard Index Across All Media and All Exposure Routes	8.37E-02

Total skin HI =	1.1E-02
Total blood HI =	1.2E-02
Total kidney HI =	8.1E-04
Total GI System HI =	2.7E-04
Total Nervous System HI =	1.35E-02

TABLE 4-13. SUMMARY OF SUBSURFACE SOIL HHRA RESULTS FOR FUTURE RESIDENT ADULT UNDER REASONABLE MAXIMUM EXPOSURE, SITE 12, AREA B, ANDERSEN AFB, GUAM.

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk[1]				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Subsurface Soil	Subsurface Soil	Site 12B	ALUMINUM	--	--	--	--	ALUMINUM	skin	2.4E-01	--	--	2.4E-01
			CADMIUM	--	--	--	--	CADMIUM	kidney	9.8E-03	--	7.8E-04	1.06E-02
			CHROMIUM, TOTAL	--	--	--	--	CHROMIUM, TOTAL		4.4E-01	--	--	4.4E-01
			LEAD	--	--	--	--	LEAD		--	--	--	--
			MANGANESE	--	--	--	--	MANGANESE	Nervous System	2.0E-01	--	--	2.0E-01
			THALLIUM	--	--	--	--	THALLIUM		3.1E-02	--	--	3.1E-02
			VANADIUM	--	--	--	--	VANADIUM		2.1E-02	--	--	2.1E-02
			BENZ[A]ANTHRACENE	2.9E-05	--	1.2E-05	4.1E-05	BENZ[A]ANTHRACENE		--	--	--	--
			BENZO[A]PYRENE	3.8E-04	--	1.5E-04	5.3E-04	BENZO[A]PYRENE		--	--	--	--
			BENZO[B]FLUORANTHENE	3.9E-05	--	1.6E-05	5.5E-05	BENZO[B]FLUORANTHENE		--	--	--	--
			BENZO[K]FLUORANTHENE	1.9E-06	--	7.8E-07	2.68E-06	BENZO[K]FLUORANTHENE		--	--	--	--
			CHRYSENE	3.3E-07	--	1.4E-07	4.7E-07	CHRYSENE		--	--	--	--
			DIBENZ[A,H]ANTHRACENE	9.8E-05	--	4.0E-05	1.38E-04	DIBENZ[A,H]ANTHRACENE		--	--	--	--
			INDENO[1,2,3-C,D]PYRENE	6.6E-05	--	2.7E-05	9.3E-05	INDENO[1,2,3-C,D]PYRENE		--	--	--	--
			(Total)	6.14E-04	--	2.46E-04	8.60E-04	(Total)		9.42E-01	--	7.8E-04	9.43E-01
	Air	Site 12B	ALUMINUM	--	--	--	--	ALUMINUM		--	3.1E-01	--	3.1E-01
			CADMIUM	--	2.7E-08	--	2.7E-08	CADMIUM		--	--	--	--
			CHROMIUM, TOTAL	--	2.5E-05	--	2.5E-05	CHROMIUM, TOTAL		--	--	--	--
			LEAD	--	--	--	--	LEAD		--	--	--	--
			MANGANESE	--	--	--	--	MANGANESE	Nervous System	--	6.2E-01	--	6.2E-01
			THALLIUM	--	--	--	--	THALLIUM		--	--	--	--
			VANADIUM	--	--	--	--	VANADIUM		--	--	--	--
			BENZ[A]ANTHRACENE	--	1.1E-08	--	1.1E-08	BENZ[A]ANTHRACENE		--	--	--	--
			BENZO[A]PYRENE	--	1.4E-07	--	1.4E-07	BENZO[A]PYRENE		--	--	--	--
			BENZO[B]FLUORANTHENE	--	1.5E-08	--	1.5E-08	BENZO[B]FLUORANTHENE		--	--	--	--
			BENZO[K]FLUORANTHENE	--	7.3E-10	--	7.3E-10	BENZO[K]FLUORANTHENE		--	--	--	--
			CHRYSENE	--	1.3E-10	--	1.3E-10	CHRYSENE		--	--	--	--
			DIBENZ[A,H]ANTHRACENE	--	3.7E-08	--	3.7E-08	DIBENZ[A,H]ANTHRACENE		--	--	--	--
			INDENO[1,2,3-C,D]PYRENE	--	2.5E-08	--	2.5E-08	INDENO[1,2,3-C,D]PYRENE		--	--	--	--
			(Total)	--	2.53E-05	--	2.53E-05	(Total)		--	9.30E-01	--	9.30E-01
						Total Risk Across Medium	8.85E-04					Total Hazard Index Across All Media and All Exposure Routes	1.87E+00

(1) Carcinogenic risks are combined for Resident Adults and Children.

Total skin HI =	2.4E-01
Total kidney HI =	1.06E-02
Total Nervous System HI =	8.20E-01

TABLE 4-14. SUMMARY OF SUBSURFACE SOIL HHRA RESULTS FOR FUTURE RESIDENT CHILDREN UNDER REASONABLE MAXIMUM EXPOSURE, SITE 12, AREA B, ANDERSEN AFB, GUAM.

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk[1]				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Subsurface Soil	Subsurface Soil	Site 12B	ALUMINUM	--	--	--	--	ALUMINUM	skin	2.2E+00	--	--	2.2E+00
			CADMIUM	--	--	--	--	CADMIUM	kidney	9.1E-02	--	7.9E-03	9.89E-02
			CHROMIUM, TOTAL	--	--	--	--	CHROMIUM, TOTAL		4.1E+00	--	--	4.1E+00
			LEAD	--	--	--	--	LEAD		--	--	--	--
			MANGANESE	--	--	--	--	MANGANESE	Nervous System	1.8E+00	--	--	1.8E+00
			THALLIUM	--	--	--	--	THALLIUM		2.8E-01	--	--	2.8E-01
			VANADIUM	--	--	--	--	VANADIUM		1.9E-01	--	--	1.9E-01
			BENZ[A]ANTHRACENE	--	--	--	--	BENZ[A]ANTHRACENE		--	--	--	--
			BENZO[A]PYRENE	--	--	--	--	BENZO[A]PYRENE		--	--	--	--
			BENZO[B]FLUORANTHENE	--	--	--	--	BENZO[B]FLUORANTHENE		--	--	--	--
			BENZO[K]FLUORANTHENE	--	--	--	--	BENZO[K]FLUORANTHENE		--	--	--	--
			CHRYSENE	--	--	--	--	CHRYSENE		--	--	--	--
			DIBENZ[A,H]ANTHRACENE	--	--	--	--	DIBENZ[A,H]ANTHRACENE		--	--	--	--
			INDENO[1,2,3-C,D]PYRENE	--	--	--	--	INDENO[1,2,3-C,D]PYRENE		--	--	--	--
			(Total)	--	--	--	--	(Total)		8.66E+00	--	7.9E-03	8.67E+00
	Air	Site 12B	ALUMINUM	--	--	--	--	ALUMINUM		--	1.1E+00	--	1.1E+00
			CADMIUM	--	--	--	--	CADMIUM		--	--	--	--
			CHROMIUM, TOTAL	--	--	--	--	CHROMIUM, TOTAL		--	--	--	--
			LEAD	--	--	--	--	LEAD		--	--	--	--
			MANGANESE	--	--	--	--	MANGANESE	Nervous System	--	2.2E+00	--	2.2E+00
			THALLIUM	--	--	--	--	THALLIUM		--	--	--	--
			VANADIUM	--	--	--	--	VANADIUM		--	--	--	--
			BENZ[A]ANTHRACENE	--	--	--	--	BENZ[A]ANTHRACENE		--	--	--	--
			BENZO[A]PYRENE	--	--	--	--	BENZO[A]PYRENE		--	--	--	--
			BENZO[B]FLUORANTHENE	--	--	--	--	BENZO[B]FLUORANTHENE		--	--	--	--
			BENZO[K]FLUORANTHENE	--	--	--	--	BENZO[K]FLUORANTHENE		--	--	--	--
			CHRYSENE	--	--	--	--	CHRYSENE		--	--	--	--
			DIBENZ[A,H]ANTHRACENE	--	--	--	--	DIBENZ[A,H]ANTHRACENE		--	--	--	--
			INDENO[1,2,3-C,D]PYRENE	--	--	--	--	INDENO[1,2,3-C,D]PYRENE		--	--	--	--
			(Total)	--	--	--	--	(Total)		--	3.30E+00	--	3.30E+00
						Total Risk Across Medium	--			Total Hazard Index Across All Media and All Exposure Routes			1.20E+01

(1) Carcinogenic risks are combined for Resident Adults and Children and are shown on Table 4-13.

Total skin HI =	2.2E+00
Total kidney HI =	9.89E-02
Total Nervous System HI =	4.00E+00

TABLE 4-15. SUMMARY OF SURFACE SOIL HHRA RESULTS FOR FUTURE RESIDENT ADULT UNDER REASONABLE MAXIMUM EXPOSURE, SITE 12, AREA F, ANDERSEN AFB, GUAM.

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk [1]				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Site 12F	CADMIUM	--	--	--	--	CADMIUM	kidney	3.6E+00	--	2.9E-01	3.89E+00
			NICKEL	--	--	--	--	NICKEL		1.9E-01	--	--	1.9E-01
			(Total)	--	--	--	--	(Total)		3.79E+00		2.9E-01	4.08E+00
	Air	Site 12F	CADMIUM	--	1.0E-05	--	1.0E-05	CADMIUM		--	--	--	--
			NICKEL	--	--	--	--	NICKEL		--	--	--	--
			(Total)	--	1.0E-05	--	1.0E-05	(Total)		--	--	--	--
						Total Risk Across Medium	1.0E-05					Total Hazard Index Across All Media and All Exposure Routes	4.08E+00

(1) Carcinogenic risks are combined for Resident Adults and Children.

Total kidney HI =	3.89E+00

TABLE 4-16. SUMMARY OF SURFACE SOIL HHRA RESULTS FOR FUTURE RESIDENT CHILDREN UNDER REASONABLE MAXIMUM EXPOSURE, SITE 12, AREA F, ANDERSEN AFB, GUAM.

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk [1]				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Site 12F	CADMIUM	--	--	--	--	CADMIUM	kidney	3.4E+01	--	2.9E+00	3.69E+01
			NICKEL	--	--	--	--	NICKEL		1.8E+00	--	--	1.8E+00
			(Total)	--	--	--	--	(Total)		3.58E+01		2.9E+00	3.87E+01
	Air	Site 12F	CADMIUM	--	--	--	--	CADMIUM		--	--	--	--
			NICKEL	--	--	--	--	NICKEL		--	--	--	--
			(Total)	--	--	--	--	(Total)		--	--	--	--
							Total Risk Across Medium --						Total Hazard Index Across All Media and All Exposure Routes 3.87E+01

(1) Carcinogenic risks are combined for Resident Adults and Children and are shown in Table 4-15.

Total Kidney HI = 3.69E+01

TABLE 4-17. ECOLOGICAL SCREENING VALUES FOR ANALYTES DETECTED AT SITE 12, AREAS A - F, ANDERSEN AFB, GUAM.

Analyte	Ecotoxicologically Based Screening Level (mg/kg)	Source	Background Threshold Value (ICF, 1997) (mg/kg)	Ecological Screening Value (mg/kg)
INORGANICS				
Aluminum	N/A		173,500	173,500
Antimony	3.5	Dutch 1997	63	63
Arsenic	34	Dutch 1997	62	62
Barium	165	Dutch 1997	335	335
Beryllium	1.1	Dutch 1997	3.4	3.4
Cadmium	1.6	Dutch 1997	6.5	6.5
Calcium	N/A	Essential Nutrient		N/A
Chromium	100	Dutch 1997	1,080	1,080
Cobalt	70	Dutch 1994, 1995 (average)	29	70
Copper	40	Dutch 1997	72	72
Cyanide (a)	11	Dutch 1994, 1995 (average)	1.5	11
Iron	N/A	Essential Nutrient		N/A
Lead	140	Dutch 1997	166	166
Magnesium	N/A	Essential Nutrient		N/A
Manganese	N/A		5,500	5,500
Mercury	2.2	Dutch 1997	0.28	2.2
Nickel	38	Dutch 1997	243	243
Potassium	N/A	Essential Nutrient		N/A
Selenium	0.81	Dutch 1997	3.3(g)	3.3
Silver	N/A		14.9	14.9
Sodium	N/A	Essential Nutrient		N/A
Thallium	1.3	Dutch 1997	1.4	1.4
Vanadium	43	Dutch 1997	206	206
Zinc	130	Dutch 1997	111	130
POLYCYCLIC AROMATIC HYDROCARBONS (PAHs)				
2-Methylnapthalene	21 (b)	Dutch 1994, 1995 (average)	N/A	21 (b)
Acenaphthene	21 (b)	Dutch 1994, 1995 (average)	N/A	21 (b)
Acenaphthylene	21 (b)	Dutch 1994, 1995 (average)	N/A	21 (b)
Anthracene	21 (b)	Dutch 1994, 1995 (average)	N/A	21 (b)
Benz[a]anthracene	21 (b)	Dutch 1994, 1995 (average)	N/A	21 (b)
Benzo[a]pyrene	21 (b)	Dutch 1994, 1995 (average)	N/A	21 (b)
Benzo[b]fluoranthene	21 (b)	Dutch 1994, 1995 (average)	N/A	21 (b)
Benzo[g,h,i]perylene	21 (b)	Dutch 1994, 1995 (average)	N/A	21 (b)
Benzo[k]fluoranthene	21 (b)	Dutch 1994, 1995 (average)	N/A	21 (b)
Chrysene	21 (b)	Dutch 1994, 1995 (average)	N/A	21 (b)
Dibenz[a,h]anthracene	21 (b)	Dutch 1994, 1995 (average)	N/A	21 (b)
Fluoranthene	21 (b)	Dutch 1994, 1995 (average)	N/A	21 (b)
Fluorene	21 (b)	Dutch 1994, 1995 (average)	N/A	21 (b)
Indeno[1,2,3-cd]pyrene	21 (b)	Dutch 1994, 1995 (average)	N/A	21 (b)
Phenanthrene	21 (b)	Dutch 1994, 1995 (average)	N/A	21 (b)
Pyrene	21 (b)	Dutch 1994, 1995 (average)	N/A	21 (b)
Total PAH	21 (b)	Dutch 1994, 1995 (average)	N/A	21 (b)

TABLE 4-17. ECOLOGICAL SCREENING VALUES FOR ANALYTES DETECTED AT SITE 12, AREAS A - F, ANDERSEN AFB, GUAM.

Analyte	Ecotoxicologically Based Screening Level (mg/kg)	Source	Background Threshold Value (ICF, 1997) (mg/kg)	Ecological Screening Value (mg/kg)
PESTICIDES				
Aldrin	0.18	Dutch 1994, 1995 (average)	N/A	0.18
Alpha-Chlordane	6.25(e)	Cikutovic et all. 1993	N/A	6.25
Total DDT (c)	2	Dutch 1994, 1995 (average)	N/A	2
Dieldrin	0.011	USEPA, 2000b	N/A	0.011
Endosulfan I	0.18	USEPA, 2000b (f)	N/A	0.18
Endosulfan II	0.18	USEPA, 2000b (f)	N/A	0.18
Endosulfan Sulfate	0.18	USEPA, 2000b (f)	N/A	0.18
Endrin	0.03	Dutch 1994, 1995 (average)	N/A	0.03
Endrin Aldehyde(d)	0.03	Dutch 1994, 1995 (average)	N/A	0.03
Gamma-chlordane	6.25(e)	Cikutovic et al. 1993	N/A	6.25
Total HCH/BHC (g)	1	Dutch 1994, 1995 (average)	N/A	1
Heptachlor	6.25(e)	Cikutovic et al. 1993	N/A	6.25
Heptachlor Epoxide	6.25(e)	Cikutovic et al. 1993	N/A	6.25
Methoxychlor	6.25(e)	Cikutovic et al. 1993	N/A	6.25
Toxaphene	0.5	USEPA, 2000b	N/A	0.5
SEMIVOLATILE ORGANIC COMPOUNDS (SVOCs)				
Carbazole	N/A		N/A	No Criteria
Dibenzofuran	N/A		N/A	No Criteria
N-Nitrosodiphenylamine	20	USEPA, 2000b (h)	N/A	20
Pentachlorophenol	2.5	Dutch 1994, 1995 (average)	N/A	2.5
Total Phthalates (i)	30	Dutch 1994, 1995 (average)	N/A	30

(a) Based on free cyanide.
(b) PAH intervention is based on Total PAH only. Exceedance based on summing all PAH.
(c) Based on sum of DDT, DDE, and DDD.
(d) Based on endrin.
(e) Based on chlordane.
(f) Ontario screening value cited in USEPA, 2000b
(g) Based on sum of alpha-, beta-, delta-, and gamma-HCH.
(h) Oak Ridge National Lab value cited in USEPA, 2000b
(i) Based on the sum of bis(2-ethylhexyl)phthalate, butylbenzylphthalate, dibutylphthalate, diethylphthalate and dioctylphthalate.
N/A = Not Available
mg/kg = millagrams per kilogram

TABLE 4-18. SUMMARY OF CONTAMINANTS OF POTENTIAL CONCERN AT SITE 12, ANDERSEN AFB, GUAM.

Analyte	Site 12 Area					
	A	B	C	D	E	F
Inorganics						
Aluminum		X[a]				
Antimony	X	X				
Arsenic	X	X				
Barium	X					
Beryllium	X	X			X	
Cadmium	X	X	X	X	X	X
Chromium		X				
Copper	X	X			X	
Lead	X	X	X		X	X
Manganese	X	X			X	
Mercury	X					
Nickel						X
Thallium	X	X				
Zinc	X	X		X	X	
Organics						
Carbazole		X				
Dibenzofuran		X				
Dieldrin	X					
Pentachlorophenol	X					
Total DDT	X				X	
Total PAH		X				

(a) Not considered further as a COPC due to soil pH, limiting aluminum toxicity (USEPA, 2000b).

TABLE 4-19. ECOLOGICAL RISK ASSESSMENT ENDPOINTS FOR SITE 12, AREAS A – F, ANDERSEN AFB, GUAM.

Assessment Endpoint	Null Hypothesis	Measurement Endpoint	Specifics of Assessment
Ecological health of terrestrial invertebrate communities	Soils are not exhibiting a detrimental effect on invertebrate population survival and growth.	Evaluation of soil chemistry with respect to soil invertebrate toxicity values	• Comparison of soil concentrations to soil invertebrate toxicity values.
Ecological health of terrestrial plant communities	Soils are not exhibiting a detrimental effect on population plant survival and growth.	Evaluation of soil chemistry with respect to vegetation toxicity values	• Comparison of soil concentrations to vegetation toxicity values.
Long-term health and reproductive capacity of omnivorous avian species (Mariana crow)	Ingestion of COPC in prey does not have a negative impact on growth, survival, and reproductive success of the species.	Evaluation of dose in prey based on surface soil, fruit, and reptile data in dietary exposure models	• The risk associated with the calculated dose will be evaluated by comparison to Toxicity Reference Values (TRVs). • Fruit and reptile dose approximated using measured concentrations and other appropriate exposure assumptions.
Long-term health and reproductive capacity of carnivorous avian species (yellow bittern)	Ingestion of COPC in prey does not have a negative impact on growth, survival, and reproductive success of the species.	Evaluation of dose in prey based on surface soil and reptile data in dietary exposure models	• The risk associated with the calculated dose will be evaluated by comparison to TRVs. • Reptile dose approximated using measured concentrations and other appropriate exposure assumptions.
Long-term health and reproductive capacity of threatened and endangered fruigivorous mammalian species (Mariana fruit bat)	Ingestion of COPC in food does not have a negative impact on growth, survival, and reproductive success individual organisms.	Evaluation of dose in prey based on surface soil and fruit data in dietary exposure models	• The risk associated with the calculated dose will be evaluated by comparison to TRVs. • Fruit dose approximated using measured concentrations and other appropriate exposure assumptions.

TABLE 4-20. SUMMARY OF HAZARD QUOTIENTS FOR CONTAMINANTS OF CONCERN, SITE 12, ANDERSEN AFB, GUAM.

	Receptor of Concern Hazard Quotient				
Analyte	**Earthworms**	**Plants**	**Mariana Crow**	**Yellow Bittern**	**Mariana Fruit Bat**
Area A					
Copper	11				
Lead	1.6	216	13	20	3.3
Zinc	15	9.3			
4,4'-DDE	2.0				
4,4'-DDT	4.8				
Total DDT			45	66	
Pentachlorophenol					1.2
Area B					
Lead		42	3.6	6.6	
Zinc	1.0				
Total PAH	1.8	6.5			2.4
Area C					
Lead		8.0	1.8	3.9	
Area D					
Zinc	1.9	1.2			
Area E					
Lead		4.0	1.5	3.5	
Area F					
Cadmium	4.0	15			
Nickel	19	126			

TABLE 4-21. SUMMARY OF ECOLOGICAL REMEDIAL GOALS FOR CONTAMINANTS OF CONCERN, SITE 12, ANDERSEN AFB, GUAM.

	Receptor of Concern					
Analyte	**Terrestrial Vegetation** (mg/kg)	**Soil Invertebrates** (mg/kg)	**Mariana Crow**[1] (mg/kg)	**Yellow Bittern**[2] (mg/kg)	**Mariana Fruit Bat**[1] (mg/kg)	**Background Threshold Value** (mg/kg)
Cadmium	**29**	110	--	--	--	6.5
Copper	--	61	--	--	--	**72**
Lead	50	6,630	900	4,300	3,300	**166**
Nickel	30	200	--	--	--	**243**
Zinc	190	**120**	--	--	--	111
4,4'-DDE	--	**61**	--	--	--	--
4,4'-DDT	--	**11**	--	--	--	--
Total DDT	--	--	**1.5**	15	--	--

Bolded values indicate the recommended PRG

1 PRG based on NOAEL levels due to endangered status
2 PRG based on LOAEL levels as not endangered.

TABLE 4-22. SUMMARY OF CLEANUP STANDARDS FOR SITE 12, AREA A, ANDERSEN AFB, GUAM.

Future Site Use	Cleanup Matrix	COC	Maximum Concentration (mg/kg)	RG for HI = 1.0 (mg/kg)	RG for 10^{-5} (mg/kg)	Residential PRG (mg/kg)	Industrial PRG (mg/kg)	BTV (mg/kg)	ERA Cleanup Value (mg/kg)	RG (mg/kg)
Residential and Ecological Receptors	Surface Soil	Antimony	446	31	NA	31	410	**63**	NA	**63#**
		Arsenic	207	20	9	0.39	1.6	**62**	NA	**62#**
		Benzo(a)pyrene	1.6	NA	**1.4**	0.062	0.210	NA	NA	**1.4****
		Copper	12,800	3,100	NA	3,100	41,000	**72**	61	**72#**
		DDE	64	NA	**40**	1.7	7.0	NA	61	**40****
		DDT	112	56	41	1.7	7.0	NA	**11**	**11*****
		Dieldrin	4.4	NA	**0.7**	0.03	0.10	NA	NA	**0.7***
		Lead	147,000	**400##**	800	400	800	166	900	**400##**
		Manganese	7,310	847	NA	1,800	19,000	**5,500**	NA	**5,500#**
	Subsurface Soil	Lead	6,240	**400##**	800	400	800	166	900	**400##**
Ecological Receptors	Surface Soil	Copper	12,800	NA	NA	3,100	41,000	**72**	61	**72#**
		DDE	64	NA	NA	1.7	7.0	NA	**61**	**61*****
		DDT	112	NA	NA	1.7	7.0	NA	**11**	**11*****
		Lead	147,000	NA	NA	400	800	166	**900**	**900*****

Notes:

COC = Contaminant of Concern; NA = Not Applicable; RG = Remediation Goal; PRG = USEPA Region 9 Preliminary Remediation Goal, 2004; ERA = Ecological Risk Assessment; BTV = Background Threshold Value; mg/kg = milligrams/kilogram; # = RG based on BTV; ## = based on OSWER Directive/IEUBK Model; * = RG based on non cancer risks; ** = RG based on 10-5 cancer risk; *** = RG based on ecological risks

TABLE 4-23. SUMMARY OF CLEANUP STANDARDS FOR SITE 12, AREA B, ANDERSEN AFB, GUAM.

Future Site Use	Cleanup Matrix	COC	Maximum Concentration (mg/kg)	RG for HI = 1.0 (mg/kg)	RG for 10^{-5} (mg/kg)	Residential PRG (mg/kg)	Industrial PRG (mg/kg)	BTV (mg/kg)	ERA Cleanup Value (mg/kg)	RG (mg/kg)
Residential and Ecological Receptors	Surface Soil	Antimony	4,800	31	NA	31	410	**63**	NA	**63#**
		Arsenic	910	20	9	0.39	1.6	**62**	NA	**62#**
		Chromium	1,300	231	396	210	450	**1,080**	NA	**1,080#**
		Benz(a)anthracene	260	NA	**14**	0.62	2.1	NA	NA	**14****
		Benzo(a)pyrene	290	NA	**1.5**	0.06	0.21	NA	NA	**1.5****
		Benzo(b)fluoranthene	270	NA	**15**	0.62	2.9	NA	NA	**15****
		Dibenz(a,h)anthracene	50	NA	**1.5**	0.06	0.21	NA	NA	**1.5****
		Indeno(1,2,3-cd)pyrene	300	NA	**14**	0.62	2.1	NA	NA	**14****
		Lead	122,000	**400##**	NA	400	800	166	900	**400##**
	Subsurface Soil	Chromium	1,460	231	396	210	450	**1,080**	NA	**1,080#**
		Benz(a)anthracene	59	NA	**14**	0.62	2.1	NA	NA	**14****
		Benzo(a)pyrene	77	NA	**1.5**	0.062	0.21	NA	NA	**1.5****
		Benzo(b)fluoranthene	80	NA	**15**	0.62	2.1	NA	NA	**15****
		Dibenz(a,h)anthracene	20	NA	**1.5**	0.062	0.21	NA	NA	**1.5****
		Indeno(1,2,3-cd)pyrene	136	NA	**14**	0.62	2.1	NA	NA	**14****
Ecological Receptors	Surface Soil	Lead	122,000	NA	NA	400	800	166	900	**900##**

Notes:

COC = Contaminant of Concern; NA = Not Applicable; RG = Remediation Goal; PRG = USEPA Region 9 Preliminary Remediation Goal, 2004; ERA = Ecological Risk Assessment; BTV = Background Threshold Value; mg/kg = milligrams/kilogram; # = RG based on BTV; ## = based on OSWER Directive/IEUBK Model; ** = RG based on 10-5 cancer risk; *** = RG based on ecological risks

TABLE 4-24. SUMMARY OF CLEANUP STANDARDS FOR SITE 12, AREA F, ANDERSEN AFB, GUAM.

Future Site Use	Cleanup Matrix	COC	Maximum Concentration (mg/kg)	RG for HI = 1.0 (mg/kg)	RG for 10^{-5} (mg/kg)	Residential PRG (mg/kg)	Industrial PRG (mg/kg)	BTV (mg/kg)	ERA Cleanup Value (mg/kg)	RG (mg/kg)
Residential and Ecological Receptors	**Surface Soil**	Cadmium	2,780	37	NA	37	450	6.5	**29**	**29*** **
		Nickel	2,640	1,600	NA	1,600	20,000	**242**	110	**242#**
Ecological Receptors	**Surface Soil**	Cadmium	2,780	NA	NA	37	450	6.5	**29**	**29*** **
		Nickel	2,640	NA	NA	1,600	20,000	**242**	110	**242#**

Notes:

COC = Contaminant of Concern; NA = Not Applicable; RG = Remediation Goal; PRG = USEPA Region 9 Preliminary Remediation Goal, 2004; ERA = Ecological Risk Assessment; BTV = Background Threshold Value; mg/kg = milligrams/kilogram; # = RG based on BTV; *** = RG based on ecological risks

TABLE 4-25. COST ESTIMATE FOR INSTITUTIONAL CONTROLS, SITE 12, ALL AREAS, ANDERSEN AFB, GUAM.

Item	Reference	Quantity	Unit	Rate ($)	Year 1 Capital Costs ($)	Present Worth ($) at 5% for 30 years (rounded)
Capital Cost. Fence Construction						
Sr Labor Hours	BPJ	16	Hour	$ 135	$ 2,160	
Mid Labor Hours	BPJ	16	Hour	$ 80	$ 1,280	
Jr Labor Hours	BPJ	16	Hour	$ 72	$ 1,158	
Travel, Per Diem, ODCs	BPJ	1	Lump Sum	$ 2,500	$ 2,500	
Fence Construction	Vendor Quote	400	Linear Feet	$ 20	$ 8,000	
Posting Signs	BPJ	2	Each	$ 50	$ 100	
Press release	BPJ	2	Each	$ 1,920	$ 3,840	
15% Markup on ODC					$ 576	
4% Guam Tax					$ 762	
					$ 20,376	**20,400**
Capital Cost. Write Site-specific Work Plan						
Sr Labor Hours	BPJ	32	Hour	$ 135	$ 4,320	
Mid Labor Hours	BPJ	40	Hour	$ 80	$ 3,200	
Jr Labor Hours	BPJ	32	Hour	$ 72	$ 2,315	
Clerical/Editor/Word Processor/CADD Hours	BPJ	24	Hour	$ 60	$ 1,439	
Reproduction, shipping, per diem, travel	BPJ	1	Lump Sum	$ 1,000	$ 1,000	
15% Markup on ODC					$ 150	
4% Guam Tax					$ 491	
					$ 12,915	**13,000**
				TOTAL Capital Cost		**33,400**
Long-Term Material Cost. Fence Fixing						
Fence Material	Vendor Quote	1	Lump Sum	$ 1,000	$ 1,000	
Signs	BPJ	8	Each	$ 50	$ 400	
15% Markup on ODC					$ 210	
4% Guam Tax					$ 56	
Subtotal					**$ 1,666**	**6,400**
Long-Term O&M Cost.						
Sr Labor Hours	BPJ	16	Hour	$ 135	$ 2,160	
Mid Labor Hours	BPJ	40	Hour	$ 80	$ 3,200	
Jr Labor Hours	BPJ	16	Hour	$ 72	$ 1,158	
Clerical/Editor/CADD Hours	BPJ	16	Hour	$ 60	$ 960	
Project Travel/Per Diem	BPJ	1	Task	$ 3,500	$ 3,500	
15% Markup on ODC					$ 1,647	
4% Guam Tax					$ 440	
Subtotal					**$ 13,065**	**49,500**
Long-Term Cost. Site Periodic Review Costs Shared by multiple sites with ICs (Table 2-24)					**$24,891**	**$94,200**
				TOTAL Long-Term Cost		**$ 150,100**
				TOTAL COST		**$ 183,500**

Notes:
O&M = Operation & Maintenance; ODC = other direct costs; IC = Institutional Control

TABLE 4-26. SUMMARY OF CLEANUP VOLUMES FOR RESIDENTIAL USE AT SITE 12, AREA A, ANDERSEN AFB, GUAM.

Cleanup Protective Scenario	Cleanup Matrix	COC	RG (mg/kg)	Cleanup Sample Locations	Estimated COC Cleanup Area (sq ft)	Estimated COC Cleanup Volume	
						(bcy)	(lcy)
Residential and Ecological Receptors	Surface Soil	Antimony	63#	S064, S064D	19,444	1,440	1,880
		Arsenic	62#	S062, S064, S064D, S072, S210			
		Benzo(a)pyrene	1.4**	S215			
		Copper	72#	S062			
		DDE	40**	S064/S064D			
		DDT	11***	S064/S064D			
		Dieldrin	0.7*	S064,S064D			
		Lead	400##	S061, S062, S063, S064/S064D, S068, S069, S072, S073, S204, S206/206D, S210, S211, S212, S213, S214, S215, S216, S217/217D			
		Manganese	5,500#	S070, S072, S203			
	Subsurface Soil	Lead	400##	S104, S105, S108, S109, S205	10,200	380	500
					Total Cleanup Volume	1,820	2,380
Ecological Receptors	Surface Soil	Copper	72#	S062	11,500	860	1,120
		DDE	61***	S064/S064D			
		DDT	11***	S064, S064D, S215			
		Lead	900***	S061, S062, S064/S064D, S068, S072, S204, S206/206D, S210, S214, S215, S216, S217/217D			
					Total Cleanup Volume	860	1,120

Notes:

COC = Contaminant of Concern; RG = Remediation Goal;sq ft = Square Feet; bcy = Bank Cubic Yards; lcy = loose cubic yards (assuming 30% "fluff factor")# = RG base on BTV, ## = based on OSWER Directive/IEUBK Model, * = RG base on non cancer risks, ** = RG based on 10-5 cander risk, *** = RG based on ecological risks

Volume calculations assume surface soil thickness of 2 feet and subsurface soil thickness of 1 foot.

TABLE 4-27. SUMMARY OF CLEANUP VOLUMES AT SITE 12, AREA B, ANDERSEN AFB, GUAM.

Cleanup Protective Scenario	Cleanup Matrix	COC	RG (mg/kg)	Cleanup Sample Locations	Estimated COC Cleanup Area (sq ft)	Estimated COC Cleanup Volume	
						(bcy)	(lcy)
Residential and Ecological Receptors	Surface Soil	Antimony	63#	S025, S151/151D	96,800	7,180	9,340
		Arsenic	62#	S025, S151D			
		Chromium	1,080#	S026, S150			
		Benz(a)anthracene	14**	S007, S009/009D, S011, S164, S167, S171, S174, S177, S187, S200			
		Benzo(a)pyrene	1.5**	S003, S004, S007, S008, S009/009D, S011, S012, S164, S167, S169, S170, S171, S174, S175, S177, S187, S197, S200			
		Benzo(b)fluoranthene	15**	S007, S009/009D, S011, S164, S167, S169, S170, S171, S174, S177, S187, S197, S200			
		Dibenz(a,h)anthracene	1.5**	S164, S167, S169, S170, S171, S174, S177, S187, S197, S200			
		Indeno(1,2,3-cd)pyrene	14**	S007, S008, S009/009D, S011, S164, S167, S169, S170, S171, S174, S177, S187, S197, S200			
		Lead	400##	S007, S009/009D, S014, S018, S019, S020/020D, S024, S025, S026, S149, S151/151D, S153, S154, S155, S156, S160			
	Subsurface Soil	Chromium	1,080#	S082	51,300	1,900	2470
		Benz(a)anthracene	14**	S099, S100, S165, S168, S176, S195,			
		Benzo(a)pyrene	1.5**	S079, S099, S100, S165, S166, S168, S176, S186, S195, S199			
		Benzo(b)fluoranthene	15**	S079, S099, S100, S165, S168, S176, S195			
		Dibenz(a,h)anthracene	1.5**	S165, S166, S168, S176, S186, S195			
		Indeno(1,2,3-cd)pyrene	14**	S079, S99, S100, S165, S168, S176, S195			
					Total Cleanup Volume	**9,080**	**11,810**
Ecological Receptors	**Surface Soil**	Lead	900##	S018, S020/020D, S025, S026, S149, S151/151D, S154, S156	**15,500**	**1,150**	**1,500**
					Total Cleanup Volume	**1,150**	**1,500**

Notes:

COC = Contaminant of Concern; RG = Remediation Goal;sq ft = Square Feet; bcy = Bank Cubic Yards; lcy = loose cubic yards (assuming 30% "fluff factor"), # = RG based on BTV, ## based on OSWER Directive/IEUBK Model, * = RG based on non cancer risks, ** = RG based on 10-5 cancer risk, *** = RG based on ecological risks

Volume calculations assume surface soil thickness of 2 feet and subsurface soil thickness of 1 foot.

TABLE 4-28. SUMMARY OF CLEANUP VOLUMES AT SITE 12, AREA F, ANDERSEN AFB, GUAM.

Cleanup Protective Scenario	Cleanup Matrix	COC	RG (mg/kg)	Cleanup Sample Locations	Estimated COC Cleanup Area (sq ft)	Estimated COC Cleanup Volume	
						(bcy)	(lcy)
Residential and Ecological Receptors	**Surface Soil**	Cadmium	29***	S074, S144	**1,300**	**100**	**130**
		Nickel	242#				
	Total Cleanup Volume					**100**	**130**
Ecological Receptors	**Surface Soil**	Cadmium	29***	S074, S144	**1,300**	**100**	**130**
		Nickel	242#				
	Total Cleanup Volume					**100**	**130**

Notes:

COC = Contaminant of Concern; RG = Remediation Goal; sq ft = Square Feet; bcy = Bank Cubic Yards; lcy = loose cubic yards (assuming 30% "fluff factor"),
*** = RG based on ecological risks, # = RG based on BTV
Volume calculations assume surface soil thickness of 2 feet and subsurface soil thickness of 1 foot.

TABLE 4-29. COST ESTIMATE FOR SOIL REMOVAL PROTECTIVE OF RESIDENTIAL AND ECOLOGICAL RECEPTORS, SITE 12, AREA A, ANDERSEN AFB, GUAM.

Item	Reference	Quantity	Unit	Rate ($)	Year 1 Capital Costs ($)	Present Worth at 5% for 30 years (rounded)
Capital Cost. Write Site-specific Work Plan						
Sr Labor Hours	BPJ	120	Hour	$ 135	$ 16,200	
Mid Labor Hours	BPJ	120	Hour	$ 80	$ 9,600	
Jr Labor Hours	BPJ	160	Hour	$ 72	$ 11,520	
Clerical/Editor/Word Processor/CADD Hours	BPJ	160	Hour	$ 60	$ 9,600	
Reproduction, shipping, per diem, travel	BPJ	1	Lump Sum	$ 6,000	$ 6,000	
15% Markup on ODC					$ 900	
4% Guam Tax					$ 2,117	
Subtotal					**$ 55,937**	**$ 56,000**
Capital Cost. Clear, Grub, and Pre-survey						
Sr Labor Hours	BPJ	16	Hour	$ 135	$ 2,160	
Jr Labor Hours	BPJ	80	Hour	$ 72	$ 5,760	
Clerical/Editor/Word Processor/CADD Hours	BPJ	16	Hour	$ 60	$ 960	
Reproduction, shipping, per diem, travel	BPJ	1	Lump Sum	$ 2,000	$ 2,000	
Surveyors and Laborers to Clear	Vendor Quote	2	Week	$ 8,000	$ 12,000	
15% Markup on ODC					$ 2,100	
4% Guam Tax					$ 916	
Subtotal					**$ 24,980**	**$ 25,000**
Capital Cost. Mob-demob, Remove and Dispose of Soil, and Stabilize and Revegetate Slope; Assume 5 weeks			**Volume 2,380**	**Weeks 5**		
Sr Labor Hours	BPJ	200	Hour	$ 135	$ 27,000	
Mid Labor Hours	BPJ	80	Hour	$ 80	$ 6,400	
Jr Labor Hours	BPJ	200	Hour	$ 72	$ 14,400	
Clerical/Editor/Word Processor/CADD Hours	BPJ	80	Hour	$ 60	$ 4,800	
Reproduction, shipping, per diem, travel	BPJ	5	Week	$ 3,000	$ 15,000	
Mobilization/Demobilization	Vendor Quote	2	Task	$ 600	$ 1,200	
Trackhoe/Dozer Rental	Vendor Quote	25	Day	$ 800	$ 20,000	
Drag Line with Clam Shell Bucket	Vendor Quote	25	Day	$ 1,650	$ 41,250	
Rolloff Bins	BPJ	12	Each	$ 2,200	$ 26,400	
Laborers	Vendor Quote	0	Hour	$ 15	$ -	
Dump Trucks and Drivers	Vendor Quote	25	Day	$ 450	$ 11,250	
Steam/Water Truck	Vendor Quote	25	Day	$ 1,100	$ 27,500	
Transport/dispose non-haz waste at consolidation unit (80%)	BPJ	1,904	Loose Cubic Yard	$ 10	$ 19,040	
Transport/dispose hazwaste off island (2%)	BPJ	48	Loose Cubic Yard	$ 2,000	$ 95,200	
TSP Treated non-hazwaste waste (18%)	BPJ	238	Loose Cubic Yard	$ 220	$ 52,360	
Reseeding/revegetation	Vendor Quote	0	Square Feet	$ 0.50	$ -	
Clean Backfill**	Vendor Quote	0	Loose Cubic Yard	$ 26	$ -	
15% Markup on ODC					$ 46,380	
4% Guam Tax					$ 12,368	
Subtotal					**$ 420,548**	**$ 420,600**
Capital Cost. Confirmatory Samples & Closure Report						
Sr Labor Hours	BPJ	40	Hour	$ 135	$ 5,400	
Mid Labor Hours	BPJ	40	Hour	$ 80	$ 3,200	
Jr Labor Hours	BPJ	60	Hour	$ 72	$ 4,320	
Clerical/Editor/Word Processor/CADD Hours	BPJ	60	Hour	$ 60	$ 3,600	
Survey confirmatory samples	Vendor Quote	1	Week	$ 4,500	$ 4,500	
Reproduction, perdiem, etc.	BPJ	1	Lump Sum	$ 6,500	$ 6,500	
Analytical Cost	Vendor Quote	50	Sample	$ 500	$ 25,000	
Sampling & Shipment Cost	BPJ	1	Task	$ 5,000	$ 5,000	
15% Markup on ODC					$ 8,628	
4% Guam Tax					$ 2,301	
Subtotal					**$ 68,449**	**$ 68,500**
				TOTAL Capital Cost		**$ 570,100**
Long-Term Cost. No long-term costs if site cleaned up						**$ -**
				TOTAL Long-Term Cost		**$ -**
				TOTAL COST		**$ 570,100**

Notes:
BPJ = Best Professional Judgement; O&M = Operation & Maintenance; ODC = other Short-Term Costs; IC = Institutional Control
** - Assumes that the slope fill will be graded 0.5 feet thick and the soil cover will be 0.5 feet thick.

TABLE 4-30. COST ESTIMATE FOR SOIL REMOVAL PROTECTIVE OF RESIDENTIAL AND ECOLOGICAL RECEPTORS, SITE 12, AREA B, ANDERSEN AFB, GUAM.

Item	Reference	Quantity	Unit	Rate ($)	Year 1 Capital Costs ($)	Present Worth at 5% for 30 years (rounded)
Capital Cost. Write Site-specific Work Plan						
Sr Labor Hours	BPJ	120	Hour	$ 135	$ 16,200	
Mid Labor Hours	BPJ	120	Hour	$ 80	$ 9,600	
Jr Labor Hours	BPJ	160	Hour	$ 72	$ 11,520	
Clerical/Editor/Word Processor/CADD Hours	BPJ	160	Hour	$ 60	$ 9,600	
Reproduction, shipping, per diem, travel	BPJ	1	Lump Sum	$ 6,500	$ 6,500	
15% Markup on ODC					$ 975	
4% Guam Tax					$ 2,137	
Subtotal					**$ 56,532**	**56,600**
Capital Cost. Clear, Grub, and Pre-survey						
Sr Labor Hours	BPJ	16	Hour	$ 135	$ 2,160	
Mid Labor Hours	BPJ	0	Hour	$ 80	$ -	
Jr Labor Hours	BPJ	60	Hour	$ 72	$ 4,320	
Clerical/Editor/Word Processor/CADD Hours	BPJ	16	Hour	$ 60	$ 960	
Reproduction, shipping, per diem, travel	BPJ	1	Lump Sum	$ 2,500	$ 2,500	
Surveyors and Laborers to Clear	Vendor Quote	1.5	Week	$ 8,800	$ 13,200	
15% Markup on ODC					$ 2,355	
4% Guam Tax					$ 926	
Subtotal					**$ 25,495**	**25,500**
Capital Cost. Mob-demob, Remove and Dispose of Soil, and Stabilize and Revegetate Slope; Assume 15 weeks			**Volume 11,810**	**Weeks 15**		
Sr Labor Hours	BPJ	600	Hour	$ 135	$ 81,000	
Mid Labor Hours	BPJ	80	Hour	$ 80	$ 6,400	
Jr Labor Hours	BPJ	600	Hour	$ 72	$ 43,200	
Clerical/Editor/Word Processor/CADD Hours	BPJ	80	Hour	$ 60	$ 4,800	
Reproduction, shipping, per diem, travel	BPJ	15	Week	$ 3,000	$ 45,000	
Mobilization/Demobilization	Vendor Quote	2	Task	$ 600	$ 1,200	
Trackhoe/Dozer Rental	Vendor Quote	75	Day	$ 800	$ 60,000	
Drag Line with Clam Shell Bucket	Vendor Quote	75	Day	$ 1,500	$ 112,500	
Equipment Operator	Vendor Quote	0	Hour	$ 55	$ -	
Rolloff Bins	BPJ	8	Each	$ 2,200	$ 17,600	
Laborers	Vendor Quote	0	Hour	$ 15	$ -	
Dump Trucks and Drivers	Vendor Quote	75	Day	$ 450	$ 33,750	
Steam/Water Truck	Vendor Quote	75	Day	$ 1,100	$ 82,500	
Transport/dispose non-haz waste at consolidation unit (90%)	BPJ	9,448	Loose Cubic Yard	$ 10	$ 94,480	
Transport/dispose hazwaste off island (1%)	BPJ	118	Loose Cubic Yard	$ 2,000	$ 236,200	
TSP Treated non-hazwaste waste (9%)	BPJ	1,063	Loose Cubic Yard	$ 220	$ 233,838	
Reseeding/revegetation	Vendor Quote	0	Square Feet	$ 0.50	$ -	
Clean Backfill**	Vendor Quote	0	Loose Cubic Yard	$ 26	$ -	
15% Markup on ODC					$ 137,561	
4% Guam Tax					$ 36,683	
Subtotal					**$ 1,226,712**	**1,226,800**
Capital Cost. Confirmatory Samples & Closure Report						
Sr Labor Hours	BPJ	40	Hour	$ 135	$ 5,400	
Mid Labor Hours	BPJ	40	Hour	$ 80	$ 3,200	
Jr Labor Hours	BPJ	60	Hour	$ 72	$ 4,320	
Clerical/Editor/Word Processor/CADD Hours	BPJ	60	Hour	$ 60	$ 3,600	
ODCs: Survey confirmatory samples	Vendor Quote	1	Week	$ 4,500	$ 4,500	
Reproduction, perdiem, etc.	BPJ	1	Lump Sum	$ 6,500	$ 6,500	
Analytical Cost	Vendor Quote	50	Sample	$ 500	$ 25,000	
Sampling & Shipment Cost	BPJ	1	Task	$ 5,000	$ 5,000	
15% Markup on ODC					$ 8,628	
4% Guam Tax					$ 2,301	
Subtotal					**$ 68,449**	**68,500**
				TOTAL Capital Cost		**$ 1,402,900**
Long-Term Cost. No long-term costs if site cleaned up						**$ -**
				TOTAL Long-Term Cost		**$ -**
				TOTAL COST		**$ 1,402,900**

Notes:
BPJ - Best Professional Judgment; O&M = Operation & Maintenance; ODC = other direct costs; IC = Institutional Control
** - Assumes that the slope fill will be graded 0.5 feet thick and the soil cover will be 0.5 feet thick.

TABLE 4-31. COST ESTIMATE FOR SOIL REMOVAL PROTECTIVE OF RESIDENTIAL AND ECOLOGICAL RECEPTORS, SITE 12, AREA F, ANDERSEN AFB, GUAM.

Item	Reference	Quantity	Unit	Rate ($)	Year 1 Capital Costs ($)	Present Worth at 5% for 30 years (rounded)
Captial Cost. Write Site-specific Work Plan						
Sr Labor Hours	BPJ	54	Hour	$ 135	$ 7,290	
Mid Labor Hours	BPJ	32	Hour	$ 80	$ 2,560	
Jr Labor Hours	BPJ	54	Hour	$ 72	$ 3,888	
Clerical/Editor/Word Processor/CADD Hours	BPJ	54	Hour	$ 60	$ 3,240	
Reproduction, shipping, per diem, travel	BPJ	1	Lump Sum	$ 2,500	$ 2,500	
15% Markup on ODC					$ 375	
4% Guam Tax					$ 780	
Subtotal					**$ 20,633**	**$ 20,700**
Captial Cost. Clear, Grub, and Pre-survey						
Sr Labor Hours	BPJ	8	Hour	$ 135	$ 1,080	
Mid Labor Hours	BPJ	0	Hour	$ 80	$ -	
Jr Labor Hours	BPJ	32	Hour	$ 72	$ 2,304	
Clerical/Editor/Word Processor/CADD Hours	BPJ	8	Hour	$ 60	$ 480	
Reproduction, shipping, per diem, travel	BPJ	1	Lump Sum	$ 2,000	$ 2,000	
Surveyors and Laborers to Clear	Vendor Quote	0.5	Week	$ 8,000	$ 4,000	
15% Markup on ODC					$ 900	
4% Guam Tax					$ 395	
Subtotal					**$ 10,764**	**$ 10,800**
Captial Cost. Mob-demob, Remove and Dispose of Soil, and Stabilize and Revegetate Slope; Assume 2 weeks			**Volume 130**	**Weeks 2.0**		
Sr Labor Hours	BPJ	80	Hour	$ 135	$ 10,800	
Mid Labor Hours	BPJ	80	Hour	$ 80	$ 6,400	
Jr Labor Hours	BPJ	80	Hour	$ 72	$ 5,760	
Clerical/Editor/Word Processor/CADD Hours	BPJ	80	Hour	$ 60	$ 4,800	
Reproduction, shipping, per diem, travel	BPJ	2	Week	$ 3,000	$ 6,000	
Mobilization/Demobilization	Vendor Quote	2	Task	$ 2,500	$ 5,000	
Trackhoe/Dozer Rental	Vendor Quote	10	Day	$ 800	$ 8,000	
Drag Line with Clam Shell Bucket	Vendor Quote	10	Day	$ 1,500	$ 15,000	
Equipment Operator	Vendor Quote	0	Hour	$ 55	$ -	
Rolloff Bins	BPJ	1	Each	$ 2,200	$ 2,200	
Laborers	Vendor Quote	0	Hour	$ 15	$ -	
Dump Trucks and Drivers	Vendor Quote	10	Day	$ 450	$ 4,500	
Steam/Water Truck	Vendor Quote	10	Day	$ 1,100	$ 11,000	
Transport/dispose non-haz waste at Consolidation Unit (90%)	BPJ	117	Loose Cubic Yard	$ 11	$ 1,287	
Transport/dispose hazwaste off island (2%)	BPJ	3	Loose Cubic Yard	$ 1,760	$ 4,576	
TSP Treated non-hazwaste waste (8%)	BPJ	10	Loose Cubic Yard	$ 220	$ 2,288	
Reseeding/revegetation	Vendor Quote	0	Square Feet	$ 0.50	$ -	
Clean Backfill**	Vendor Quote	0	Loose Cubic Yard	$ 56	$ -	
15% Markup on ODC					$ 8,978	
4% Guam Tax					$ 2,395	
Subtotal					**$ 98,984**	**$ 99,000**
Capital Cost. Confirmatory Samples & Closure Report						
Sr Labor Hours	BPJ	32	Hour	$ 135	$ 4,320	
Mid Labor Hours	BPJ	32	Hour	$ 80	$ 2,560	
Jr Labor Hours	BPJ	44	Hour	$ 72	$ 3,168	
Clerical/Editor/Word Processor/CADD Hours	BPJ	44	Hour	$ 60	$ 2,640	
Survey confirmatory samples	Vendor Quote	1	Week	$ 4,500	$ 2,250	
Reproduction, perdiem, etc.	BPJ	1	Lump Sum	$ 2,500	$ 2,500	
Analytical Cost	Vendor Quote	20	Sample	$ 500	$ 10,000	
Sampling & Shipment Cost	BPJ	1	Task	$ 5,000	$ 5,000	
15% Markup on ODC					$ 4,866	
4% Guam Tax					$ 1,298	
Subtotal					**$ 38,602**	**$ 38,700**
					TOTAL Capital Cost	**$ 169,200**
Long-Term Cost. No long-term costs if site cleaned up						**$ -**
					TOTAL Long-Term Cost	**$ -**
					TOTAL COST	**$ 169,200**

Notes:
BPJ - Best Professional Judgment; O&M = Operation & Maintenance; ODC = other direct costs; IC = Institutional Control
** - Assumes that the slope fill will be graded 1/2 feet thick and the soil cover will be 1/2 feet thick.

TABLE 4-32. COST ESTIMATE FOR SOIL REMOVAL PROTECTIVE OF ECOLOGICAL RECEPTORS, SITE 12, AREA A, ANDERSEN AFB, GUAM.

Item	Reference	Quantity	Unit	Rate ($)	Year 1 Capital Costs ($)	Present Worth at 5% for 30 years (rounded)
Capital Cost. Write Site-specific Work Plan						
Sr Labor Hours	BPJ	120	Hour	$ 135	$ 16,200	
Mid Labor Hours	BPJ	120	Hour	$ 80	$ 9,600	
Jr Labor Hours	BPJ	160	Hour	$ 72	$ 11,572	
Clerical/Editor/Word Processor/CADD Hours	BPJ	160	Hour	$ 60	$ 9,592	
Reproduction, shipping, per diem, travel	BPJ	1	Lump Sum	$ 6,500	$ 6,500	
15% Markup on ODC					$ 975	
4% Guam Tax					$ 2,139	
Subtotal					**$ 56,578**	**$ 56,600**
Capital Cost. Clear, Grub, and Pre-survey						
Sr Labor Hours	BPJ	16	Hour	$ 135	$ 2,160	
Mid Labor Hours	BPJ	0	Hour	$ 80	$ -	
Jr Labor Hours	BPJ	40	Hour	$ 72	$ 2,893	
Clerical/Editor/Word Processor/CADD Hours	BPJ	16	Hour	$ 60	$ 960	
Reproduction, shipping, per diem, travel	BPJ	1	Lump Sum	$ 2,500	$ 2,500	
Surveyors and Laborers to Clear	Vendor Quote	1.0	Week	$ 8,500	$ 8,500	
15% Markup on ODC					$ 1,650	
4% Guam Tax					$ 681	
Subtotal					**$ 18,663**	**$ 18,700**
Capital Cost. Mob-demob, Remove and Dispose of Soil, and Stabilize and Revegetate Slope; Assume 5 weeks			**Volume 1,120**	**Weeks 3**		
Sr Labor Hours	BPJ	120	Hour	$ 135	$ 16,200	
Mid Labor Hours	BPJ	80	Hour	$ 80	$ 6,400	
Jr Labor Hours	BPJ	120	Hour	$ 72	$ 8,679	
Clerical/Editor/Word Processor/CADD Hours	BPJ	80	Hour	$ 60	$ 4,796	
Reproduction, shipping, per diem, travel	BPJ	3	Week	$ 3,000	$ 9,000	
Mobilization/Demobilization	Vendor Quote	2	Task	$ 2,000	$ 4,000	
Trackhoe/Dozer Rental	Vendor Quote	15	Day	$ 800	$ 12,000	
Equipment Operator*	Vendor Quote	120	Hour	$ 55	$ 6,600	
Drag Line with Clam Shell Bucket	Vendor Quote	15	Day	$ 1,500	$ 22,500	
Rolloff Bins	BPJ	12	ea	$ 2,200	$ 26,400	
Laborers	Vendor Quote	0	Hour	$ 15	$ -	
Steam/Water Truck	Vendor Quote	15	Day	$ 1,100	$ 16,500	
Transport/dispose non-hazwaste at consolidation unit (80%)	BPJ	896	Loose Cubic Yard	$ 10	$ 8,960	
Transport/dispose hazwaste off island (2%)	BPJ	22	Loose Cubic Yard	$ 2,000	$ 44,800	
TSP Treated non-hazwaste waste (18%)	BPJ	202	Loose Cubic Yard	$ 220	$ 50,380	
Reseeding/revegetation	Vendor Quote	0	Square Feet	$ 0.55	$ -	
Clean Backfill**	Vendor Quote	0	Loose Cubic Yard	$ 26	$ -	
15% Markup on ODC					$ 30,171	
4% Guam Tax					$ 8,046	
Subtotal					**$ 275,432**	**$ 275,500**
Capital Cost. Confirmatory Samples & Closure Report						
Sr Labor Hours	BPJ	40	Hour	$ 135	$ 5,400	
Mid Labor Hours	BPJ	40	Hour	$ 80	$ 3,200	
Jr Labor Hours	BPJ	60	Hour	$ 72	$ 4,340	
Clerical/Editor/Word Processor/CADD Hours	BPJ	60	Hour	$ 60	$ 3,597	
Survey confirmatory samples	Vendor Quote	1	Week	$ 4,500	$ 4,500	
Reproduction, perdiem, etc.	BPJ	1	Lump Sum	$ 6,500	$ 6,500	
Analytical Cost	Vendor Quote	40	Sample	$ 500	$ 20,000	
Sampling & Shipment Cost	BPJ	1	Task	$ 5,000	$ 5,000	
15% Markup on ODC					$ 7,881	
4% Guam Tax					$ 2,102	
Subtotal					**$ 62,520**	**$ 62,600**
				TOTAL Capital Cost		**$ 413,400**
Long-Term Cost. Site Periodic Review Costs Shared by multiple sites with ICs (Table 2-24)					**$24,891**	**$94,200**
				TOTAL Long-Term Cost		**$ 94,200**
				TOTAL COST		**$ 507,600**

Notes:
BPJ - Best Professional Judgment; O&M = Operation & Maintenance; ODC = other direct costs; IC = Institutional Control
** - Assumes that the slope fill will be graded 0.5 feet thick and the soil cover will be 0.5 feet thick.

TABLE 4-33. COST ESTIMATE FOR SOIL REMOVAL PROTECTIVE OF ECOLOGICAL RECEPTORS, SITE 12, AREA B, ANDERSEN AFB, GUAM.

Item	Reference	Quantity	Unit	Rate ($)	Year 1 Capital Costs ($)	Present Worth at 5% for 30 years (rounded)
Capital Cost. Write Site-specific Work Plan						
Sr Labor Hours	BPJ	120	Hour	$ 135	$ 16,200	
Mid Labor Hours	BPJ	120	Hour	$ 80	$ 9,600	
Jr Labor Hours	BPJ	160	Hour	$ 72	$ 11,572	
Clerical/Editor/Word Processing/CADD Hours	BPJ	160	Hour	$ 60	$ 9,592	
Reproduction, shipping, per diem, travel	BPJ	1	Lump Sum	$ 6,500	$ 6,500	
15% Markup on ODC					$ 975	
4% Guam Tax					$ 2,139	
Subtotal					**$ 56,578**	**$ 56,600**
Capital Cost. Clear, Grub, and Pre-survey						
Sr Labor Hours	BPJ	16	Hour	$ 135	$ 2,160	
Jr Labor Hours	BPJ	60	Hour	$ 72	$ 4,340	
Clerical/Editor/Word Processing/CADD Hours	BPJ	16	Hour	$ 60	$ 960	
Reproduction, shipping, per diem, travel	BPJ	1	Lump Sum	$ 2,500	$ 2,500	
Surveyors and Laborers to Clear	Vendor Quote	1.5	Week	$ 8,800	$ 13,200	
15% Markup on ODC					$ 2,355	
4% Guam Tax					$ 927	
Subtotal					**$ 25,515**	**$ 25,600**
Capital Cost. Mob-demob, Remove and Dispose of Soil, and Stabilize and Revegetate Slope; Assume 5 weeks			**Volume 1,500**	**Weeks 8**		
Sr Labor Hours	BPJ	320	Hour	$ 135	$ 43,200	
Mid Labor Hours	BPJ	80	Hour	$ 80	$ 6,400	
Jr Labor Hours	BPJ	320	Hour	$ 72	$ 23,143	
Clerical/Editor/Word Processing/CADD Hours	BPJ	80	Hour	$ 60	$ 4,796	
Reproduction, shipping, per diem, travel	BPJ	8	Week	$ 3,000	$ 24,000	
Mobilization/Demobilization	Vendor Quote	2	Task	$ 2,500	$ 5,000	
Trackhoe/Dozer Rental	Vendor Quote	40	Day	$ 800	$ 32,000	
Drag Line with Clam Shell Bucket	Vendor Quote	40	Day	$ 1,500	$ 60,000	
Rolloff Bins	BPJ	8	Each	$ 2,200	$ 17,600	
Laborers	Vendor Quote	0	Hour	$ 15	$ -	
Dump Trucks and Drivers*	Vendor Quote	40	Day	$ 450	$ 18,000	
Steam/Water Truck	Vendor Quote	40	Day	$ 1,100	$ 44,000	
Transport/dispose non-haz waste at consolidation unit (90%)	BPJ	1,350	Loose Cubic Yard	$ 10	$ 13,500	
Transport/dispose hazwaste off island (1%)	BPJ	15	Loose Cubic Yard	$ 2,000	$ 30,000	
TSP Treated non-hazwaste waste (9%)	BPJ	135	Loose Cubic Yard	$ 220	$ 29,700	
Reseeding/revegetation	Vendor Quote	0	Square Feet	$ 0.50	$ -	
Clean Backfill**	Vendor Quote	0	Loose Cubic Yard	$ 26	$ -	
15% Markup on ODC					$ 41,070	
4% Guam Tax					$ 10,952	
Subtotal					**$ 403,361**	**$ 403,400**
Capital Cost. Confirmatory Samples & Closure Report						
Sr Labor Hours	BPJ	40	Hour	$ 135	$ 5,400	
Mid Labor Hours	BPJ	40	Hour	$ 80	$ 3,200	
Jr Labor Hours	BPJ	60	Hour	$ 72	$ 4,340	
Clerical/Editor/Word Processing/CADD Hours	BPJ	60	Hour	$ 60	$ 3,597	
ODCs: Survey confirmatory samples	Vendor Quote	1	Week	$ 4,500	$ 4,500	
Reproduction, perdiem, etc.	BPJ	1	Lump Sum	$ 6,500	$ 6,500	
Analytical Cost	Vendor Quote	50	Sample	$ 550	$ 27,500	
Sampling & Shipment Cost	BPJ	1	Task	$ 250	$ 250	
Other Sampling Supply Cost	BPJ	1	Task	$ 1,500	$ 1,500	
15% Markup on ODC					$ 8,519	
4% Guam Tax					$ 2,272	
Subtotal					**$ 67,578**	**$ 67,600**
				TOTAL Capital Cost		**$ 553,200**
Long-Term Cost. Site Periodic Review Costs Shared by multiple sites with ICs (Table 2-24)					**$24,891**	**$94,200**
				TOTAL Long-Term Cost		**$ 94,200**
				TOTAL COST		**$ 647,400**

Notes:
BPJ - Best Professional Judgment; O&M = Operation & Maintenance; ODC = other direct costs; IC = Institutional Control
** - Assumes that the slope fill will be graded 0.5 feet thick and the soil cover will be 0.5 feet thick.

TABLE 4-34. COST ESTIMATE FOR SOIL REMOVAL PROTECTIVE OF OCCASIONAL USER AND ECOLOGICAL RECEPTORS, SITE 12, AREA F, ANDERSEN AFB, GUAM.

Item	Reference	Quantity	Unit	Rate ($)	Year 1 Capital Costs ($)	Present Worth at 5% for 30 years (rounded)
Capital Cost. Write Site-specific Work Plan						
Sr Labor Hours	BPJ	54	Hour	$ 135	$ 7,290	
Mid Labor Hours	BPJ	32	Hour	$ 80	$ 2,560	
Jr Labor Hours	BPJ	54	Hour	$ 72	$ 3,888	
Clerical/Editor/Word Processor/CADD Hours	BPJ	54	Hour	$ 60	$ 3,240	
Reproduction, shipping, per diem, travel	BPJ	1	Lump Sum	$ 2,500	$ 2,500	
15% Markup on ODC					$ 375	
4% Guam Tax					$ 780	
Subtotal					**$ 20,633**	**$ 20,700**
Capital Cost. Clear, Grub, and Pre-survey						
Sr Labor Hours	BPJ	8	Hour	$ 135	$ 1,080	
Jr Labor Hours	BPJ	32	Hour	$ 72	$ 2,304	
Clerical/Editor/Word Processor/CADD Hours	BPJ	8	Hour	$ 60	$ 480	
Reproduction, shipping, per diem, travel	BPJ	1	Lump Sum	$ 2,000	$ 2,000	
Surveyors and Laborers to Clear	Vendor Quote	0.5	Week	$ 8,000	$ 4,000	
15% Markup on ODC					$ 900	
4% Guam Tax					$ 395	
Subtotal					**$ 10,764**	**$ 10,800**
			Volume	**Weeks**		
Capital Cost. Mob-demob, Remove and Dispose of Soil, and			**130**	**2.0**		
Stabilize and Revegetate Slope; Assume 5 weeks	BPJ	80	Hour	$ 135	$ 10,800	
Mid Labor Hours	BPJ	80	Hour	$ 80	$ 6,400	
Jr Labor Hours	BPJ	80	Hour	$ 72	$ 5,760	
Clerical/Editor/Word Processor/CADD Hours	BPJ	80	Hour	$ 60	$ 4,800	
Reproduction, shipping, per diem, travel	BPJ	2	Week	$ 3,000	$ 6,000	
Mobilization/Demobilization	Vendor Quote	2	Task	$ 2,500	$ 5,000	
Trackhoe/Dozer Rental	Vendor Quote	10	Day	$ 800	$ 8,000	
Drag Line with Clam Shell Bucket	Vendor Quote	10	Day	$ 1,500	$ 15,000	
Equipment Operator	Vendor Quote	0	Hour	$ 55	$ -	
Rolloff Bins	BPJ	1	Each	$ 2,200	$ 2,200	
Laborers	Vendor Quote	0	Hour	$ 15	$ -	
Dump Trucks and Drivers	Vendor Quote	10	Day	$ 450	$ 4,500	
Steam/Water Truck	Vendor Quote	10	Day	$ 1,100	$ 11,000	
Transport/dispose non-haz waste at Consolidation Unit (90%)	BPJ	117	Loose Cubic Yard	$ 11	$ 1,287	
Transport/dispose hazwaste off island (2%)	BPJ	3	Loose Cubic Yard	$ 1,760	$ 4,576	
TSP Treated non-hazwaste waste (8%)	BPJ	10	Loose Cubic Yard	$ 220	$ 2,288	
Reseeding/revegetation	Vendor Quote	0	Square Feet	$ 0.50	$ -	
Clean Backfill**	Vendor Quote	0	Loose Cubic Yard	$ 56	$ -	
15% Markup on ODC					$ 8,978	
4% Guam Tax					$ 2,395	
Subtotal					**$ 98,984**	**$ 99,000**
Capital Cost. Confirmatory Samples & Closure Report						
Sr Labor Hours	BPJ	32	Hour	$ 135	$ 4,320	
Mid Labor Hours	BPJ	32	Hour	$ 80	$ 2,560	
Jr Labor Hours	BPJ	44	Hour	$ 72	$ 3,168	
Clerical/Editor/Word Processor/CADD Hours	BPJ	44	Hour	$ 60	$ 2,640	
Survey confirmatory samples	Vendor Quote	1	Week	$ 4,500	$ 2,250	
Reproduction, perdiem, etc.	BPJ	1	Lump Sum	$ 2,500	$ 2,500	
Analytical Cost	Vendor Quote	20	Sample	$ 500	$ 10,000	
Sampling & Shipment Cost	BPJ	1	Task	$ 5,000	$ 5,000	
15% Markup on ODC					$ 4,866	
4% Guam Tax					$ 1,298	
Subtotal					**$ 38,602**	**$ 38,700**
				TOTAL Capital Cost		**$ 169,200**
Long-Term Cost. Ecological RAOs less than Residential so no 5-yr review required					**$0**	**$0**
				TOTAL Long-Term Cost		**$ -**
				TOTAL COST		**$ 169,200**

Notes:
BPJ - Best Professional Judgment; O&M = Operation & Maintenance; ODC = other direct costs; IC = Institutional Control
** - Assumes that the slope fill will be graded 1/2 feet thick and the soil cover will be 1/2 feet thick.

TABLE 4-35. SUMMARY OF PERTINENT ARARs AND TBCs FOR SITE 12, AREAS A, B, AND F, ANDERSEN AFB, GUAM.

AUTHORITY/ACT	CITATION	ARAR DETERMINATION (note: may not pertain to every remedial alternative)	SYNOPSIS OF REQUIREMENT
Chemical Specific			
Federal			
Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)	7 U.S.C. Section 136 et seq and 40 CFR Parts 150-189	Relevant and Appropriate	Regulates sale, use, storage and disposal of pesticides.
USEPA Region 9 PRGs to screen and establish RGs	USEPA Region 9 PRGs Table (2004)	To Be Considered	Generic RBCs that are intended to assist risk assessors and others in initial screening-level evaluations of environmental measurements.
Risk Assessment Guidance - Cancer Slope Factors and Reference Doses	USEPA Integrated Risk Information System Database and U.S. Department of Energy Risk Assessment Information System	To Be Considered	Used in HHRAs as guidance values to evaluate the potential carcinogenic hazard caused by exposure to COCs.
Territorial (No chemical specific territorial ARARs or TBCs have been identified.)			
Location Specific			
Federal			
Endangered Species Act	16 USC 1531 et seq. 50 CFR 200, 402	Applicable	Promotes actions to conserve endangered species or habitats.
Territorial			
Guam Wellhead Protection Program	Guam EPA (August 1993)	Relevant and Appropriate	Protects groundwater in wells/well fields that supply drinking water.
Historical Objects and Sites	21 Guam Code Annotated, Chapter 76	Relevant and Appropriate	Promotes historic preservation, restoration and presentation of historic sites and objects.

TABLE 4-35. SUMMARY OF PERTINENT ARARs AND TBCs FOR SITE 12, AREAS A, B, AND F, ANDERSEN AFB, GUAM.

AUTHORITY/ACT	CITATION	ARAR DETERMINATION (note: may not pertain to every remedial alternative)	SYNOPSIS OF REQUIREMENT
Fish, Game, Forestry & Conservation	5 Guam Code Annotated, Chapter 63	Applicable	Promotes actions to conserve endangered species or habitats. Also authorizes control of "conservation reserves" by Guam Department of Agriculture to ensure proper management of water, soil, and biota
Action Specific			
Federal			
RCRA regulations for Identification of Hazardous Waste 40 CFR 261, Transport of Hazardous, and for LDRs and landfills	40 CFR 261 40 CFR 263	Applicable	These requirements identify the maximum concentrations of contaminants for which a waste would be considered a RCRA characteristic waste due to toxicity. The analytical test specified in Appendix II of 40 CFR 61 is referred to as the TCLP.
RCRA Generator Requirements for Manifesting Waste for Offsite Disposal	40 CFR 262	Applicable	Standards for manifesting, marking, and recording hazardous waste shipments for offsite treatment/disposal.
RCRA - Subpart I, Use and Management of Containers	40 CFR 264, Subpart I	Applicable	Outlines use and management standards applicable to owners and operators of all hazardous waste facilities that store containers of hazardous waste.
RCRA Standards Applicable to Generators of Hazardous Waste	40 CFR 262	Applicable	These regulations establish standards for generators of hazardous waste including labeling, manifesting, and reporting requirements.
EPA OSWER	Publication 9345.3-03 FS (January 1992)	To Be Considered	Management of wastes generated during remedial activities must ensure protection of human health and the environment.

TABLE 4-35. SUMMARY OF PERTINENT ARARs AND TBCs FOR SITE 12, AREAS A, B, AND F, ANDERSEN AFB, GUAM.

AUTHORITY/ACT	CITATION	ARAR DETERMINATION (note: may not pertain to every remedial alternative)	SYNOPSIS OF REQUIREMENT
LDR ("Land Ban")	40 CFR 268	Applicable	LDR treatment standards for contaminated soils require that contaminated soils that will be land disposed be treated to reduce concentrations of hazardous constituents by 90 percent or meet hazardous constituent concentrations that are ten times the universal treatment standards.
Clean Air NAAQSs	40 CFR 50	To Be Considered	NAAQSs define guideline air quality levels that should be achieved to ensure protection of human health and welfare.
CAMU Regulations	40 CFR 264.552	Relevant and Appropriate	Regulates the management and disposal of RCRA defined hazardous waste as part of corrective response actions and remedial actions
Territorial			
Water Pollution Control Act	10 Guam Code Annotated, Chapter 47	Applicable	Regulates the discharge of pollutants to water resources on Guam.
Solid Waste Management Act	10 Guam Code Annotated, Chapter 51	Applicable	Regulates the management of solid waste and hazardous waste.
Air Pollution Control Act	10 Guam Code Annotated **,** Chapter 49	Applicable	Prohibits the generation of fugitive dust emissions.

TABLE 4-36. SUMMARY OF ARARs AND TBCs FOR REMEDIAL ALTERNATIVES FOR SITE 12, AREAS A, B, AND F, ANDERSEN AFB, GUAM.

AUTHORITY	ALTERNATIVE			
	No Action	**Institutional Controls**	**Soil Removal Protective of Residential and Ecological Receptors**	**Soil Removal Protective of Ecological Receptors (includes institutional controls)**
Chemical Specific				
FIFRA	**Areas A,B and F -** NA	**Areas A,B and F -** NA	**Area A –** Remediation will include the removal of pesticide impacted soils. Any impacted soils will be properly managed to minimize risk to human health, safety and the environment. **Area B and F–** NA	**Area A –** Remediation will include the removal of pesticide impacted soils. Any impacted soils will be properly managed to minimize risk to human health, safety and the environment. **Area B and F–** NA
USEPA Region 9 PRG to screen and establish RGs	**Areas A, B and F -** Preliminary cleanup criteria will not be met; no waiver is justified.	**Areas A, B and F -** Probability of human exposure to soils exceeding preliminary cleanup criteria will be reduced. However, ecological receptors would not be protected	**Areas A, B and F -** RGs would be achieved through the removal and offsite disposal of impacted soil, except from the native limestone forest area.	**Areas A, B and F -** RGs would be achieved through the removal and offsite disposal of impacted soil, except from the native limestone forest area.
Risk Assessment Guidance - Cancer Slope Factors and Reference Doses	**Areas A, B, and F -** Cancer and non-cancer risk was evaluated at site incorporating slope factors and reference doses.	**Areas A, B, and F -** Cancer and non-cancer risk was evaluated at site incorporating slope factors and reference doses.	**Areas A, B, and F -** Cancer and non-cancer risk was evaluated at site incorporating slope factors and reference doses.	**Areas A, B, and F -** Cancer and non-cancer risk was evaluated at site incorporating slope factors and reference doses.

TABLE 4-36. SUMMARY OF ARARs AND TBCs FOR REMEDIAL ALTERNATIVES FOR SITE 12, AREAS A, B, AND F, ANDERSEN AFB, GUAM.

AUTHORITY	ALTERNATIVE			
	No Action	**Institutional Controls**	**Soil Removal Protective of Residential and Ecological Receptors**	**Soil Removal Protective of Ecological Receptors (includes institutional controls)**
Location Specific				
Endangered Species Act 16 USC 1531 et seq.	**Areas A, B, and F -** NA	**Areas A, B, and F -** NA	**Area A, B, and F –**Remedial actions are not to be conducted in native limestone forest. Impacts to endangered species habitat are not expected; however, the action will be assessed to ensure that there is no impact to roosting, nesting, or foraging habitat of endangered species.	**Area A, B, and F –**Remedial actions are not to be conducted in native limestone forest. Impacts to endangered species habitat are not expected; however, the action will be assessed to ensure that there is no impact to roosting, nesting, or foraging habitat of endangered species.
Guam Wellhead Protection Program	**Areas A, B, and F -** NA	**Areas A, B, and F -** NA	**Area A, B, and F -** Groundwater is not a media of concern. Site 12 is located Downgradient of Groundwater Protection Zone boundary. However, all groundwater on the Northern Plateau has been designated as a Sole Source Aquifer; therefore, Guam EPA must review any project in this aquifer regardless if a permit is required.	**Area A, B, and F -** Groundwater is not a media of concern. Site 12 is located Downgradient of Groundwater Protection Zone boundary. However, all groundwater on the Northern Plateau has been designated as a Sole Source Aquifer; therefore, Guam EPA must review any project in this aquifer regardless if a permit is required.
Historic Objects and Sites - 21 Guam Code Annotated, Chapter 76	**Areas A, B, and F -** NA	**Areas A, B, and F -** NA	**Area A, B, and F -** Soil excavation activities would avoid impacts to any historical objects at the sites.	**Area A, B, and F -** Soil excavation activities would avoid impacts to any historical objects at the sites.

TABLE 4-36. SUMMARY OF ARARs AND TBCs FOR REMEDIAL ALTERNATIVES FOR SITE 12, AREAS A, B, AND F, ANDERSEN AFB, GUAM.

AUTHORITY	ALTERNATIVE			
	No Action	**Institutional Controls**	**Soil Removal Protective of Residential and Ecological Receptors**	**Soil Removal Protective of Ecological Receptors (includes institutional controls)**
Fish, Game, Forestry & Conservation - 5 Guam Code Annotated, Chapter 63	**Areas A, B, and F -** NA	**Areas A, B, and F -** NA	**Area A, B, and F –**Remedial actions are not to be conducted in native limestone forest. Impacts to endangered species habitat are not expected; however, the action will be assessed to ensure that there is no impact to roosting, nesting, or foraging habitat of endangered species.	**Area A, B, and F –**Remedial actions are not to be conducted in native limestone forest. Impacts to endangered species habitat are not expected; however, the action will be assessed to ensure that there is no impact to roosting, nesting, or foraging habitat of endangered species.
Action Specific				
RCRA regulations for Identification of Hazardous Waste 40 CFR 261, Transport of Hazardous, and for LDRs and landfills	**Areas A, B, and F -** NA	**Areas A, B, and F -** NA	**Areas A, B, and F -** Removal action may produce hazardous waste. If soil exhibits at least one of the four hazardous waste characteristics (ignitability, reactivity, corrosivity, or TCLP), the material is treated as hazardous waste.	**Areas A, B, and F –** Removal action may produce hazardous waste. If soil exhibits at least one of the four hazardous waste characteristics (ignitability, reactivity, corrosivity, or TCLP), the material is treated as hazardous waste.
RCRA - Generator Requirements for Manifesting Waste for Offsite Disposal	**Areas A, B, and F -** NA	**Areas A, B, and F -** NA	**Areas A, B, and F -** If remedial actions require the offsite disposal of RCRA-defined hazardous waste, then the substantive requirements of these regulations will be followed.	**Areas A, B, and F -** If remedial actions require the offsite disposal of RCRA-defined hazardous waste, then the substantive requirements of these regulations will be followed.

TABLE 4-36. SUMMARY OF ARARs AND TBCs FOR REMEDIAL ALTERNATIVES FOR SITE 12, AREAS A, B, AND F, ANDERSEN AFB, GUAM.

AUTHORITY	ALTERNATIVE			
	No Action	**Institutional Controls**	**Soil Removal Protective of Residential and Ecological Receptors**	**Soil Removal Protective of Ecological Receptors (includes institutional controls)**
RCRA - Subpart I, Use and Management of Containers	**Areas A, B, and F -** NA	**Areas A, B, and F -** NA	**Areas A, B, and F -** If remedial actions require storage of hazardous waste in containers, then the substantive requirements of these regulations will be followed.	**Areas A, B, and F -** If remedial actions require storage of hazardous waste in containers, then the substantive requirements of these regulations will be followed.
RCRA Standards Applicable to Generators of Hazardous Waste	**Areas A, B, and F -** NA	**Areas A, B, and F -** NA	**Areas A, B, and F -** Remediation-derived waste may be characterized as hazardous waste. If so, the material will be handled in compliance with the substantive requirements of these standards.	**Areas A, B, and F -** Remediation-derived waste may be characterized as hazardous waste. If so, the material will be handled in compliance with the substantive requirements of these standards.
RCRA Chemical, Physical, and Biological Treatment	**Areas A, B, and F -** NA	**Areas A, B, and F -** NA	**Areas A, B, and F -** If a remedial activity involves the treatment of RCRA hazardous waste by chemical, physical, or biological methods in units other than tanks, surface impoundments, and land treatment facilities, these requirements would be met.	**Areas A, B, and F -** If a remedial activity involves the treatment of RCRA hazardous waste by chemical, physical, or biological methods in units other than tanks, surface impoundments, and land treatment facilities, these requirements would be met.

TABLE 4-36. SUMMARY OF ARARs AND TBCs FOR REMEDIAL ALTERNATIVES FOR SITE 12, AREAS A, B, AND F, ANDERSEN AFB, GUAM.

AUTHORITY	ALTERNATIVE			
	No Action	**Institutional Controls**	**Soil Removal Protective of Residential and Ecological Receptors**	**Soil Removal Protective of Ecological Receptors (includes institutional controls)**
RCRA LDRs	**Areas A, B, and F -** NA	**Areas A, B, and F -** NA	**Areas A, B, and F -** LDR treatment standards for contaminated soils require that contaminated soils that will be land disposed be treated to reduce concentrations of hazardous constituents by 90 percent or meet hazardous constituent concentrations that are ten times the universal treatment standards.	**Areas A, B, and F -** LDR treatment standards for contaminated soils require that contaminated soils that will be land disposed be treated to reduce concentrations of hazardous constituents by 90 percent or meet hazardous constituent concentrations that are ten times the universal treatment standards.
CAMU Regulations 40 CFR 264.552	**Areas A, B, and F -** NA	**Areas A, B, and F -** NA	**Areas A, B, and F -** No hazardous waste or recently generated waste will be placed at the site. Groundwater in the vicinity of the site will be monitored under a separate program.	**Areas A, B, and F -** No hazardous waste or recently generated waste will be placed at the site. Groundwater in the vicinity of the site will be monitored under a separate program.
Water Pollution Control Act 10 Guam Code Annotated, Chapter 47	**Areas A, B, and F -** NA	**Areas A, B, and F -** NA	**Areas A, B, and F -** Removal would be conducted in a manner to prevent surface erosion of soil to nearby streams and marine waters.	**Areas A, B, and F -** Removal would be conducted in a manner to prevent surface erosion of soil to nearby streams and marine waters.
Solid Waste Management Act, 10 Guam Code Annotated, Chapter 51	**Areas A, B, and F -** NA	**Areas A, B, and F -** NA	**Areas A, B, and F -** Any solid waste will be managed in accordance with the substantive requirements of these regulations will be followed.	**Areas A, B, and F -** Any solid waste will be managed in accordance with the substantive requirements of these regulations will be followed.

TABLE 4-36. SUMMARY OF ARARs AND TBCs FOR REMEDIAL ALTERNATIVES FOR SITE 12, AREAS A, B, AND F, ANDERSEN AFB, GUAM.

AUTHORITY	ALTERNATIVE			
	No Action	**Institutional Controls**	**Soil Removal Protective of Residential and Ecological Receptors**	**Soil Removal Protective of Ecological Receptors (includes institutional controls)**
Guam Air Pollution Control Act	**Areas A, B, and F -** NA	**Areas A, B, and F -** NA	**Areas A, B, and F -** Remedial activities would be conducted in a manner to minimize fugitive dust emissions.	**Areas A, B, and F -** Remedial activities would be conducted in a manner to minimize fugitive dust emissions.

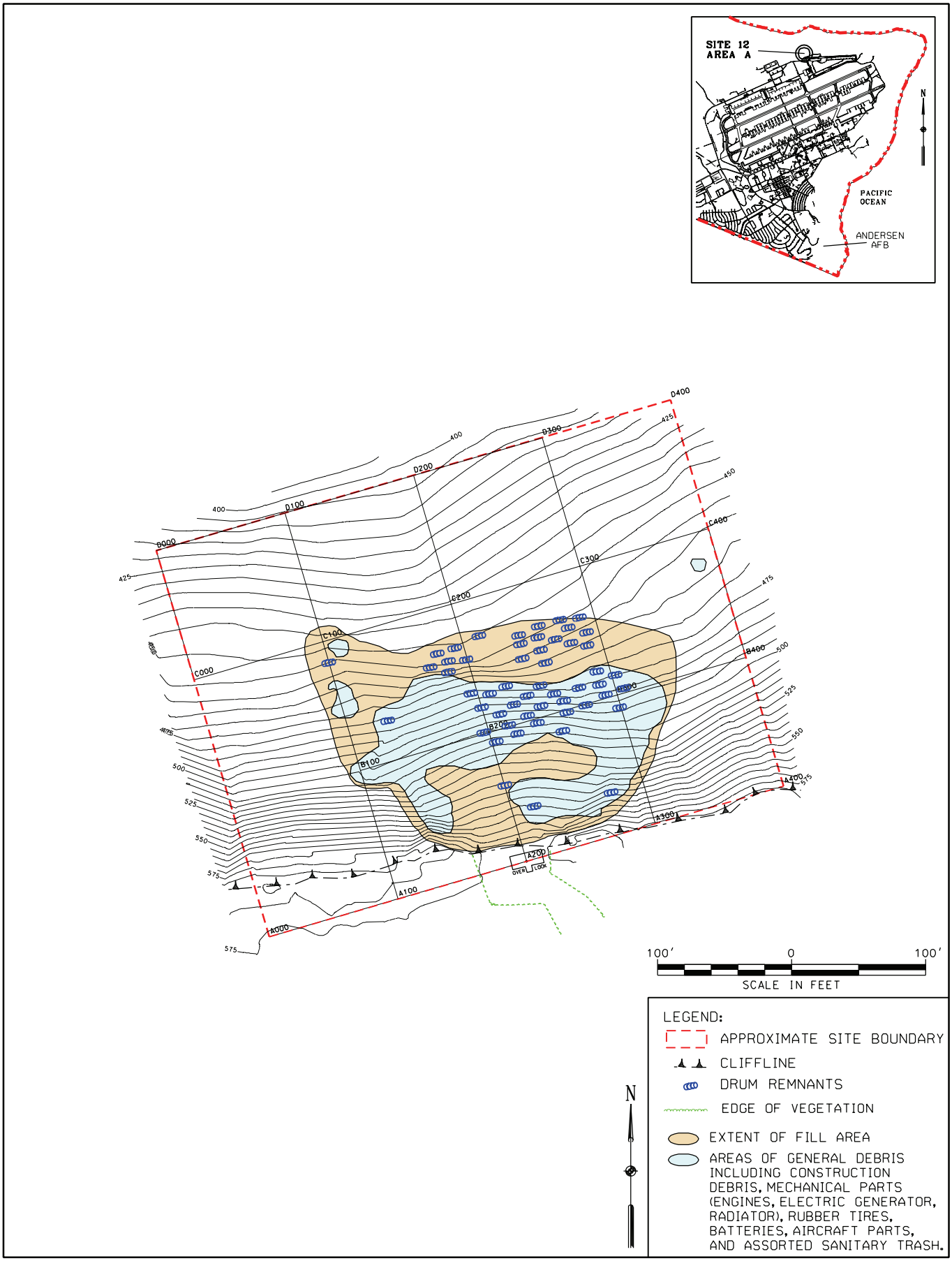


Figure 4-1. Suspected Sources of Contamination at Area A of Site 12, Andersen AFB, Guam.

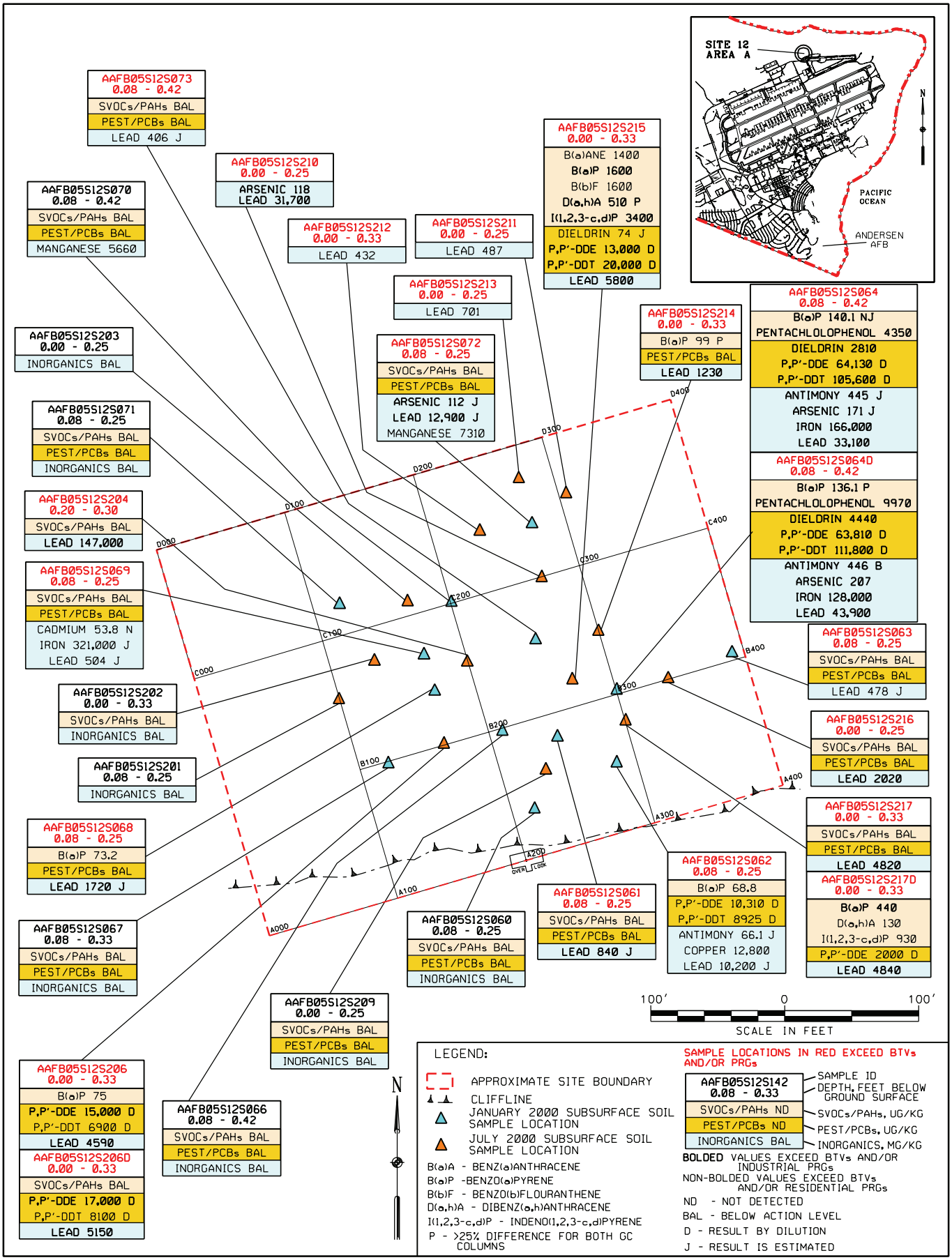


Figure 4-2. Surface Soil Sample Results at Area A of Site 12, Andersen AFB, Guam.

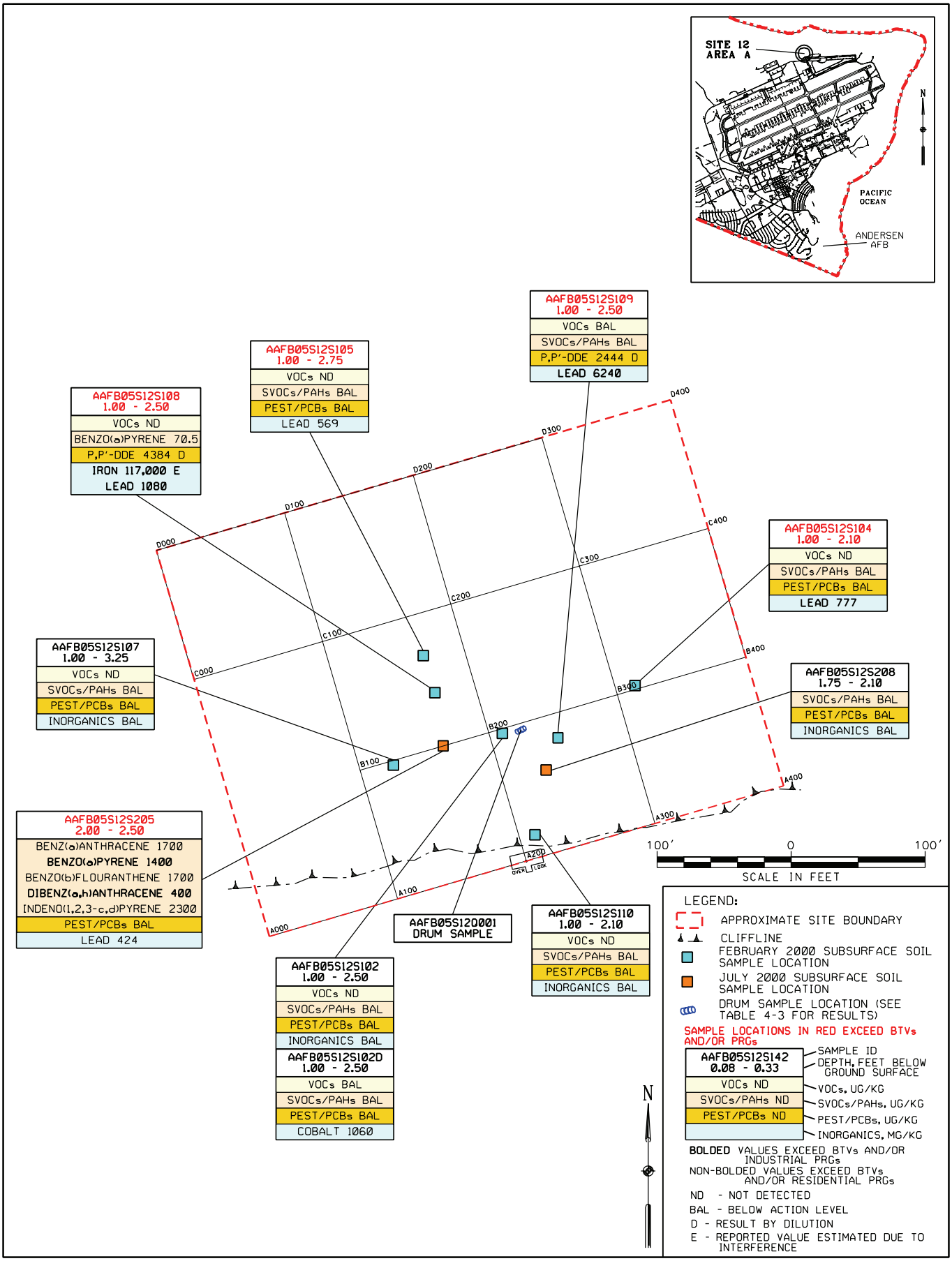
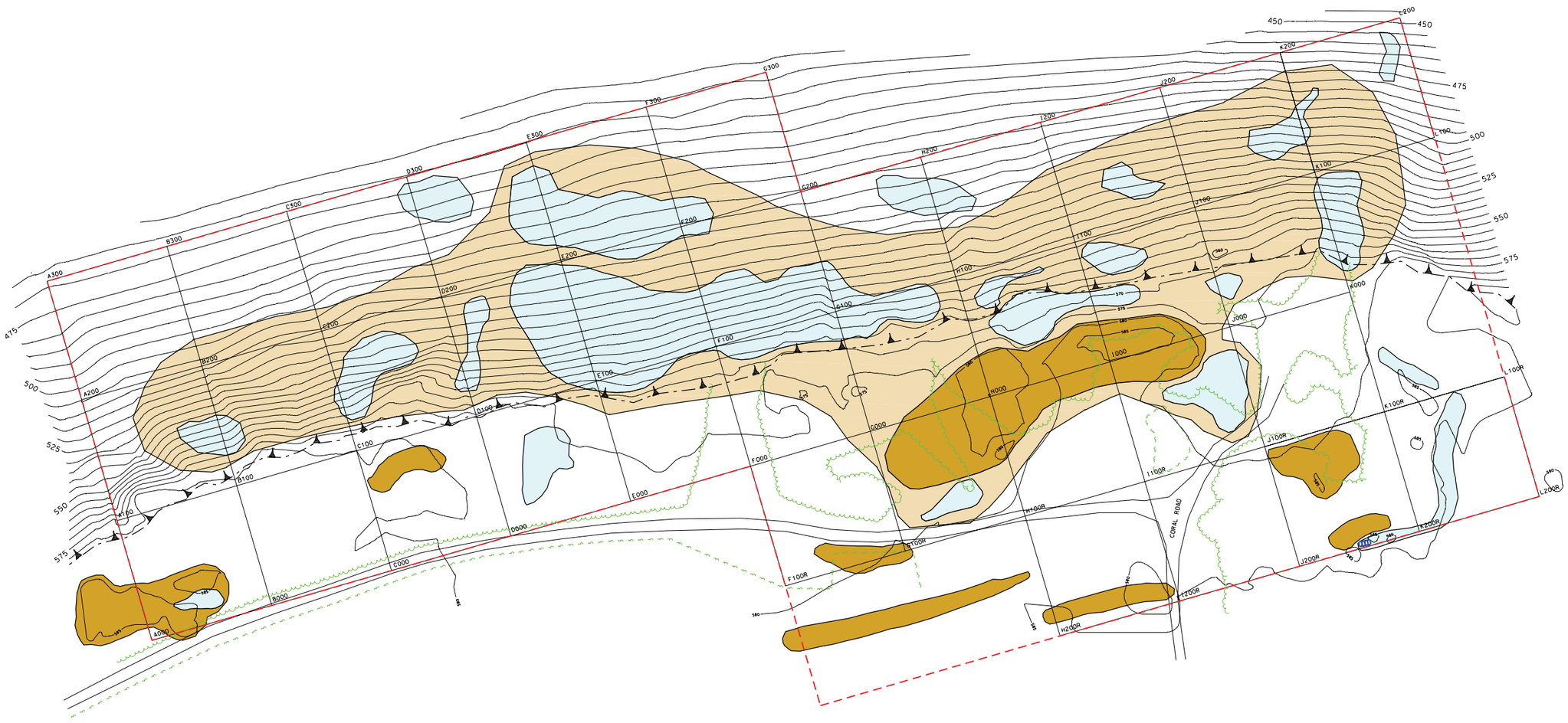
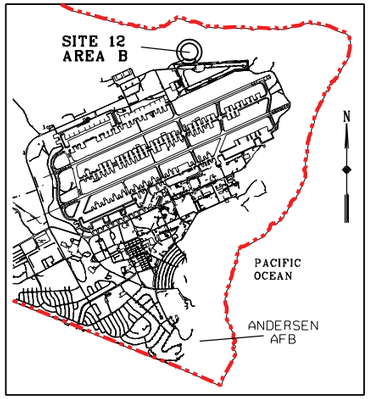


Figure 4-3. Subsurface Soil Sample Results at Area A of Site 12, Andersen AFB, Guam.





LEGEND:

- APPROXIMATE SITE BOUNDARY
- CLIFFLINE
- DRUM REMNANTS
- EDGE OF VEGETATION
- EXTENT OF FILL AREA
- MOUNDED AREAS
- AREAS OF GENERAL DEBRIS INCLUDING AIRCRAFT PARTS, TRUCK PARTS, ELECTRICAL AND MECHANICAL PARTS, VARIOUS CONSTRUCTION DEBRIS, SANITARY TRASH, PAINT CANS, METAL SIGNS, VARIOUS SIZE BULLETS AND CASINGS, CONCRETE AND ASPHALT DEBRIS, TELEPHONE POLES, AND DUMPSTERS.

N

100′ 0 100′

SCALE IN FEET

Figure 4-4.
Suspected Sources of Contamination at Area B of Site 12, Andersen AFB, Guam.

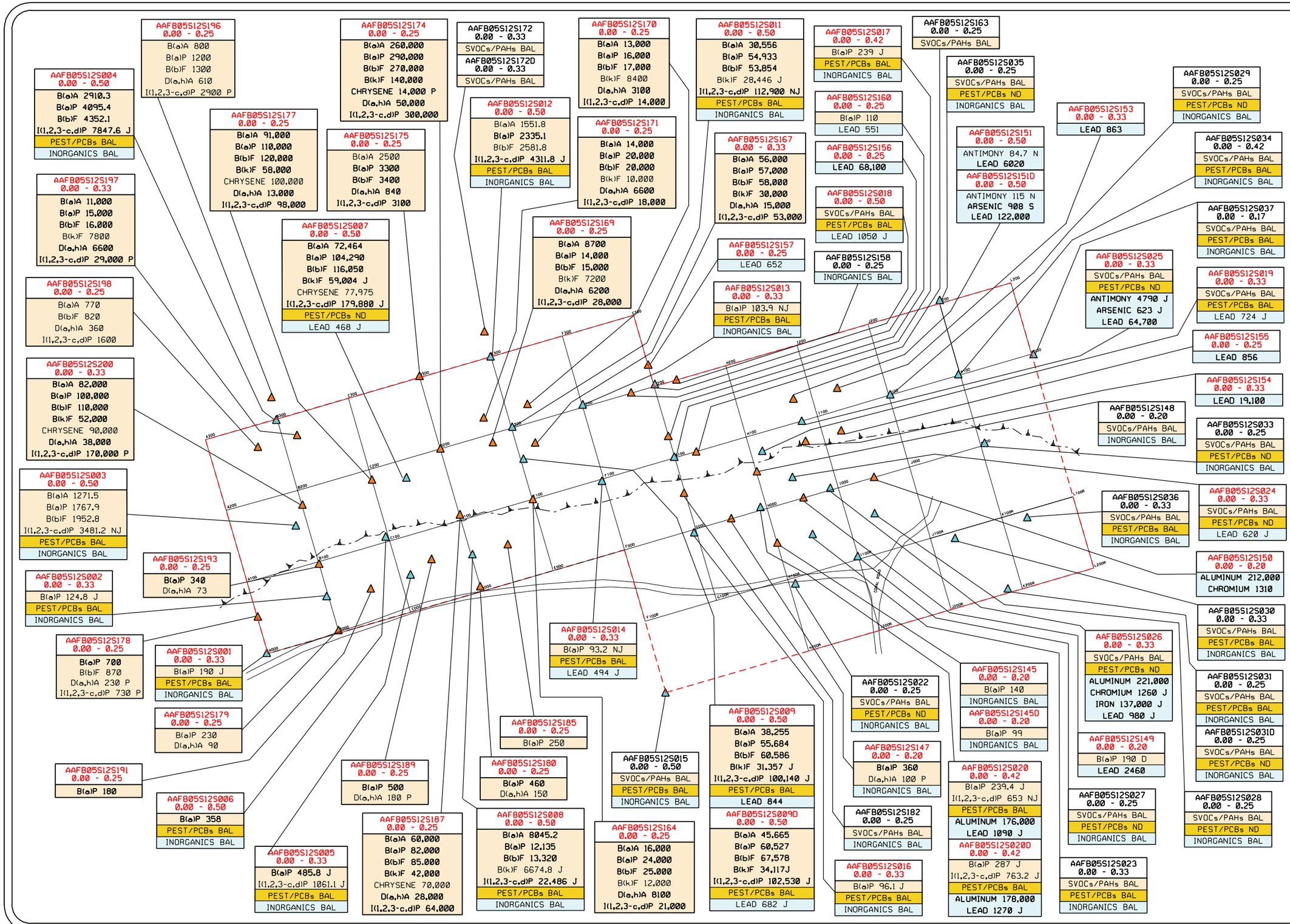
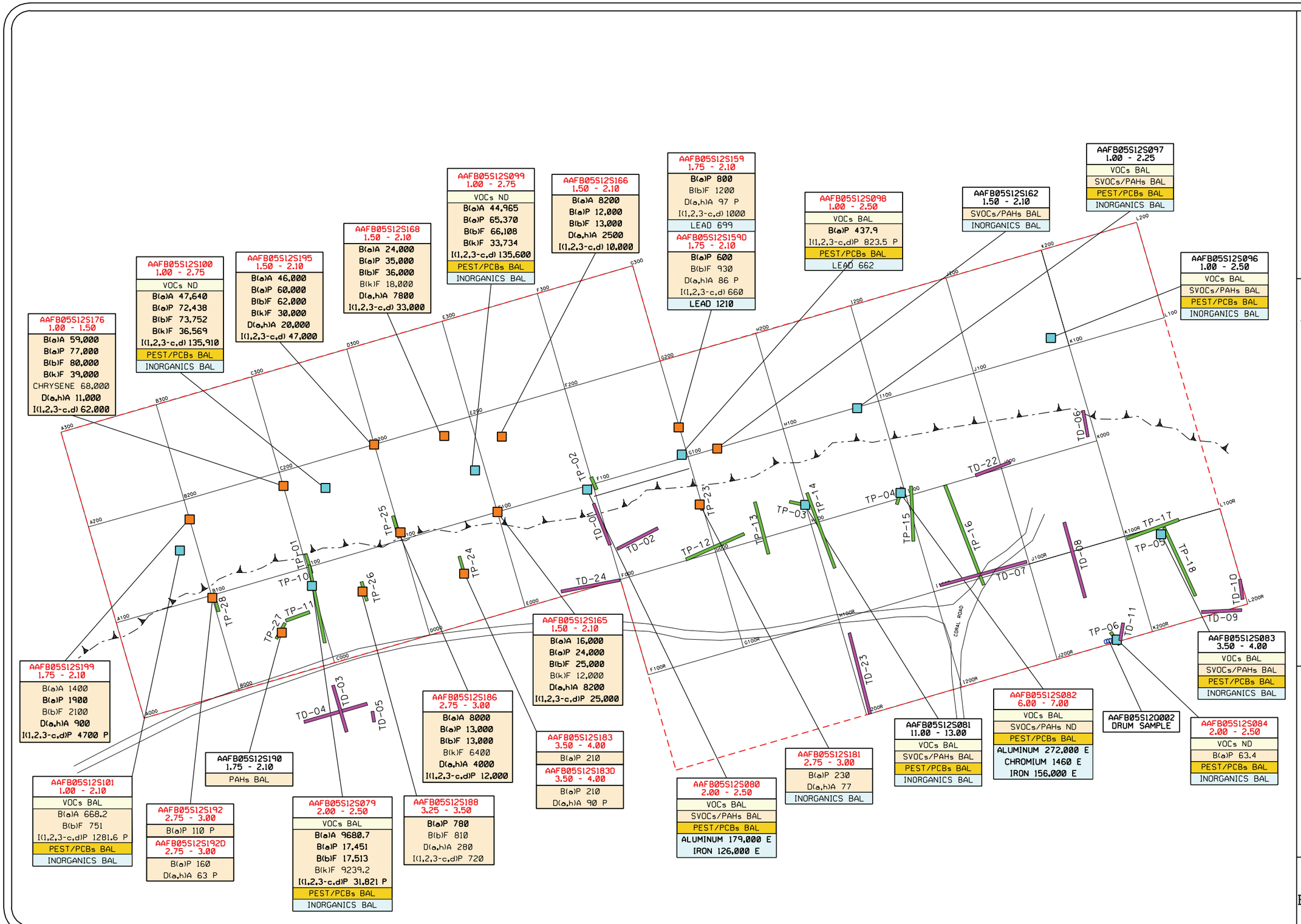
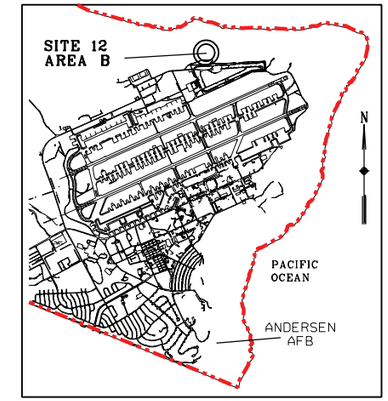


Figure 4-5.
Surface Soil Sample Results at Area B of Site 12, Andersen AFB, Guam.





LEGEND:

- APPROXIMATE SITE BOUNDARY
- CLIFFLINE
- TD-7 TEST DITCH LOCATION
- TP-11 TEST PIT LOCATION
- DRUM SAMPLE LOCATION (SEE TABLE 4-6 FOR RESULTS)
- DECEMBER 1999 SUBSURFACE SOIL SAMPLE LOCATION
- JULY 2000 SUBSURFACE SOIL SAMPLE LOCATION

SAMPLE LOCATIONS IN RED EXCEED BTVs AND/OR PRGs

AAFB05S12S090 1.00 - 1.25	
VOCs BAL	VOCs, UG/KG
SVOCs/PAHs BAL	SVOCs/PAHs, UG/KG
PEST/PCBs BAL	PEST/PCBs, UG/KG
INORGANICS BAL	INORGANICS, MG/KG

SAMPLE ID
DEPTH, FEET BELOW GROUND SURFACE

BOLDED VALUES EXCEED BTVs AND/OR INDUSTRIAL PRGs
NON-BOLDED VALUES EXCEED BTVs AND/OR RESIDENTIAL PRGs
ND - NOT DETECTED
BAL - BELOW ACTION LEVEL
B(a)A - BENZ(a)ANTHRACENE
B(a)P - BENZO(a)PYRENE
B(b)F - BENZO(b)FLOURANTHENE
B(k)F - BENZO(k)FLOURANTHENE
D(a,h)A - DIBENZ(a,h)ANTHRACENE
I(1,2,3-c,d)P - INDENO(1,2,3-c,d)PYRENE
E - RESULT ESTIMATED DUE TO INTERFERENCE
P - >25% DIFFERENCE FOR BOTH GC COLUMNS

N

100' 0 100'
SCALE IN FEET

Figure 4-6.
Subsurface Soil Sample Results at Area B of Site 12, Andersen AFB, Guam.

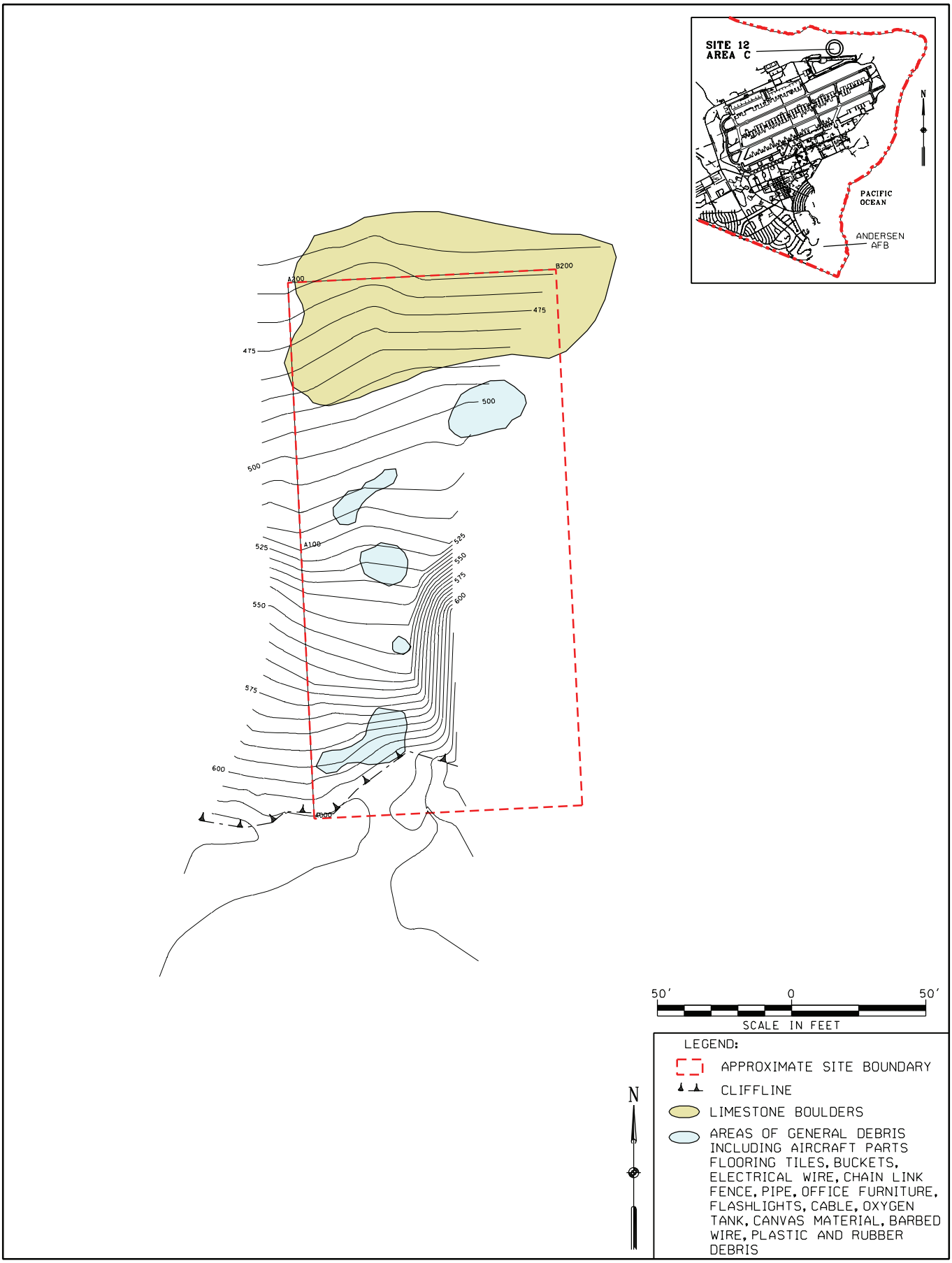


Figure 4-7. Suspected Sources of Contamination at Area C of Site 12, Andersen AFB, Guam.

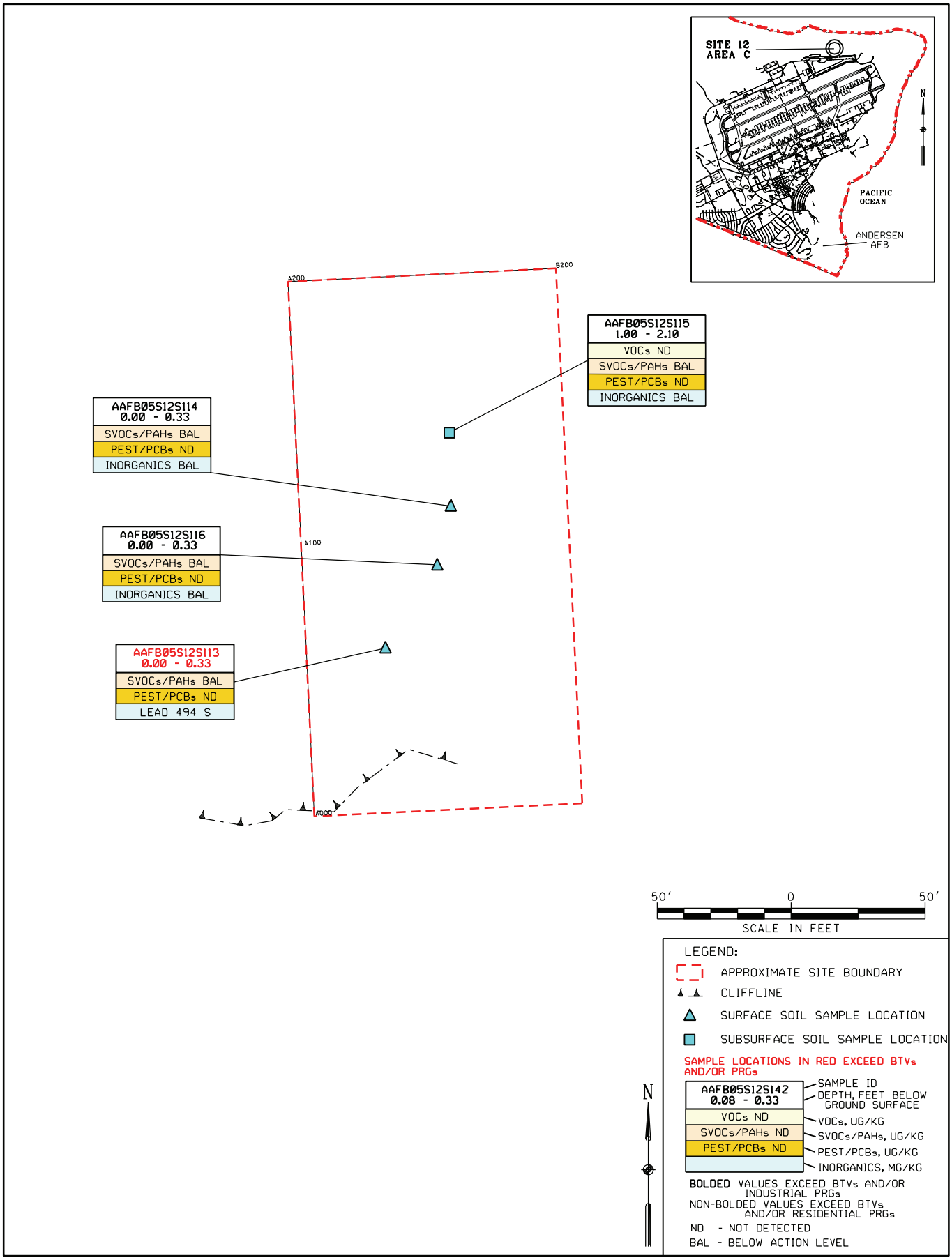


Figure 4-8. Surface and Subsurface Soil Sample Results at Area C of Site 12, Andersen AFB, Guam.

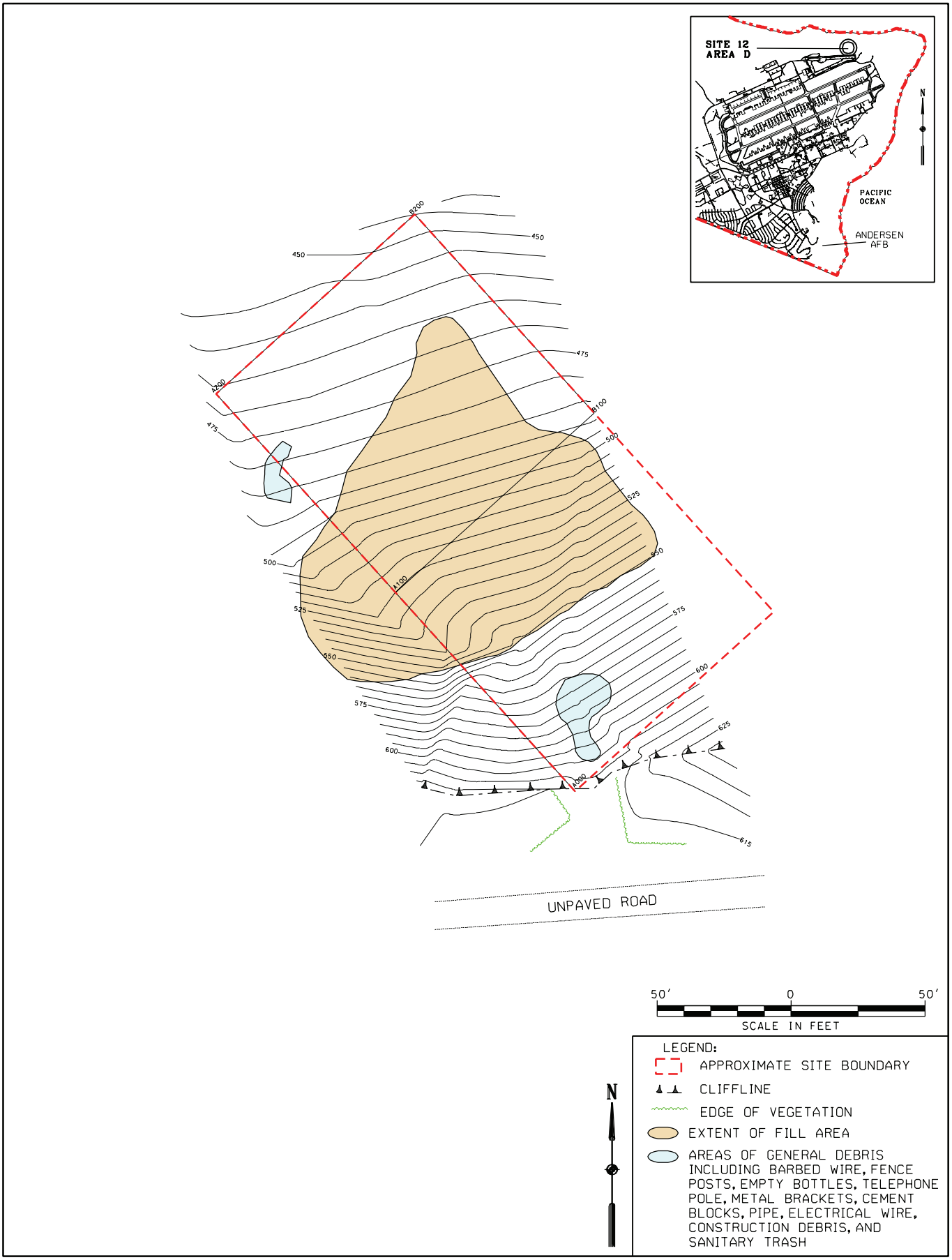


Figure 4-9. Suspected Sources of Contamination at Area D of Site 12, Andersen AFB, Guam.

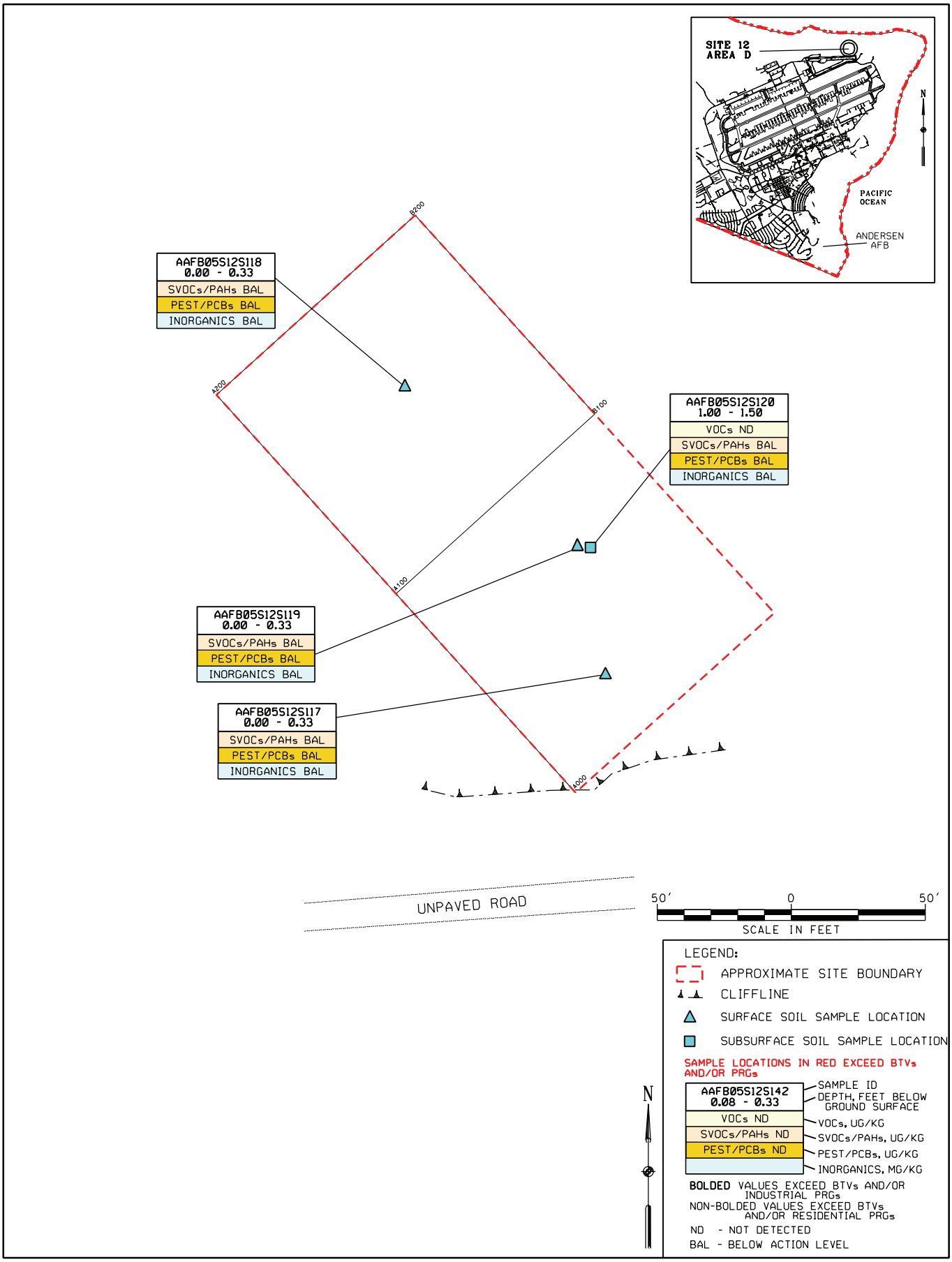
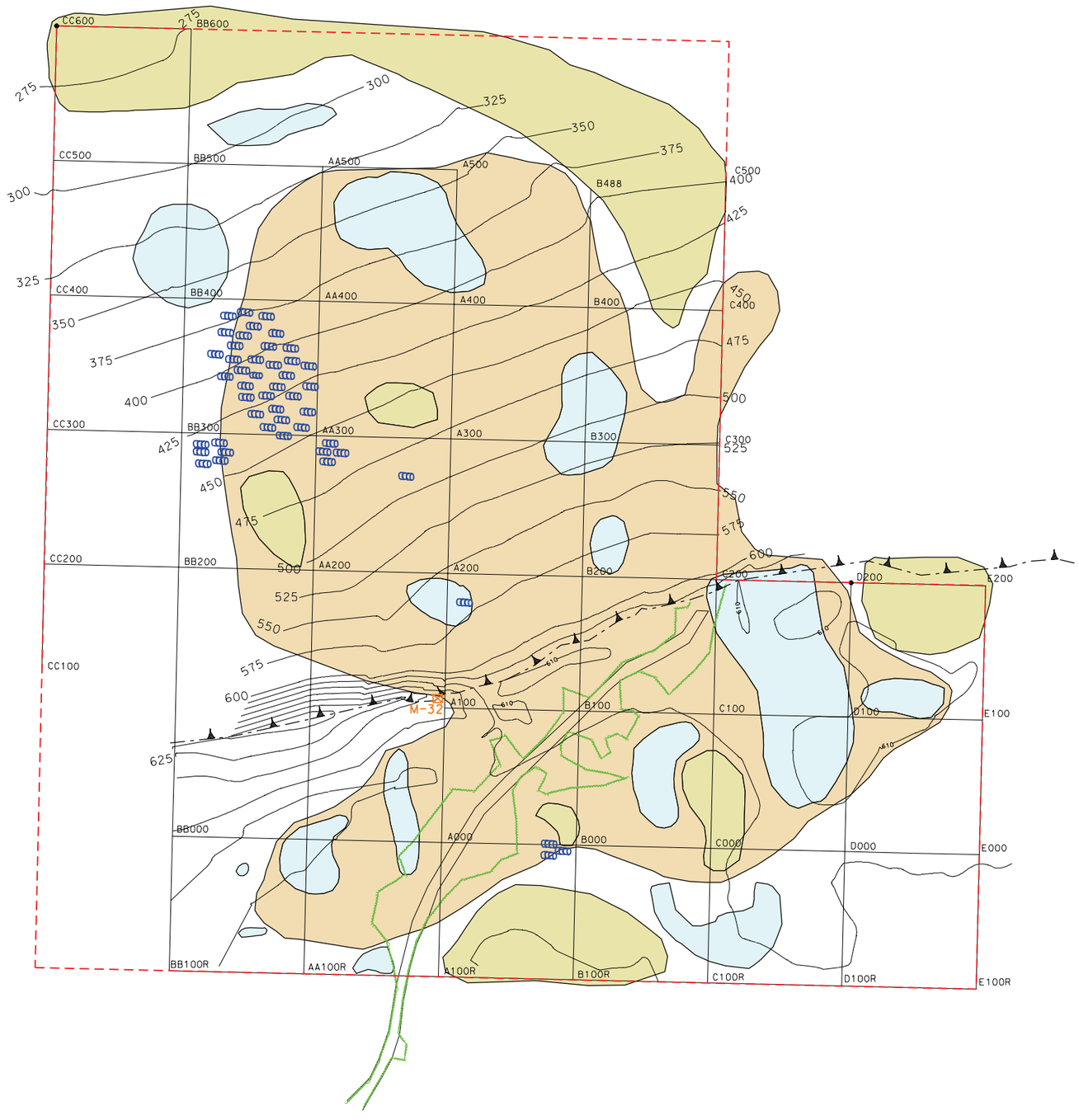
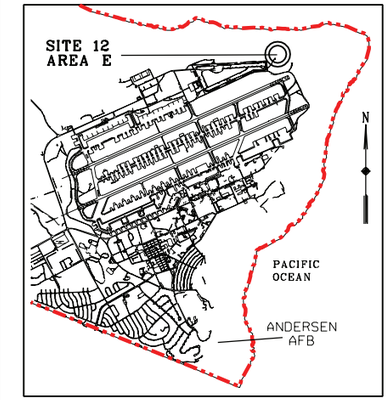


Figure 4-10. Surface and Subsurface Soil Sample Results at Area D of Site 12, Andersen AFB, Guam.





LEGEND:

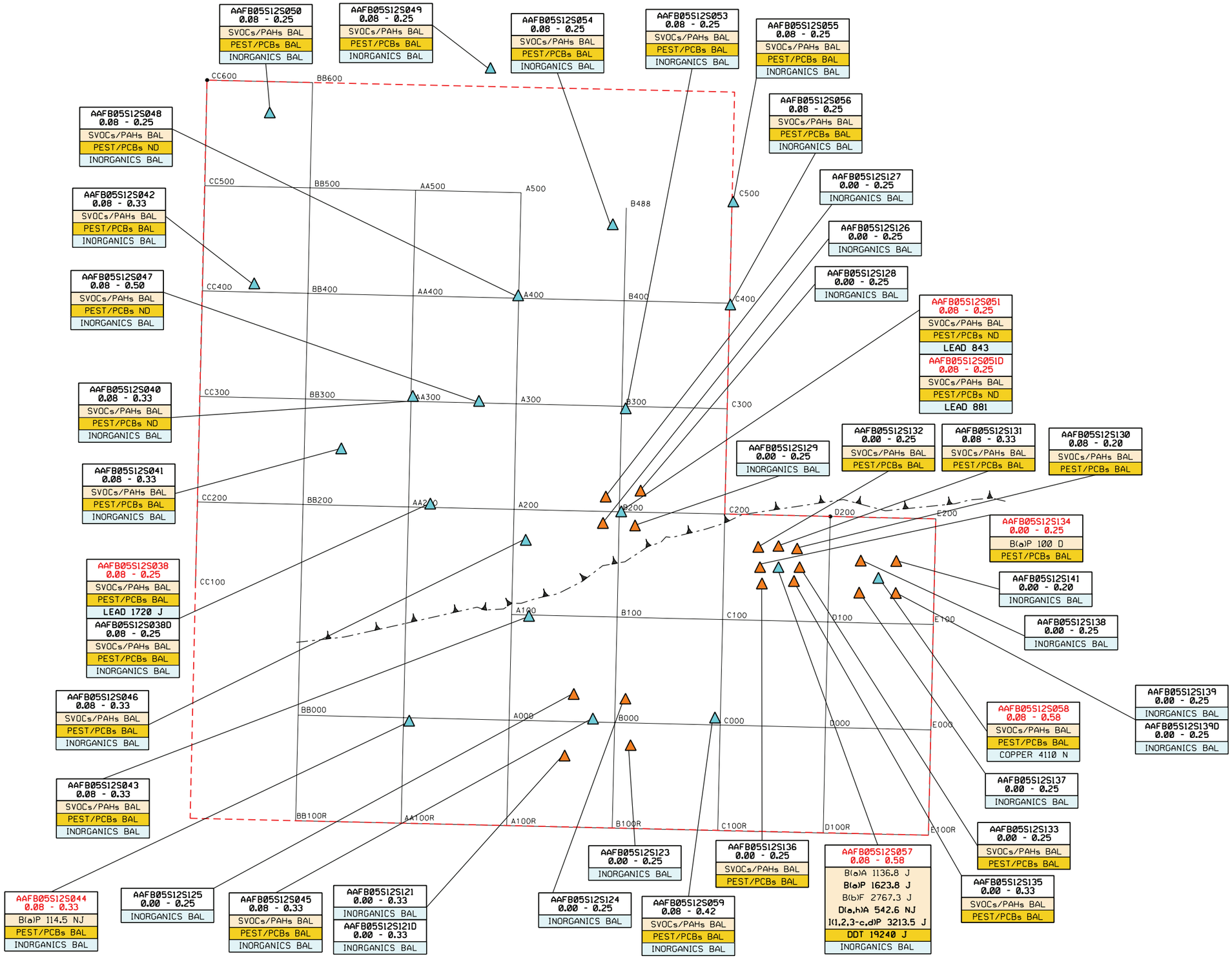
- APPROXIMATE SITE BOUNDARY
- CLIFFLINE
- DRUM REMNANTS
- EDGE OF VEGETATION
- M-32 4X4 CONCRETE MONUMENT
- EXTENT OF FILL AREA
- LIMESTONE BOULDERS
- AREAS OF GENERAL DEBRIS INCLUDING ALODINE AND DEOXIDINE BOTTLES, DRUMS, BUCKETS, MECHANICAL PARTS, ELECTRICAL PARTS, CONSTRUCTION DEBRIS, CANISTERS, PIPE, AIRCRAFT PARTS, VEHICLE PARTS, AND VARIOUS SANITARY TRASH

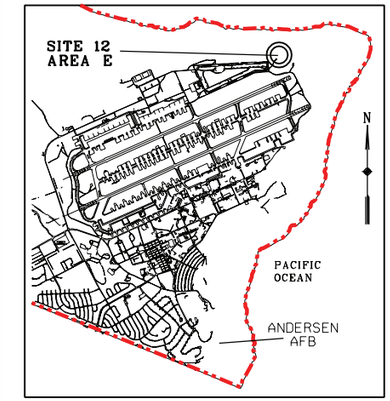
N

100′ 0 100′

SCALE IN FEET

Figure 4-11.
Suspected Sources of Contamination at Area E of Site 12, Andersen AFB, Guam.





LEGEND:

- APPROXIMATE SITE BOUNDARY
- CLIFFLINE
- JANUARY 2000 SURFACE SOIL SAMPLE LOCATION
- JUNE 2000 SURFACE SOIL SAMPLE LOCATION

SAMPLE LOCATIONS IN RED EXCEED BTVs AND/OR PRGs

AAFB05S12S090 1.00 - 1.25	SAMPLE ID; DEPTH, FEET BELOW GROUND SURFACE
SVOCs/PAHs BAL	SVOCs/PAHs, UG/KG
PEST/PCBs BAL	PEST/PCBs, UG/KG
INORGANICS BAL	INORGANICS, MG/KG

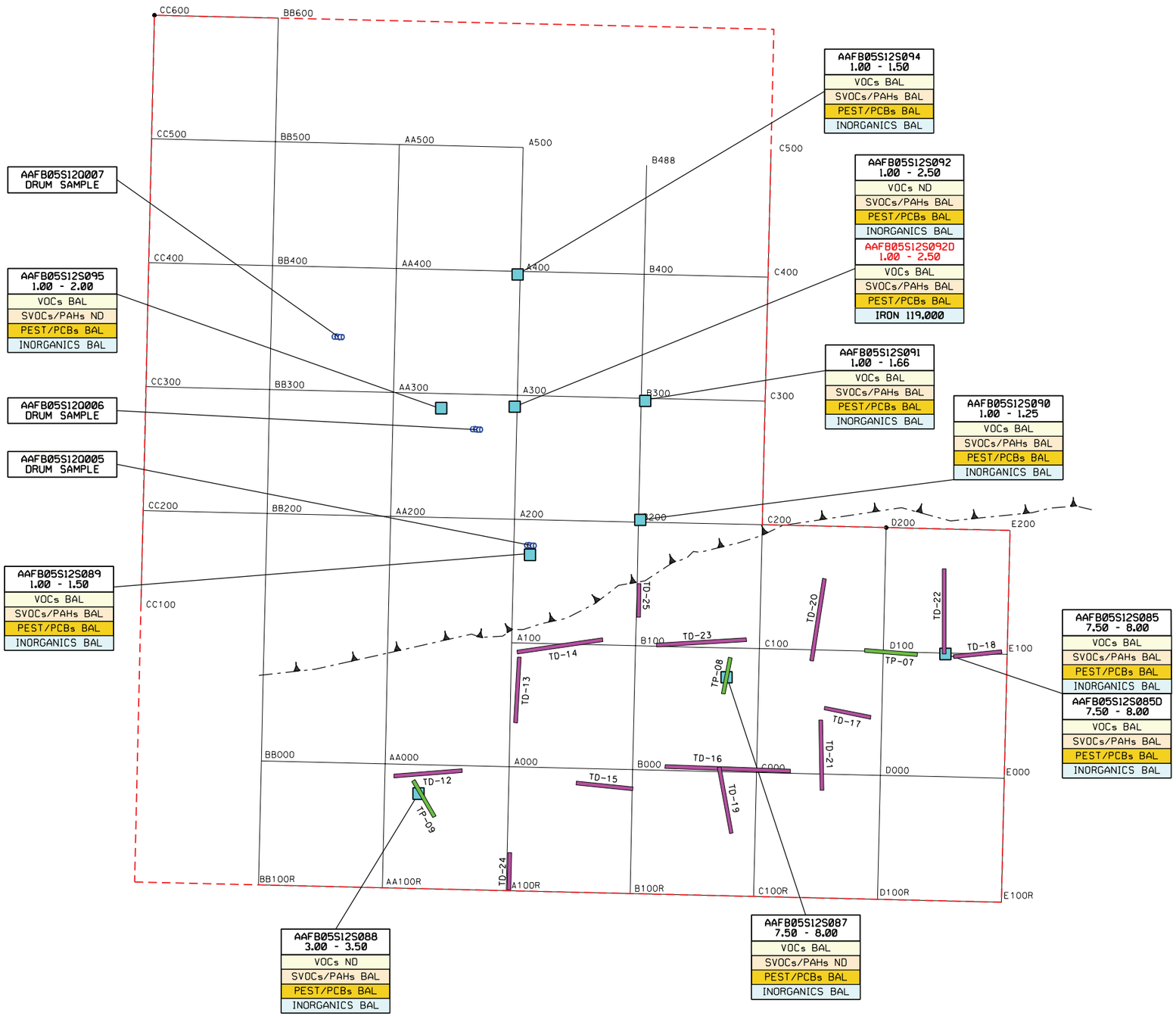
BOLDED VALUES EXCEED BTVs AND/OR INDUSTRIAL PRGs
NON-BOLDED VALUES EXCEED BTVs AND/OR RESIDENTIAL PRGs

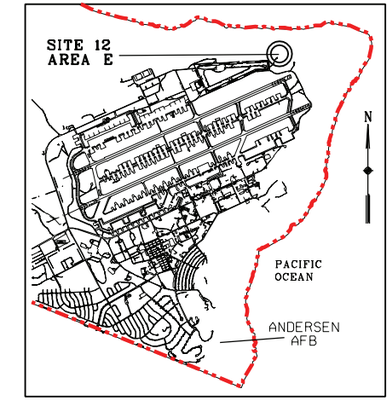
ND - NOT DETECTED
BAL - BELOW ACTION LEVEL
B(a)A - BENZ(a)ANTHRACENE
B(a)P - BENZO(a)PYRENE
B(b)F - BENZO(b)FLOURANTHENE
D(a,h)A - DIBENZ(a,h)ANTHRACENE
I(1,2,3-c,d)P - INDENO(1,2,3-c,d)PYRENE
D - RESULT BY DILUTION
J - RESULT IS ESTIMATED
N - SPIKED SAMPLE RECOVERY NOT W/I LIMITS
NJ - ANALYTE IS TENTATIVELY IDENTIFIED AND CONCENTRATION IS APPROXIMATE

N

100′ 0 100′
SCALE IN FEET

Figure 4-12.
Surface Soil Sample Results at Area E of Site 12, Andersen AFB, Guam.





LEGEND:

- APPROXIMATE SITE BOUNDARY
- CLIFFLINE
- TD-7 TEST DITCH LOCATION
- TP-11 TEST PIT LOCATION
- DRUM SAMPLE LOCATION (SEE TABLE 4-13 FOR RESULTS)
- SUBSURFACE SOIL SAMPLE LOCATION

SAMPLE LOCATIONS IN RED EXCEED BTVs AND/OR PRGs

AAFB05S12S090 1.00 - 1.25	SAMPLE ID; DEPTH, FEET BELOW GROUND SURFACE
VOCs BAL	VOCs, UG/KG
SVOCs/PAHs BAL	SVOCs/PAHs, UG/KG
PEST/PCBs BAL	PEST/PCBs, UG/KG
INORGANICS BAL	INORGANICS, MG/KG

BOLDED VALUES EXCEED BTVs AND/OR INDUSTRIAL PRGs
NON-BOLDED VALUES EXCEED BTVs AND/OR RESIDENTIAL PRGs
ND - NOT DETECTED
BAL - BELOW ACTION LEVEL

N

100' 0 100'
SCALE IN FEET

Figure 4-13.
Subsurface Soil Sample Results at Area E of Site 12, Andersen AFB, Guam.

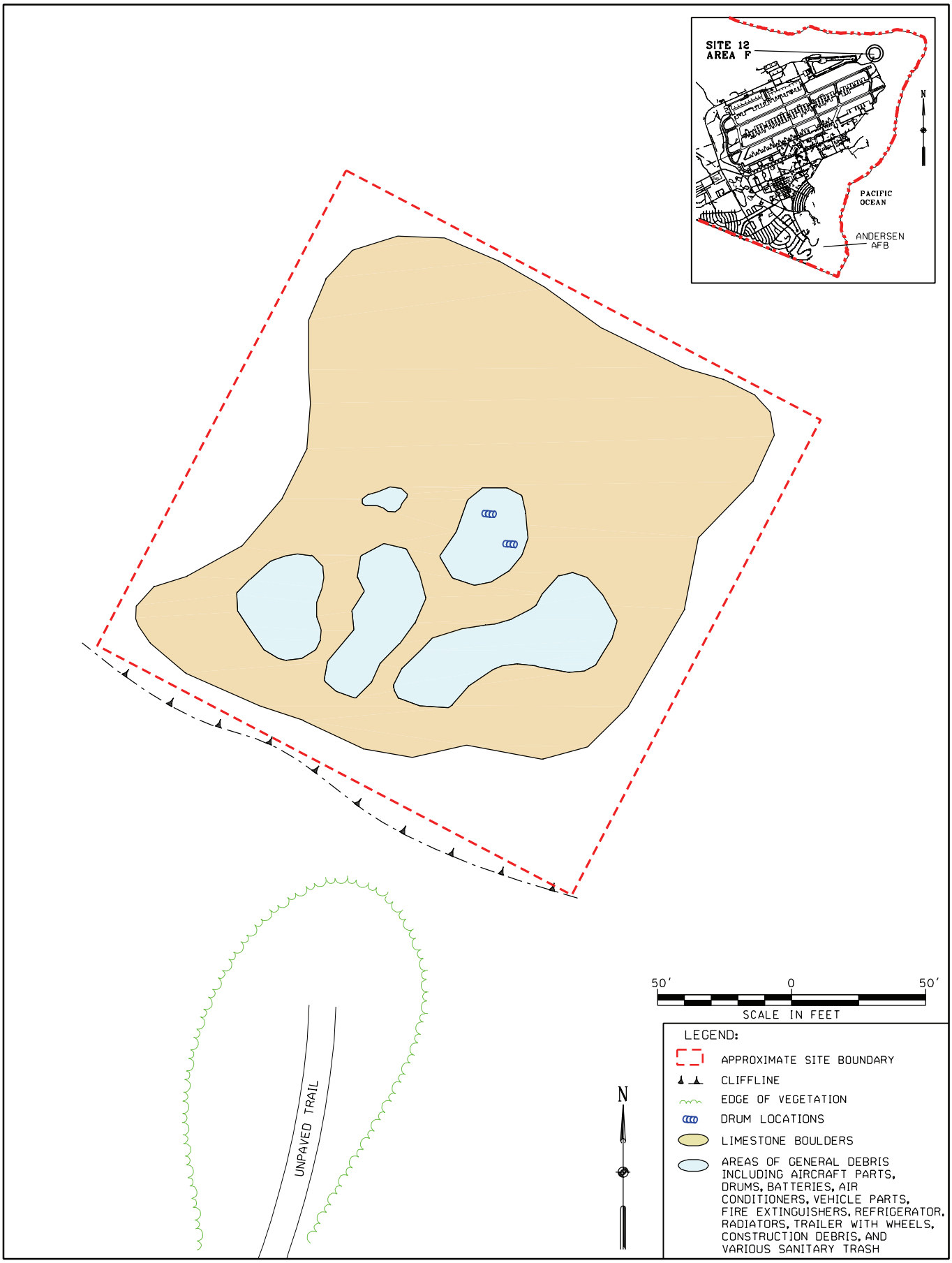


Figure 4-14. Suspected Sources of Contamination at Area F of Site 12, Andersen AFB, Guam.

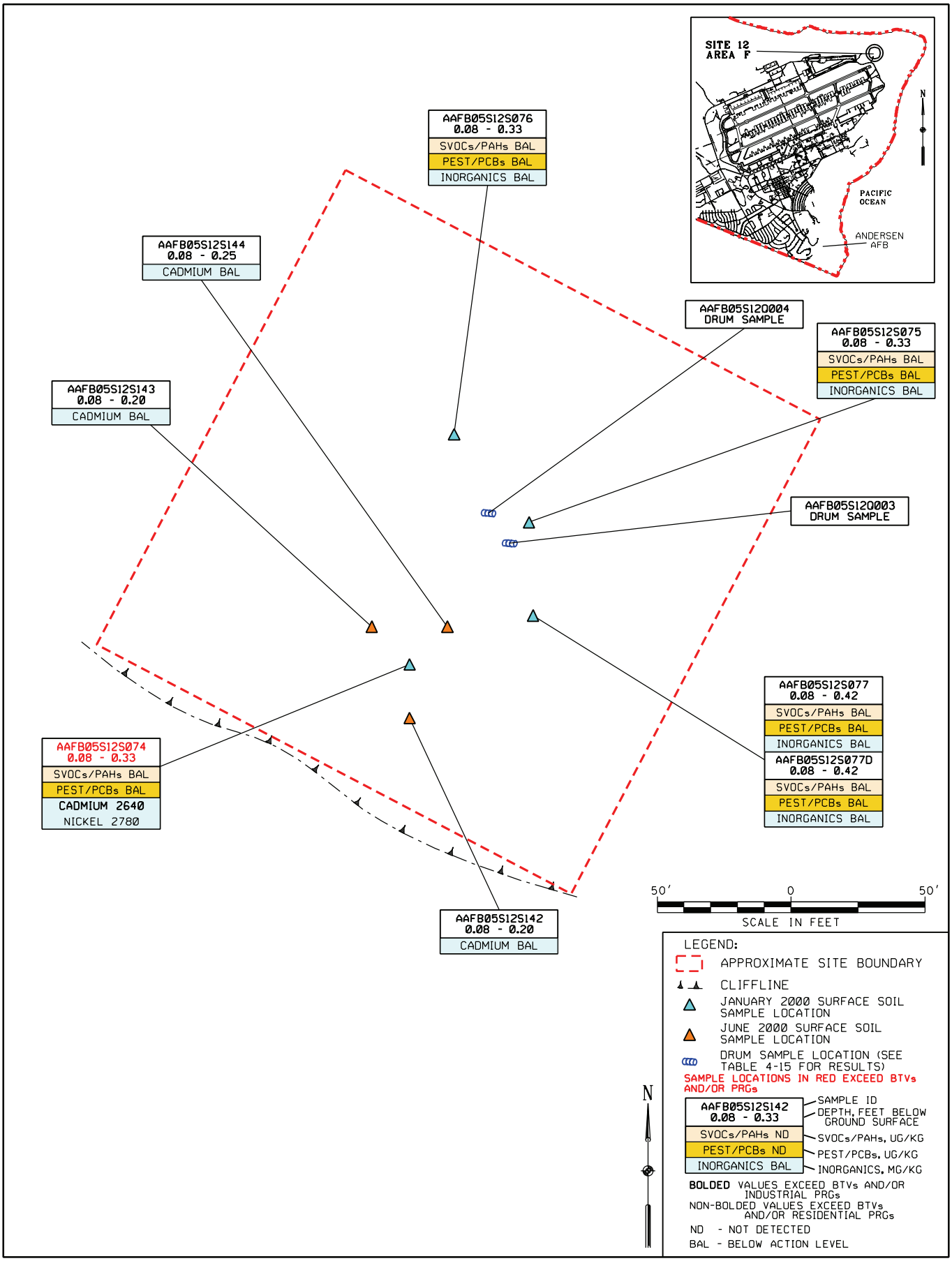
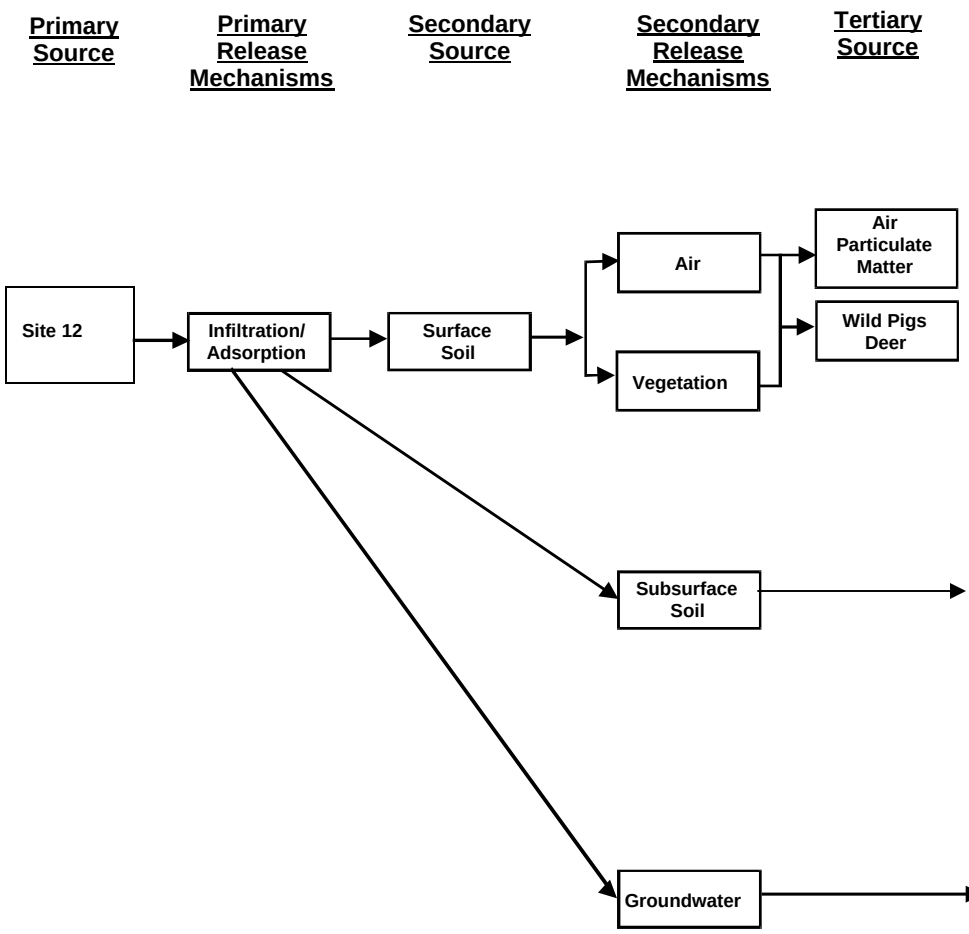


Figure 4-15. Surface Soil Sample Results at Area F of Site 12, Andersen AFB, Guam.



Specific Receptors of Concern

Potential Exposure Routes	Current Residents (Adults, Children)	Future Residents (Adults, Children)	Trespasser/ Occasional User/ Hunter
Soil Ingestion	X	X	X
Dermal Contact with Soils	X	X	X
Inhalation of Air Particulates	X	X	
Ingestion of Deer, Pig			X

Potential Exposure Routes	Future Residents (Adult and Children)	Current Construction/ Utility Worker	Future Construction/ Utility Worker
Soil Ingestion	X	X	X
Dermal Contact with Soil	X	X	X
Inhalation of Air Particulates	X	X	X

Figure 4-16. Human Health Risk Assessment Conceptual Site Model for Site 12, Andersen AFB, Guam.

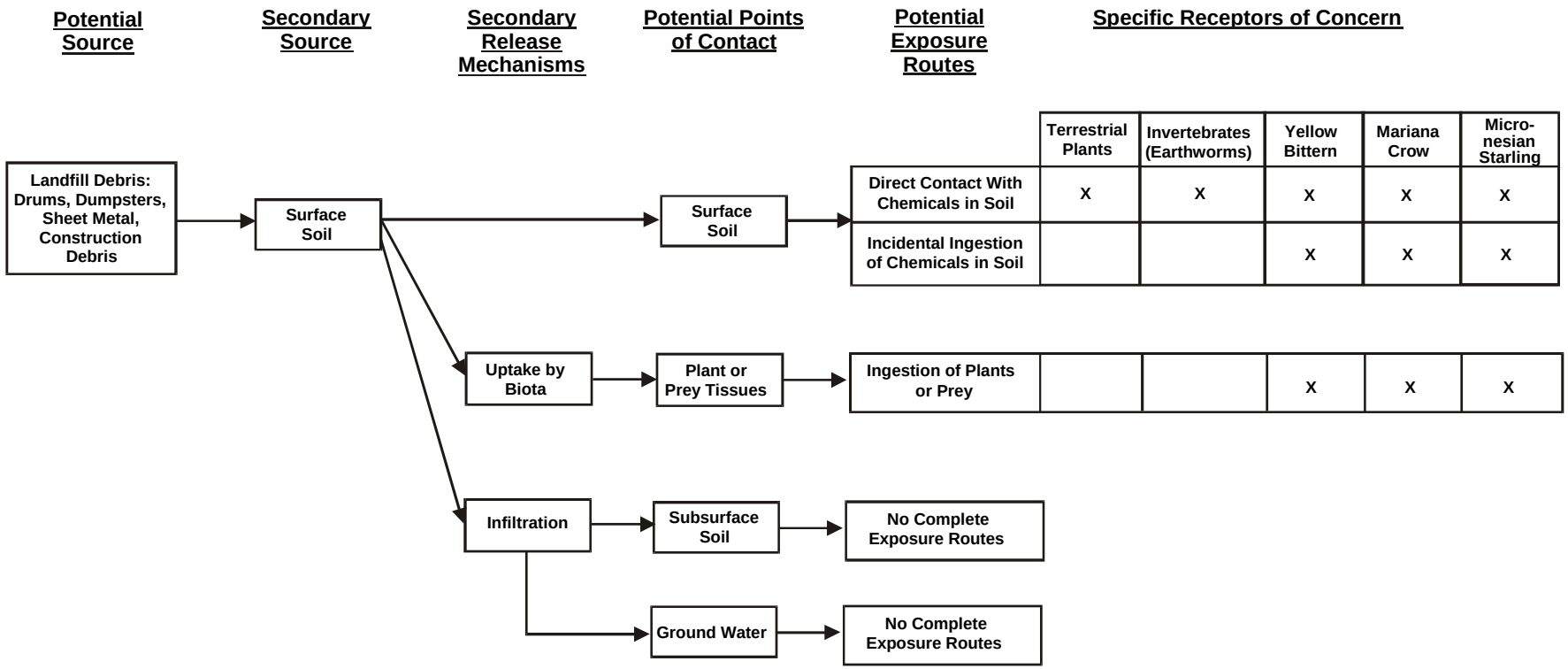


Figure 4-17. Ecological Risk Assessment Conceptual Site Model for Site 12, Andersen AFB, Guam.

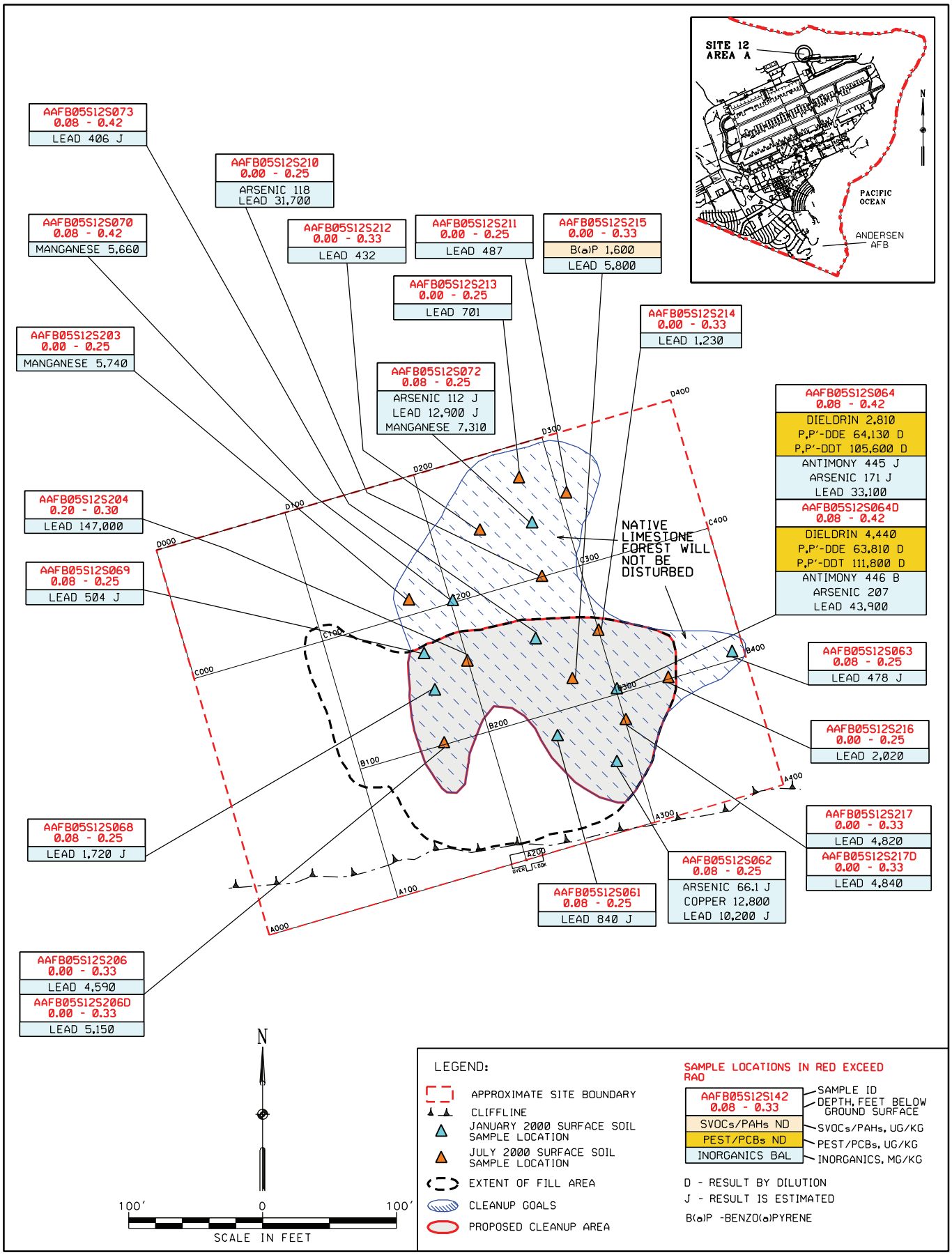


Figure 4-18. Proposed Cleanup Areas - Area A Surface Soil - Protective of Residential and Ecological Receptors, Site 12, Andersen AFB, Guam.

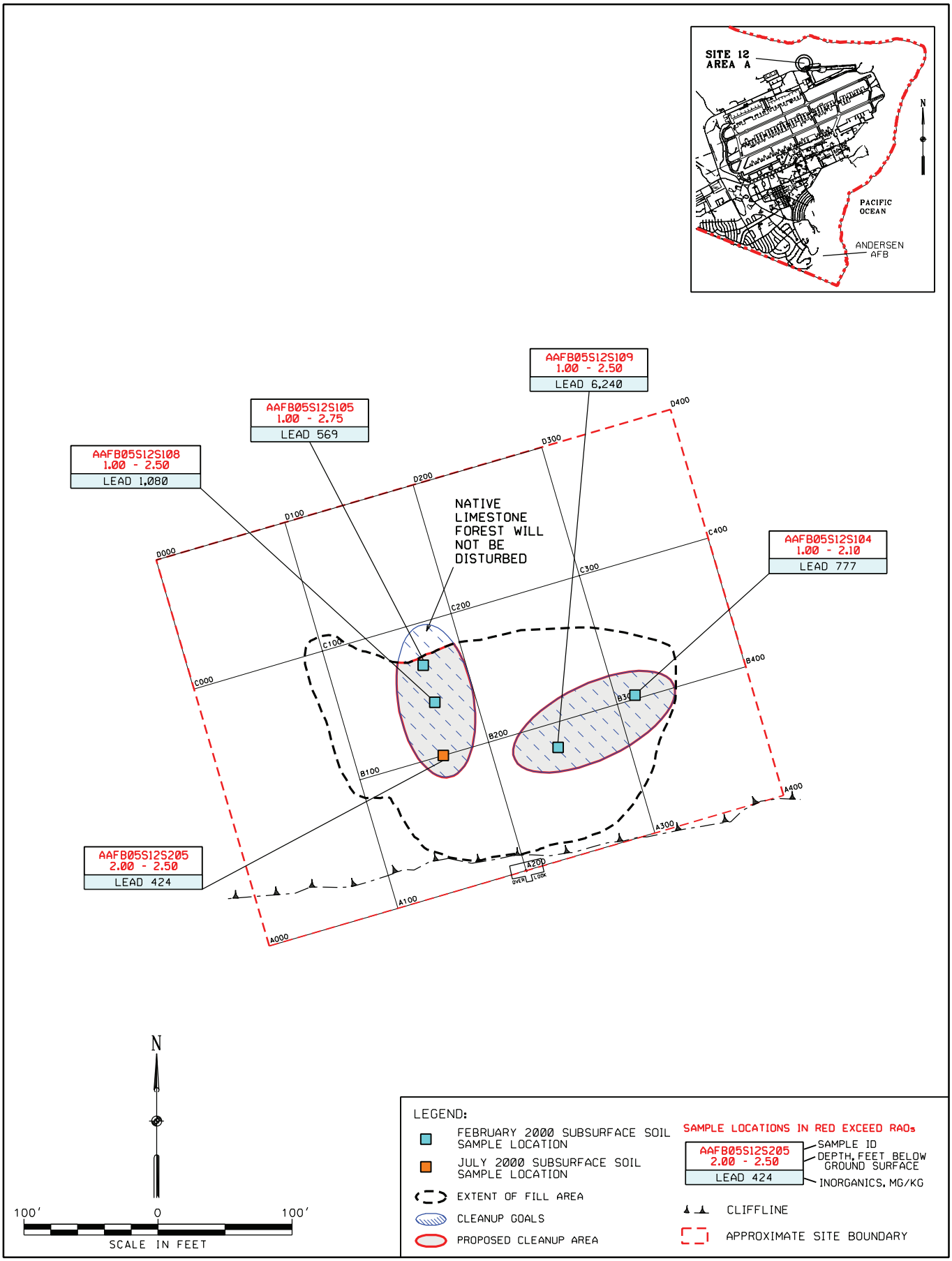


Figure 4-19. Proposed Cleanup Areas - Area A Subsurface Soil - Protective of Residential and Ecological Receptors, Site 12, Andersen AFB, Guam.

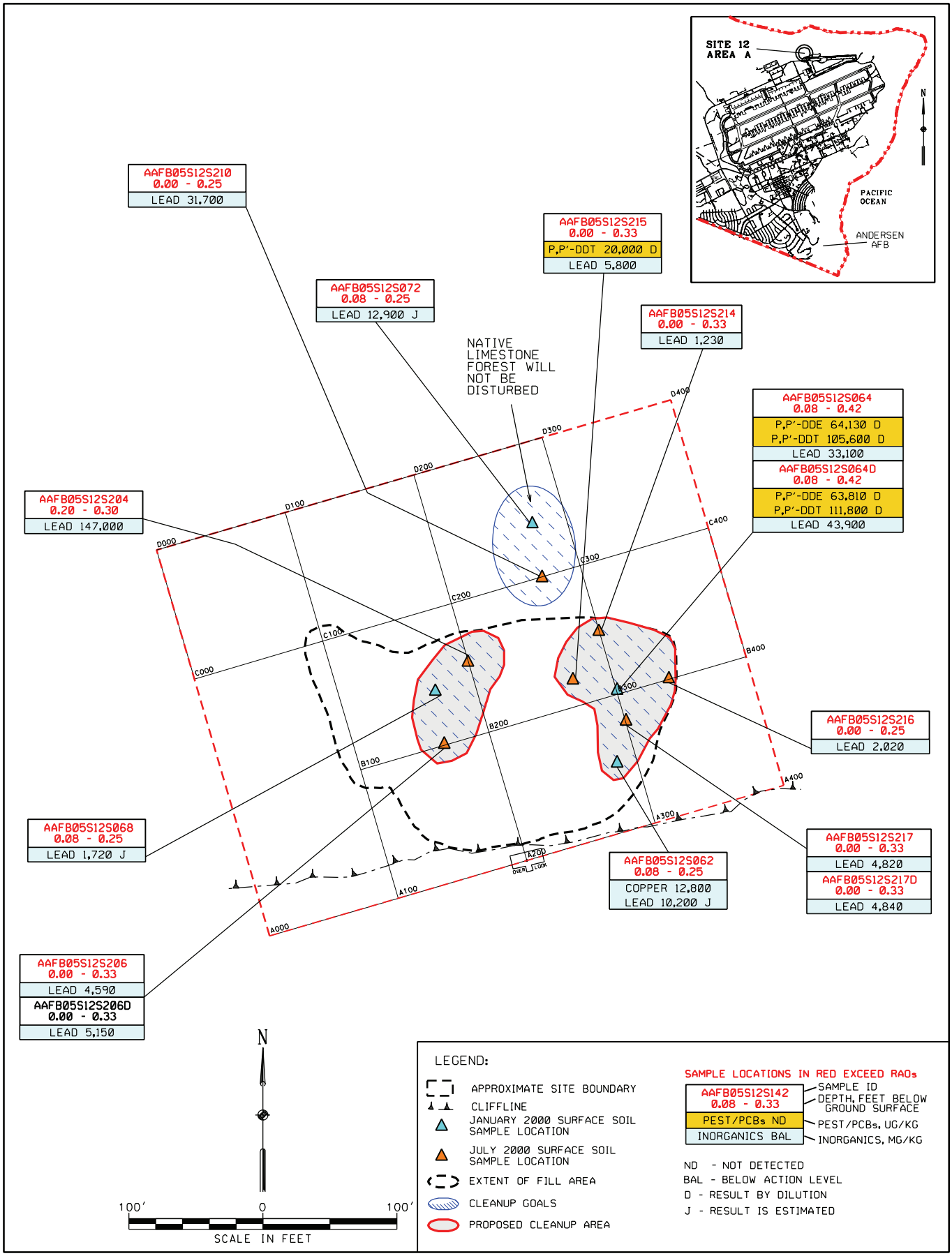
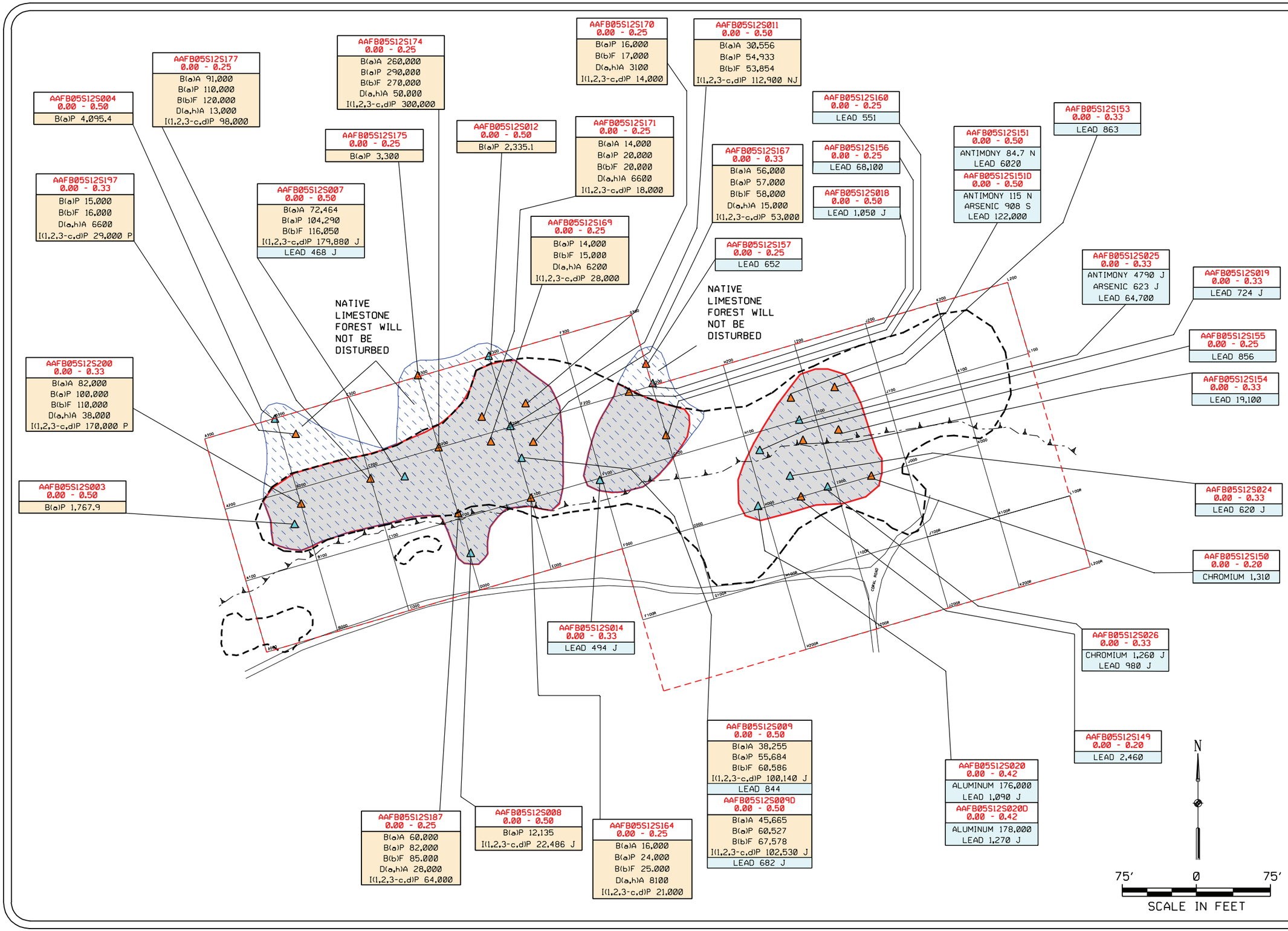
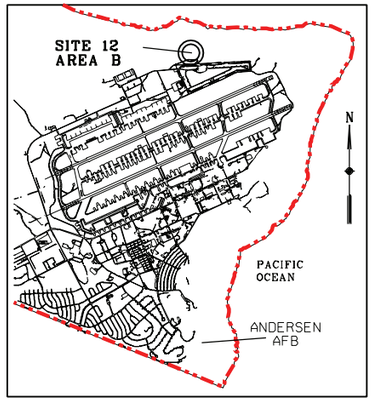


Figure 4-20. Proposed Cleanup Areas - Area A Surface Soil - Protective of Ecological Receptors, Site 12, Andersen AFB, Guam.





LEGEND:

- APPROXIMATE SITE BOUNDARY
- CLIFFLINE
- JULY 2000 SURFACE SOIL SAMPLE LOCATION
- DECEMBER 1999 SURFACE SOIL SAMPLE LOCATION
- EXTENT OF FILL AREA
- CLEANUP GOALS
- PROPOSED CLEANUP AREA

SAMPLE LOCATIONS IN RED EXCEED RAOs

AAFB05S12S090 1.00 - 1.25	SAMPLE ID; DEPTH, FEET BELOW GROUND SURFACE
SVOCs/PAHs BAL	SVOCs/PAHs, UG/KG
INORGANICS BAL	INORGANICS, MG/KG

B(a)A - BENZ(a)ANTHRACENE

B(a)P - BENZO(a)PYRENE

B(b)F - BENZO(b)FLOURANTHENE

D(a,h)A - DIBENZ(a,h)ANTHRACENE

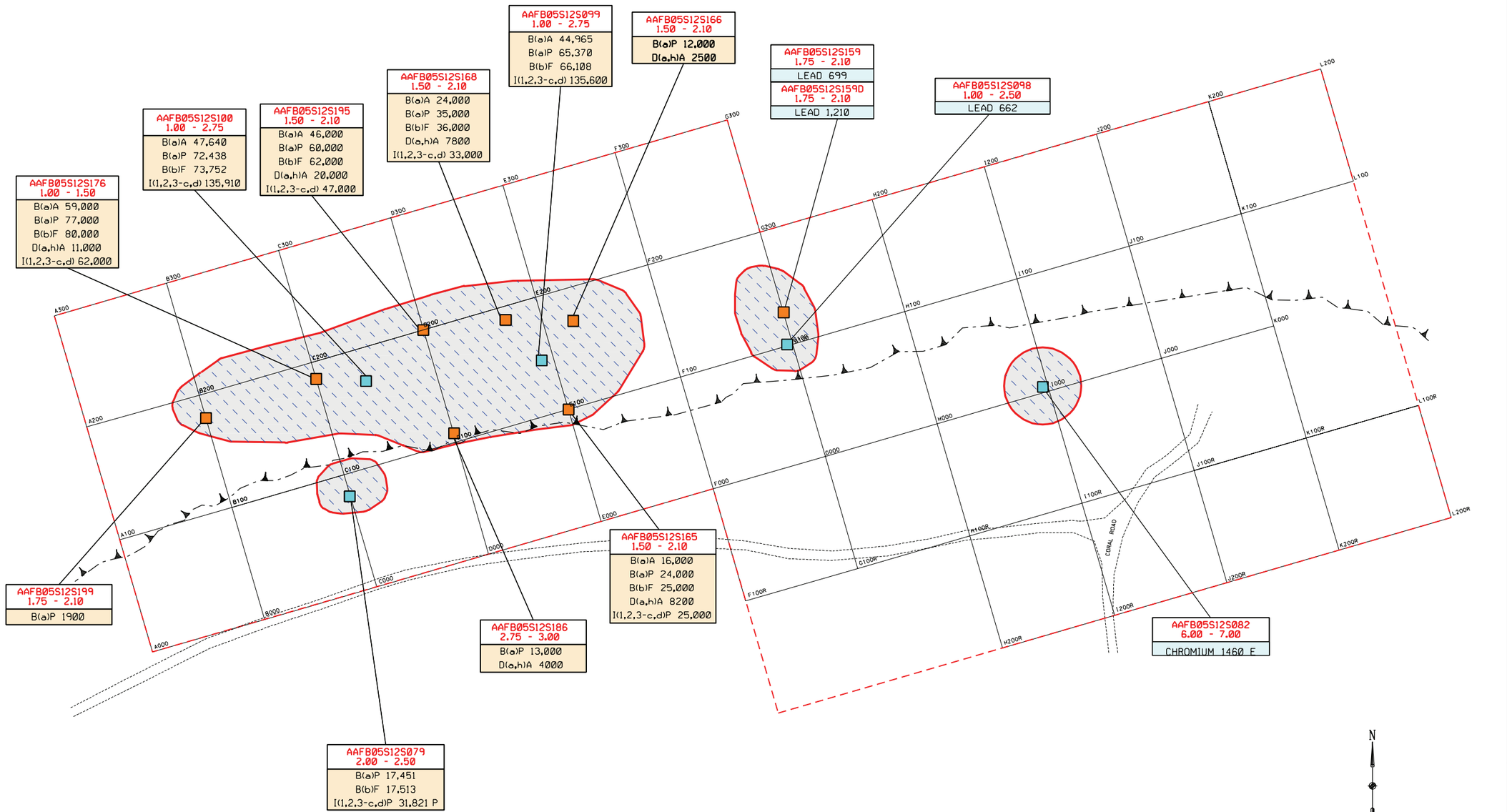
I(1,2,3-c,d)P - INDENO(1,2,3-c,d)PYRENE

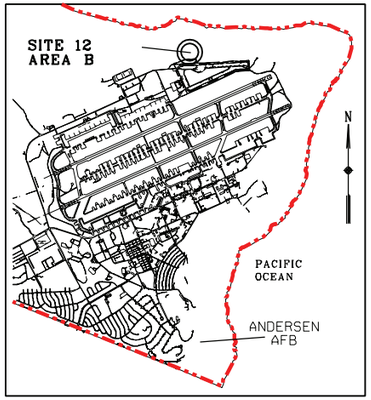
J - RESULT IS ESTIMATED

N - SPIKED SAMPLE RECOVERY IS NOT WITHIN CONTROL LIMITS

P - >25% DIFFERENCE FOR BOTH GC COLUMNS

Figure 4-21.
Proposed Cleanup Areas-
Area B Surface Soil-
Protective of Residential and
Ecological Receptors, Site 12,
Andersen AFB, Guam.





LEGEND:

- APPROXIMATE SITE BOUNDARY
- CLIFFLINE
- DRUM SAMPLE LOCATION (SEE TABLE 3-9 FOR RESULTS)
- DECEMBER 1999 SUBSURFACE SOIL SAMPLE LOCATION
- JULY 2000 SUBSURFACE SOIL SAMPLE LOCATION
- EXTENT OF FILL AREA
- CLEANUP GOALS
- PROPOSED CLEANUP AREA

SAMPLE LOCATIONS IN RED EXCEED RAOs

AAFB05S12S090 1.00 - 1.25	SAMPLE ID DEPTH, FEET BELOW GROUND SURFACE
SVOCs/PAHs BAL	SVOCs/PAHs, UG/KG
INORGANICS BAL	INORGANICS, MG/KG

B(a)A - BENZ(a)ANTHRACENE

B(a)P - BENZO(a)PYRENE

B(b)F - BENZO(b)FLOURANTHENE

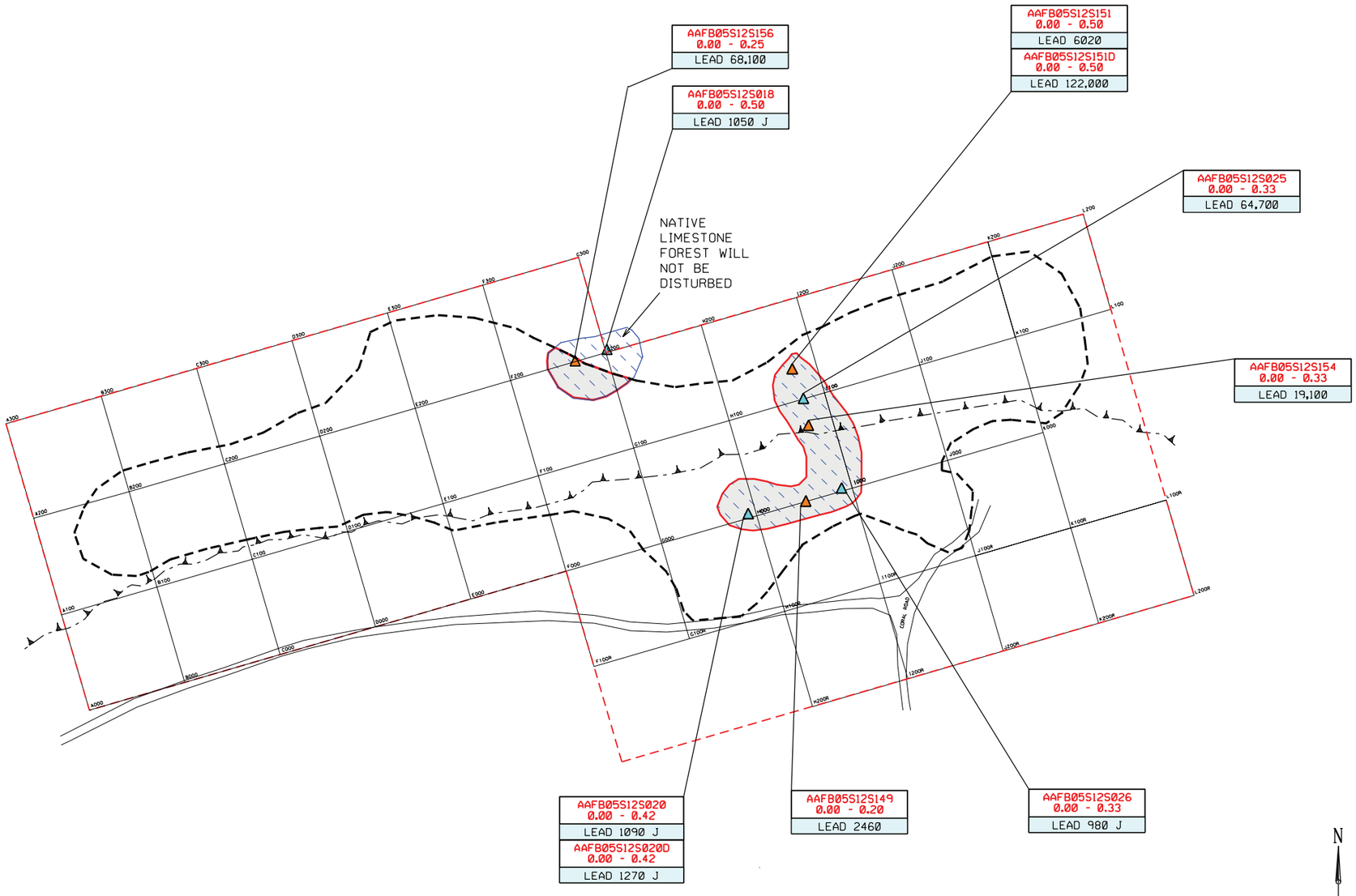
D(a,h)A - DIBENZ(a,h)ANTHRACENE

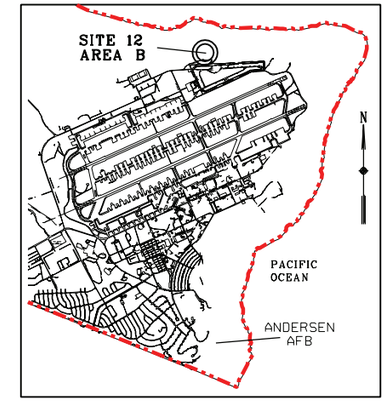
I(1,2,3-c,d)P - INDENO(1,2,3-c,d)PYRENE

E - RESULT ESTIMATED DUE TO INTERFERENCE

P - >25% DIFFERENCE FOR BOTH GC COLUMNS

Figure 4-22.
Proposed Cleanup Areas-
Area B Subsurface Soil-
Protective of Residential and
Ecological Receptors, Site 12,
Andersen AFB, Guam.





LEGEND:

- APPROXIMATE SITE BOUNDARY
- CLIFFLINE
- JULY 2000 SURFACE SOIL SAMPLE LOCATION
- DECEMBER 1999 SURFACE SOIL SAMPLE LOCATION
- EXTENT OF FILL AREA
- CLEANUP GOALS
- PROPOSED CLEANUP AREA

SAMPLE LOCATIONS IN RED EXCEED RAOs

AAFB05S12S090
1.00 - 1.25
INORGANICS BAL

SAMPLE ID
DEPTH, FEET BELOW GROUND SURFACE
INORGANICS, MG/KG

J - RESULT IS ESTIMATED

N

75′ 0 75′

SCALE IN FEET

Figure 4-23.
Proposed Cleanup Areas-
Area B Surface Soil-
Protective of
Ecological Receptors, Site 12,
Andersen AFB, Guam.

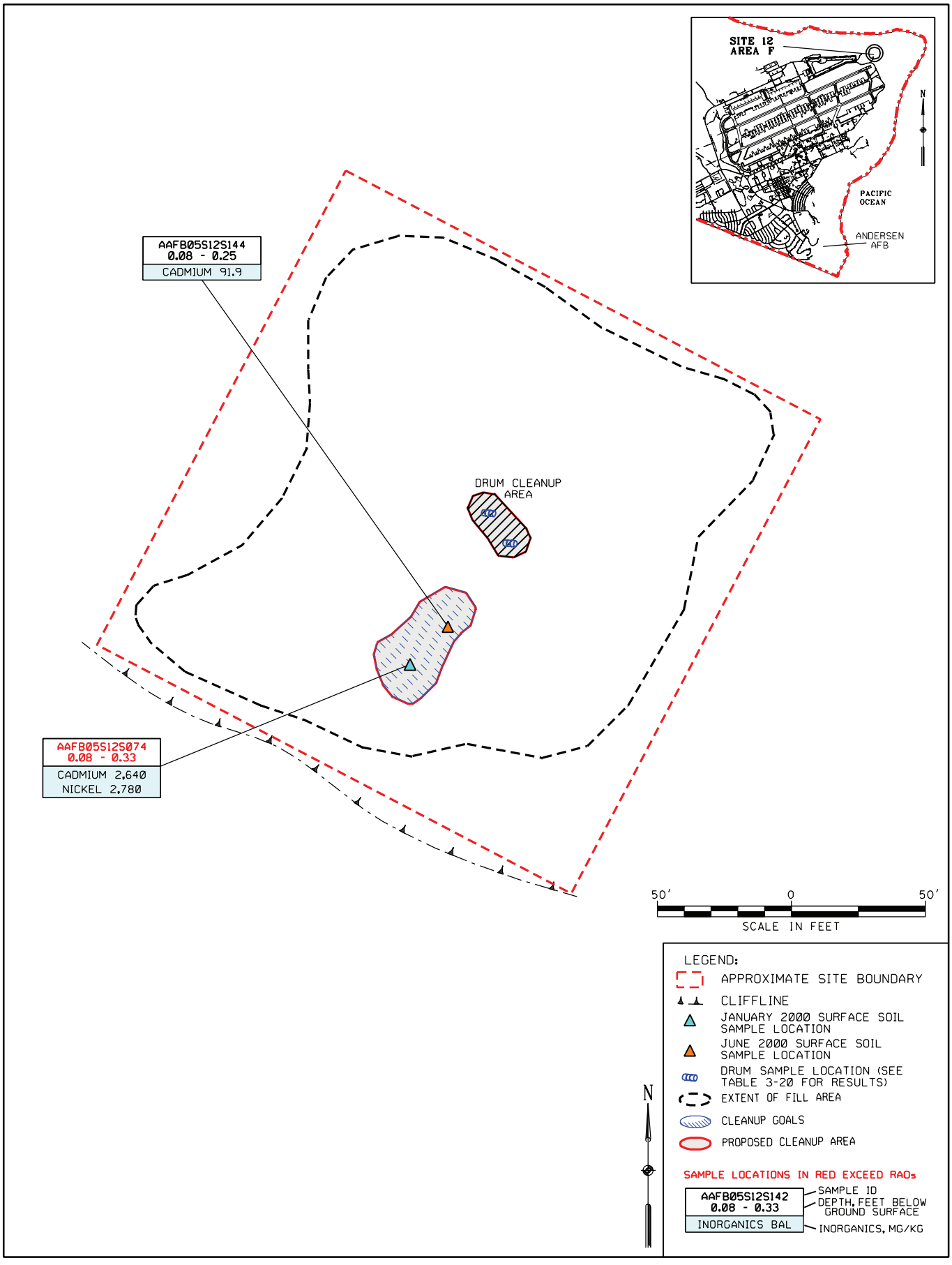


Figure 4-24. Proposed Cleanup Areas - Area F Surface Soil - Protective of Ecological Receptors, Site 12, Andersen AFB, Guam.

5. RESPONSIVENESS SUMMARY

In this section, a summary of public involvement and comments regarding Sites 6, 9, and 12 is presented.

In an effort to inform and involve the local community, the RAB was established in 1995 and includes community members, elected officials, Air Force officials, and representatives from regulatory agencies. The RAB serves as a major focal point for environmental exchange between Andersen AFB and the local community. Since 1995, the RAB has held regular quarterly meetings that are open to the public. During the RAB meetings, the progress of the environmental investigations at Andersen AFB's IRP sites is discussed.

The Proposed Plan for Sites 6, 9, and 12 was released to the public for review and comment in April 2006. Andersen AFB published a notice of availability for the Proposed Plan documents in Guam's *Pacific Daily News* from 2 through 4 April 2006. The notice also included the dates of the public comment period from 30 March to 29 April 2006. A public meeting was held in the Guam Holiday Inn on 6 April 2006 where the Proposed Plan for Sites 6, 9, and 12 was presented and representatives from USEPA, Guam EPA, and Andersen AFB responded to the public's questions regarding the Proposed Plan.

Upon completion of the public comment period, only one written question/comment was received from Senator Joanne M.S. Brown, are presented at the end of this section, followed by the USAF response. A transcript of the public meeting and the questions/comments and responses generated at the meeting are presented at the end of this section.

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DEPARTMENT OF THE AIR FORCE
HEADQUARTERS, 36TH WING (PACAF)
UNIT 14003, APO AP 96543-4003

MEMORANDUM FOR SEE DISTRIBUTION

FROM: 36 WG/CV

SUBJECT: Restoration Advisory Board (RAB) Meeting, 6 April 2006

1. Attached are the meeting minutes for the 6 April 2006 Andersen Air Force Base Restoration Advisory Board for your review. We also attached the RAB member distribution list for your information.

2. We look forward to a strong continued partnership with you. Should you have any questions, please contact Mr. Gregg Ikehara at 366-4692.

E-Signed by CV
VERIFY authenticity with ApproveIt

STEPHEN L. WOLBORSKY, Colonel, USAF
Installation Co-Chairperson, Restoration Advisory Board

Attachments:
1. RAB Minutes
2. Distribution List

ANDERSEN AIR FORCE BASE
RESTORATION ADVISORY BOARD (RAB)
MEETING MINUTES
06 April 2006

Board Members:

Colonel Wilfred Cassidy, 36 MSG/CC
Mr. Mike Gawel, RAB Member
Ms. Nadia Wood, RAB Member
Mr. Eddie Artero, RAB Member
Mr. Mark Ripperda, USEPA Region IX
Senator Joanne Brown, RAB Member
Mr. Paul Packbier, RAB Member
Ms. Lucrina Concepcion, RAB Member
Mr. Mike Cruz, GEPA

Support Staff Attendees:

Mr. Gregg Ikehara, 36 CES/CEVR
Mr. Jess Torres, 36 CES/CEVR
Mr. Danny Agar, 36 CES/CEVR
Ms. Yvette Bordallo, 36 CES/CEVR

Public Attendees:

Senator Larry Kasperbauer, Guam Legislature
Mr. Scott Whittaker, 36 CES/CEV
Mr. Pete LaPlaca, EA Engineering
Ms. Jennifer Haas, EA Engineering
Mr. Joel Lazzeri, EA Engineering
Mr. Bob Shamback, EA Engineering
Mr. Jim Rosacker, Booz, Allen-Hamilton
Mr. Chris Arnsfield, Shaw Group
Mr. Randel Sablan, GEPA
Mr. Jeff Hill, Public
Major Kristina Meyle, 36 CES/CEV
Mr. Chip Brown, EA Engineering
Mr. Bob Okoniewski, EA Engineering
Mr. Matt Casey, EA Engineering
Mr. Toraj Ghofrani, EA Engineering
Mr. Philip Guerrero, EA Engineering
Mr. Bob Hendrix, Shaw Group
Mr. Walter Leon Guerrero, GEPA
Ms. Sue Hill, 36 CES/CEVR

1. Introduction

Mr. Ikehara called the meeting to order at 6:50 pm and welcomed all attendees. He introduced Colonel Cassidy, 36 MSG/CC, who was sitting in for Colonel Wolborsky.

2. Previous Meeting Minutes

Mr. Ikehara asked the RAB members to take a few minutes and review the 20 October 2005 meeting minutes. With no discrepancies noted in the minutes, the minutes were approved.

3. Election of Community Co-Chair

Mr. Ikehara asked the RAB members for their nomination(s) for the Community Co-Chair position. Mr. Packbier and Mr. Gawel nominated Mr. John Jocson. ***Mr. Jocson was elected as the new***

Community Co-Chair.

4. IRP Website

Mr. Ikehara stated that decision documents, RAB, and RPM meeting minutes are available on-line via the **adminrec.com** website and will soon be available on the Andersen webpage, still under construction.

5. Status Binder

A status binder containing current projects and groundwater data was available for all members. The status binder will be updated and provided at each RAB meeting.

6. Proposed Plan for Sites 6, 9, and 12

Mr.Agar presented the Proposed Plan (PP) for cleaning up Main Base Sites 6, 9, and 12 all located on Andersen AFB. The sites are also known as Landfills 8, 13, and 17. A copy of the Proposed Plan was provided to each member. The PP contained additional technical details.

Mr. Agar provided a brief description of each site and results of the investigations. He discussed which cleanup methods were considered, and the rationale for the Air Force's preferred method. He emphasized that the Air Force considered the most conservative approach for screening cleanup alternatives (future residents).

An Engineering Evaluation/Cost Analysis or EE/CA document that evaluated cleanup options for these sites was completed during the "remedial investigation" phase from 2001-2003.

Site 6/Landfill 8 covers about 8 acres in the western portion of Andersen AFB, near the active Base Landfill Complex and the Munitions Storage Area (MSA). This site was used as an asphalt batch plant during the post-World War II construction of runways and roads. Landfill 8 was used as a trench-and-fill area to bury asphalt waste material and waste liquids from 1946 to 1949. This site is restricted from future residential use and is covered by the drums and spilled asphalt tar.

During the asphalt removal project, approximately 7,800 cubic yards of asphalt and asphalt-impacted soil, 2,000 empty drums, and other metal debris were removed. A remedial investigation was conducted in 2002. Testing conducted at the site found two metals present in the surface soil that would pose a risk to future residents (adults and children), at certain locations. The surface soil poses no risk to the occasional user/trespasser or wildlife. The testing also found three metals in the subsurface soil that would pose a risk to future residents (adults and children), at certain locations. The subsurface soil poses no risk to the occasional user/trespasser or wildlife.

33 cleanup alternatives were screened and 3 cleanup alternatives were evaluated in detail for Landfill 8. The Air Force selected "institutional controls," or restricting access, as its preferred alternative because the landfill is near the active Base Landfill Complex and MSA, making it almost impossible to convert the site to future residential use. The surface debris has mainly been cleared away; and there is no risk to occasional users/trespassers at the site. Since there is no risk to the occasional user/trespasser,

Institutional Control would not require fencing off the area, but signs will be posted warning against digging, which will require a permit. Landfill 8 will be included in Andersen's Land Use Control Management Plan. Approximately 5 CY of asphalt, drums containing asphalt, and drum remnants are recommended for removal from Site 6 as part of the surface preparation activities for the Institutional Control alternative.

Site 9/Landfill 13 covers about 4.5 acres near Andersen's South Runway. The site was used for disposal of sanitary trash, equipment, waste petroleum, oils, and lubricants (POL), and various unknown waste chemicals between 1951 and 1956. During the detailed site inventory, unexploded ordnance, (UXO) ordnance, and explosive waste (OEW) were observed, along with deteriorated metal, aircraft and motor vehicle parts, and miscellaneous construction debris.

Testing at the site found two metals present in the surface soil that would pose a risk to future residents (adults and children), at certain locations. There were no constituents found that would pose risks to the occasional user/trespasser or wildlife. Four metals were found in surface soil below the cliff that would pose a risk to future residents and three metals to wildlife. There were no constituents found that would pose risks to occasional user/trespasser.

Subsurface soil testing above the cliff found two metals that would pose a risk to future residents (adults and children), at certain locations. There were no constituents found that would pose risks to the occasional user/trespasser or wildlife in subsurface soil above the cliff. Three metals were found in subsurface soil below the cliff that would pose a risk to future residents (adults and children), and two metals that would pose a risk to wildlife. There were no constituents found that would pose risks to the occasional user/trespasser in subsurface soil below the cliff.

33 cleanup alternatives were screened and 4 cleanup alternatives were evaluated in detail for Landfill 13. The Air Force selected "institutional controls," or restricting access, below the cliff and removal/treatment of soil above the cliff as its preferred alternative because there is limited site access at Landfill 13 below the cliff and remedial activities will only be possible above the cliff. Institutional controls, such as signs warning against digging will be posted and any digging will require a work clearance permit below the cliff. Landfill 13 will be incorporated into Andersen's Land Use Control Management Plan.

Site 12/Landfill 17 covers about 20 acres along the cliff bordering Andersen's North Runway. It is subdivided into Areas A, B, C, D, E, and F (Pati Point Dump). The 1955 Base Master Plan indicated that trash and inorganic wastes with no salvage value were disposed of over the cliff.

Area A covers about 3 acres along the northern slope of the cliff line. During the detailed site inventory, it was estimated the fill area extends about 300 feet down the slope and about 200 feet along the cliff line. Construction debris and approximately 85 empty 55-gallon drums were observed over the cliff line. A number of constituents were found in surface soil that would pose a risk to future residents, occasional user/trespasser and wildlife. A few constituents were found in subsurface soil that would pose a risk to future residents and wildlife. There were no constituents found that would pose risks in subsurface soil for occasional user/trespasser. Approximately 1,120 CY of soil will be removed.

Area B covers about 9 acres with half of the site on the plateau above the cliff line and the other half along the cliff line slope. Many small mounds, 1 to 3 feet high, were observed on the plateau at the top of Area B. The mounds consisted of soil, pieces of metal, trash, fire hose, solid asphalt, and concrete debris. One large mound located along the plateau's edge was used as a target range backstop in the early 1960's. A number of constituents were found in surface soil that would pose a risk to future residents, occasional user/trespasser and wildlife. No constituents were found in the subsurface soil that would pose a risk to future residence, occasional user/trespasser or wildlife. Approximately 1,500 CY of soil will be removed.

Area C is a small area of less than 1 acre, below the cliff line. Small amounts of debris were located, including an aircraft propeller, plastic and fiberglass flooring tiles, a 3-gallon bucket, electrical wire, chain-link fence, 12-inch pipe, office chair, flashlights, twisted cable, oxygen tank, canvas material, barbed wire, plastic pieces, and rubber disks. Nothing of concern was found in the surface or subsurface soil that would pose a risk to future residents, occasional user/trespasser or wildlife.

Area D is less than 1 acre below the cliff line. This site contains small amounts of debris to include barbed wire, fence posts with concrete footings, an empty iodine bottle, telephone pole, metal brackets, cement blocks, galvanized pipe, electrical wire, construction debris, and sanitary trash. Nothing of concern was found in the surface or subsurface soil that would pose a risk to future residents, occasional user/trespasser or wildlife.

Area E is about 9 acres and is similar to Area B in appearance. Fill material extends about 400 feet down the slope and is about 400 feet wide. Areas of scattered debris were observed along the top of the cliff along with fill and buried trash, to an approximate depth of 9 feet. More than 80 drums were observed along the slope. Nothing of concern was found in the surface or subsurface soil that would pose a risk to future residents, occasional user/trespasser, or wildlife.

Area F is less than 1 acre and about 400 feet east of Area E at the base of a 170-foot vertical cliff. A large amount of debris is piled to an unknown depth at the base of the cliff. The material includes aircraft parts, 55-gallon drums, batteries, air conditioners, vehicle parts, bomb tail fins, fire extinguishers, refrigeration radiators, trailer with wheels, construction debris, and sanitary trash. Approximately four 55-gallon drums are partially filled with an unknown liquid. Two metals were found in surface soil that would pose a risk to future residents, and one metal that would pose a risk to wildlife. Nothing of concern was found in the surface soil that would pose a risk occasional user/trespasser. There were no available subsurface samples at area F to test. Approximately 130 CY of soil will be removed.

33 cleanup alternatives were screened and 4 were evaluated in detail for Landfill 17. The Institutional Control alternative would protect human health, but wildlife would still face a threat. The Soil Removal Protective of Residential and Ecological Receptors alternative would require high initial capital costs, but if the sites are closed there would be no associated long-term costs. The Air Force has selected "institutional controls," and soil removal protective of wildlife, as the preferred alternative because the landfill is near the active runway and adjacent to the Guam National Wildlife Overlay. There are no future plans to use the site for residential purpose and the area would be fenced. All future work conducted at the site would require a work clearance permit and approval by Andersen AFB Civil Engineer Squadron. The site will be incorporated in Andersen's Land Use Control Management Plan.

All comments will be addressed in the Record of Decision. The draft Record of Decision will be delivered to the regulators, Guam EPA and USEPA in May 2006. A final Record of Decision, with signatures from GEPA, USEPA, and Air Force is scheduled for December 2006. The cleanup is expected to begin in March 2007 and will take about one year to complete. Verbal and written comments will be accepted tonight. Written comments by mail will also be accepted and must be postmarked no later than 2 May 2006.

7. Public Comment

Ms. Concepcion asked what parameters were being tested for at each site. Mr. Agar stated that the parameters included analytes for Semi Volatile Organic Compounds, Volatile Organic Compounds and metals, which could also be found in the Proposed Plan handout that is available for review.

Senator Brown inquired on the impact to the surrounding areas upon soil removal. And, how will the AF address this issue. Mr. Ikehara responded; during the selection process the AF did consider going over the cliff and cleaning up the areas over the cliff line. The determination was made that the cleanup operation over the cliff could potentially destroy more of the habitat rather than it would enhance. Although there are a number of potential ecological receptors that could be impacted by soil, it has been there for years and the habitat has become healthy and vibrant. Material at the site can remain in-place and still be protective. The issue can be addressed in the future since the Record of Decision will be revisited every five-years to ensure it is still protective. *Senator Brown then asked if any studies on wildlife were conducted to determine what levels of contaminants exist.* Mr. Ikehara stated that in the 1990's, a tissue survey on different animal receptors was conducted. Although the survey was not for these areas, the AF did evaluate various animals that utilize those areas and potentially could have been affected by those areas. The AF found negligible impacts to those animals.

Mr. Lazzeri confirmed a study on animal tissue was conducted and the tissue survey report is available as part of the public record.

Senator Brown emphasized that more clarification when relaying technical information would be appreciated especially for areas where maximum cleanup will or will not be allowed so that there is a clearer understanding of what is to be done at those sites.

Major Meyle assured Senator Brown that the AF is very concerned about risks to wildlife. In addition, the AF will use more viable language for future RAB meetings and working the reports so they are easier to understand.

Colonel Cassidy concluded the meeting and urged the participants to submit their comments by the due date.

8. Next RAB Meeting

The meeting concluded at 8:00pm. The next RAB meeting is scheduled for 27 July 2006.

APPROVED/DISAPPROVED

_____ 7 May 06

WILFRED T. CASSIDY, Colonel, USAF DATE
Installation Representative, Restoration Advisory Board

4-27-06

Mr. Greg Ikehara
Remedial Project Manager
Environmental Flight, 36 CES/CEVR
Unit 14007
APO AP 96543-4007

Dear Mr. Ikehara:

In follow up to the April 6, 2006 Restoration Advisory Board meeting, I am providing written comments on the proposed plan for Sites #6, #9 and #12, Main Base Operable Unit for Anderson Air Force Base, Guam.

As I stated during the meeting, there is a need to further clarify the adverse impact on wildlife identified in the proposed plan. While the access of people can be restricted to these effected sites on base – thereby, limiting human exposure – the access and exposure to wildlife in their natural habitat is difficult to restrict. The proposed plan should include more information on any ongoing monitoring requirements and/or remediation that can be addressed to reduce adverse impact on plant and animal life at the identified sites where contaminants will not be fully removed.

The assessment of Site #9 indicates that the location is a proposed site for critical habitat for threatened and endangered species such as the Marianas Crow and the Marianas Fruit Bat. According to the report, the area below the cliff line provides a potential source of risk "from lead, copper and zinc." The report, however, does not provide an explanation on how the birds or plants would be affected by the contamination, or if any ongoing monitoring plan will be in place to address this concern.

In order to protect the existing habitat, the report indicates that no cleanup will occur below the cliff line. The report, however, also does not indicate if this site will be re-evaluated in the future or if ongoing monitoring of wildlife will be implemented since the contaminants in the soil will still exist. Additionally, the report does not provide any information on what effect the exposure to identified contaminants such as lead, copper, and zinc will have on the wildlife at Site #9.

In the case of Site #6 the report indicates that there would be a risk to "future" residents and no risk to occasional users, trespassers, or wildlife. The location of Site #6 to the current landfill operations would not make this a desirable location for future residential development. This site provides less of a concern as long as access is restricted.

In the case of Site #12 I am in support of the recommendation to remove contaminated soils from locations A, B, and F.

As a RAB community member I am always pleased when remediation can occur on contaminated sites to return them to safe and acceptable levels. However, when there are

evaluated constraints on identified sites where clean-up efforts cannot be fully attained, I prefer that more detailed information on both human and wildlife exposure be made available.

Thank you for the opportunity to comment on the proposed plan.

Sincerely,

JOANNE M.S. BROWN

Response by the USAF: Per Senator Brown's comments, the USAF provided additional information in the RI/FS regarding the impact of remaining lead-, copper-, and zinc-impacted soil on wildlife, along with more information regarding the implementation of *Institutional Control* at the area below the cliff line in the RI/FS for Site 9.

DISTRIBUTION LIST

Colonel Stephen L. Wolborsky
Senator Joanne M. Salas Brown
Senator Larry Kasperbauer
Mr. Randel Sablan
Ms. Carmen Sian-Denton
Mr. Edward C. Artero
Mr. John Jocson
Mr. Michael J. Gawel
Mr. Jerry Flores
Mr. Francis L.G. Damian
Ms. Lucrina Concepcion
Ms. Nadia Wood
Mr. Paul Packbier
Mr. Mark Ripperda
Mr. Michael Cruz

6. REGULATORY COMMENTS AND AIR FORCE RESPONSES

In this section of the ROD, all USEPA and Guam EPA comments are presented in tabular format along with the USAF responses. It should be noted that all reference figure, table, and section numbers in the comments refer to the June 2006 Agency Draft ROD. Some of these section and table numbers have been revised in this final August 2007 version of the ROD.

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Responses to Technical Review Comments
for
Record of Decision
for
Group 1
Main Base Operable Unit
ANDERSEN AIR FORCE BASE, GUAM
EA Engineering Science and Technology
April 2007

Item	Page	Section	Comments	Response to Comments
Comments provided by Mark Ripperda on 28 February 2007				
1	General Comment		Add MEC/OEW to the Summary of Site Risks for Sites 9 and 12b, add a remedial action objective, and add all appropriate ARARs (the Munitions Rule under RCRA is one example that is missing). While the cleanup may be handled separately outside of CERCLA, MEC/OEW does pose a risk to potential site users and must be described in the ROD. The ROD must contain some language asserting that MEC/OEW will be remediated and how it will be remediated.	The RI/FS for Sites 6, 9, and 12 was finalized in June 2006. Since then the term OEW has been universally replaced with MEC. In order to maintain consistent terminology with the RI, the term OEW was retained in the ROD. Descriptions of the potential risks posed by UXO and discussion regarding remediation have been added to Statutory Determinations and the Summary of Site Risk for Site 9. The following has been added to Section 1.5, Statutory Determination, as the last paragraph: OEW and UXO present at Site 9 are being addressed under the Military Munitions Response Program (MMRP) being conducted at Andersen AFB. Clean-up activities conducted under the MMRP at Site 9 will comply with Federal and Territorial statutory requirements. Periodic review of Site 9 may be necessary to ensure that engineering or institutional controls remain intact and functional at the site until such a time that UXO are cleared from the area and no longer pose a potential threat. For Site 9, the following has been added to Section 3.7, Summary of Site Risks, as the last paragraph: The UXO present at Site 9 pose a potential threat to human health. The cleanup of UXO at Site 9 is being addressed under the MMRP being conducted at Andersen AFB. Periodic review of Site 9 may be necessary to ensure that engineering or institutional controls remain intact and functional at the site until such a time that UXO are cleared

Item	Page	Section	Comments	Response to Comments
				from the area and no longer pose a potential threat. Under Remedial Action Objectives in Section 3.8 (for Site 9) the following sentence was paragraph was added at the end of the section: Site 9 has been included in the MMRP list of sites at Andersen AFB. RAOs to address the mitigation of potential chemical and physical hazards related to UXO will be developed as part of future MMRP response actions and will be suitable for the intended reuse at the completion of the remedial action. All response actions involving UXO will be protective of human health and the environment and will comply with ARARs.
2	1-3	1.4.1	Fencing is an engineering control, not an institution control. Please remove the third and fourth sentences, starting with "Generally, institutional controls…".	Comment acknowledged. The applicable sentences have been deleted from chapters 1 and 2.
3	2-40	2.13.3	The table reference should be 2-26 and 2-27.	The table numbers have been revised to reflect the updated table numbers (Tables 2-13 and 12 after tables identified in Comments 8 through 10 were deleted).
4	3-32	3.10.2	The table reference should be 3-32 and 3-33.	The table numbers have been revised to reflect the updated table numbers (Tables 3-17 and 3-18 after tables identified in Comments 8 through 10 were deleted).
5	3-33	3.10.2	There are no specific IC ARARs and PRGs are TBCs, not ARARs. Please replace the "comply with the institutional ARAR" with simply "comply with the ARARs". Please replace the last paragraph with: "The No Action alternative would not violate any ARARs, but it also would not meet the risk based remediation goals".	The fourth paragraph has been revised as follows: The *Institutional Controls* alternative would comply with the ARARs, but the COC-impacted surface and subsurface soils exceeding RGs would remain at the site. The last paragraph has been replaced with the following: The *No Action* alternative would not violate any ARARs, but it also would not meet the risk-based RGs.

Item	Page	Section	Comments	Response to Comments
6	Table 4-43		This table is in a different format than the other cleanup standard tables. Please make it similar to Table 3-27, for example, by listing the PRGs and footnoting the constituents whose cleanup standards are higher. A justification must be provided in the text for all cleanup goals above BTV and 10-6.	Tables 4-22 through 4-24 (formerly 4-43 through 4-45) have been revised to include the residential and industrial PRGs. The following text has been added to Section 4.10, Remedial Action Objectives, prior to the RGs: The 10^{-6} RGs presented in the RI/FS are based on the very unlikely future residential use of Site 12. This is a very conservative approach because Site 12 and adjacent areas are not currently used for residential purposes due to the steep terrain, the proximity to active runways, and the presence of the Guam National Wildlife Overlay (below the cliffline). In addition, future land use plans for Site 12 exclude residential reuse. However, as a conservative approach to potential remedial options at the site, baseline cleanup values were derived for potential future residents at the site. Risk-based cleanup values were derived for future residents to correspond to a non-cancer HI = 1.0. Risk-based cleanup values were derived for carcinogens, which correspond to three levels of potential cancer risk (10^{-6}, 10^{-5}, and 10^{-4}). These values correlate to three distinct cancer risk values, which are included in USEPA's "acceptable risk range" of 10^{-6} to 10^{-4}. The decision as to which risk level is appropriate for cleanup is a site-specific risk management decision. Future site use was considered in developing RGs during the RI/FS process. The bulleted lists of RAOs in Section 4.10 have been revised to include the basis for the RG (BTV, PRG, etc.).
7	Appendices		Remove Appendices A–C.	Appendices A through C have been removed.
8	Tables		Please remove Tables 2-1, 2-2 (and similar tables for other sites). Add the PRGs and BTV values to Tables 2-5 and 2-6, etc.	The PRGs and BTVs have been added to Tables 2-5 and 2-6, and Tables 2-1, 2-2, and 2-3 have been deleted. Comparable revisions/deletions have been made to Chapters 3 and 4 as well.
9	Tables		Remove Tables 2-7, 2-8, 2-11, 2-12 and the similar tables for the other sites.	Tables 2-7, 2-8, 2-11, and 2-12 have been deleted from the report. Comparable revisions/deletions have been made to Chapters 3 and 4 as well.
10	Tables		Delete Tables 2-15, 2-16, 2-17, 2-18, and 2-19. The pertinent results are shown in table 2-21. Same comment applied to other chapters.	Tables 2-15, 2-16, 2-17, 2-18, and 2-19 have been deleted from the report. Comparable revisions/deletions have been made to Chapters 3 and 4 as well.

Item	Page	Section	Comments	Response to Comments
11	General		Remove the definition of lognormal mean from sections 2.7.2.2, 3.7.2.2, etc.	The definition of the lognormal mean has been deleted from Chapters 2, 3, and 4.
12	General		Remove all references to Region 3 RBCs.	Region 3 RBCs have been removed from the TBCs for Sites 6, 9, and 12.
Comments provided by Mark Ripperda on 16 March 2007 in an email to EA				
1	General		In general, a ROD should never assert that MEC/UXO is outside of or exempt from CERCLA. We would rather have silence on this issue than such a statement. Thankfully, you did not make such an assertion in this ROD.	See response to comment No. 1 above.
2	General		Add a Remedial Action Objective for MEC/UXO. This can be general, something like: All known MEC/UXO will be removed prior to mobilization for the chemical contaminant field work. Any MEC/UXO encountered during field work will be handled and disposed of in an appropriate manner. The site will be suitable for the intended reuse at the completion of the remedial action with respect to MEC/UXO. All actions involving MEC/UXO will be protective of human health and the environment and will comply with ARARs.	See response to comment No. 1 above.
3	General		Add the Military Munitions Rule to the table of potential ARARs. This is found in 40 CFR 266.203, 205 and 206. Provide an analysis of whether or not this is an Action Specific ARAR for this action.	The Military Munitions Rule has been added to the Action Specific ARARs for Site 9 (Tables 3-17 and 3-18). On Table 3-18 under the Remedial Action Alternatives heading the following description has been added: *No Action*: The substantive requirements of this regulation would not be met. *Institutional Controls:* Probability of exposure to physical hazards would be reduced. If institutional controls are not implemented effectively, probability of exposure to physical hazards may increase. The substantive requirements of this regulation would not be met. *Soil Cover*: Probability of exposure to physical hazards would be minimized.

Item	Page	Section	Comments	Response to Comments
				Intrusive work on site (digging, drilling) would pose risk of exposure to physical hazards. The substantive requirements of this regulation would not be met *Soil Treatment Above the Cliffline and Institutional Controls Below the Cliffline*: Since OEW/UXO were not identified above the cliff-line this regulation does not apply. Below the cliff line, physical risks associated with OEW/UXO will be mitigated through the implementation of ICs, including land use and engineering controls until OEW/UXO are addressed under MMRP. The substantive requirements of this ARAR would be met.
4	General		Possibly add 40 CFR 264 Subpart X, the Misc. Units as an ARAR if any waste will be blown in place. If all MEC/UXO will be removed for disposal or destruction, than this doesn't apply.	This requirement was not included in the ARARs table since MMRP will address the specific methods for addressing the UXO present at the site. At this time, evaluation of appropriate response for UXO has not been determined.
Comments provided by Mark Ripperda on 11 May 2007 in an email to EA				
1	General		The RTC does not address any OEW issues at sites 12B or 12F. The text in the ROD mentions OEW in several sections for both of these sites. If these sites are known to have just spent bullets at 12B and tail fins at 12F, then make that clear and remove any mention of OEW for both sites. If either site may contain OEW, then they must be handled similar to Site 9.	Comment acknowledged. Text has been revised as follows: Section 4.5.2.1.3, Suspected Contamination Sources of Area B, last sentence: OEW material identified during test ditch excavations included expended 30-and 50-caliber shell casings; therefore, OEW on site do not pose a physical hazard to human and ecological receptors. Section 4.5.5.1.3, Suspected Contamination Sources of Area E: Two separate pieces of OEW (expended incendiary bomblets) were observed in two of the test ditches; these OEW do not pose a physical hazard to human and ecological receptors. In Section 4.11., Description of Alternatives, text referring to "reducing the safety risks associated with the UXO and OEW" has been deleted from the following sentence: "Many of these were eliminated from further consideration because they were not feasible for the physical and chemical properties of the Site 12 COCs and/or the unique environmental setting of Site 12." In Section 4.12.1, Overall Protection of Human Health and the

Item	Page	Section	Comments	Response to Comments
				Environment, text related to "minimizing risk of exposure to the OE materials" has been deleted from the following sentence: "By excavating and removing the COC-impacted soil, the source would be removed and the exposure pathways identified in the risk assessment, direct dermal contact, incidental ingestion of soil and inhalation of soil particulates, would be controlled for both human and ecological receptors."
2	General		For Site 9, please add OEW to the LUC appendix. Also, please make it clear in the discussions for Site 9 if the OEW is above or below the cliff-line. From the Figure, it looks like it is only below the cliff-line, but the icons are small and not always easy to differentiate. If there is any OEW above the cliff-line, then describe how that will impact the soil removal and any requirements for short-term ICs. If it is only below the cliff-line, then it is just another reason for the LUCs already proposed.	OEW is present at Site 9 below the cliffline. The ROD has been revised for clarification as follows: Section 1.5, Statutory Determination, first sentence of the first paragraph: "It should be noted that the ordnance and explosive waste (OEW) and UXO present at Site 9 (below the cliffline) pose a potential threat to human health by way of detonation." Section 3.5.4, Suspected Contamination Sources at Site 9, first paragraph: "Due to the presence of UXO and OEW, cell A-1+00, which is located below the cliffline, was not surveyed in detail because of personnel safety issues." Section 3.5.4, Suspected Contamination Sources at Site 9, last paragraph: "Several items of UXO/OEW were observed on site, below the cliffline." Section 3.7, Summary of Site Risks, second paragraph: The OEW/UXO present below the cliffline at Site 9 does pose a potential threat to human health. The Site 9 LUCs have been revised to include the following text after the list of COCs: "Additionally, OEW/UXO were identified in the DSI which pose potential physical hazards to humans including occasional users/trespassers that may access this site. Physical and chemical hazards associated with OEW/UXO at this site are being addressed under the Andersen AFB MMRP. ICs planned for the area below the cliff line to address risks to human health posed by COCs listed above are also protective of the risks posed by MEC/UXO until the appropriate response is determined as part of the MMRP."

Item	Page	Section	Comments	Response to Comments
				The following was added as the third item in the list of LUC Objectives Below the Cliffline: "Control access to the site to mitigate potential physical hazards associated with OEW/UXO." In the "Dig and Construction Permits" paragraph, text has been revised as well: "If intrusive activities are conducted within the designated LUC area, the work would require an approved health and safety plan and procedures for the proper handling and disposal of displaced wastes, OEW/UXO, and/or soils." In the Engineering Controls section, the verbiage for the warning sign has been revised: **WARNING-RESTRICTED AREA- IRP SITE 9** **Ordnance and potentially harmful substances in the soil below cliff** **Access or invasive activities without prior permission is prohibited** **Contact Base Civil Engineer Squadron at Ext – 4692** In addition, the following sentence has been added at the end of the O&M Activities discussion: "Modifications to LUCs resulting from activities associated with the removal of OEW/UXO under the MMRP will also be reviewed as part of the Five-Year ROD Review."
3	General		The RTC states that Site 9 has been added to the MMRP program. However, it is not included in my Draft Final Phase 1 Comprehensive Site Evaluation for the MMRP program. While the proposed text changes to the ROD are OK, please make it clear in the RTC how Site 9 is being added to the MMRP program.	Andersen Air Force Base has recently identified Site 9 for the MMRP. The base will conduct the prioritization (Munitions Response Site Prioritization Protocol) and add it to the MMRP site inventory."

Item	Page	Section	Comments	Response to Comments
Comments provided by Mark Ripperda on 13 June 2007 in an email to Gregg Ikehara				
1			We would like a little more clarification of the MEC issue. Please add a sentence in the appropriate locations in this ROD that explicitly states that MEC will be addressed in a separate FS and ROD, and that any ICs in this ROD that may relate to MEC are not intended to act as a final remedy for MEC.	The following paragraph has been added at the end of paragraph 3, Section 1.4.2, page 1-4 of the ROD: "Site 9 has been added to the list of Andersen AFB sites being addressed under the Air Force's Military Munitions Response Program (MMRP). OEW/UXO response actions performed under the MMRP will resemble a response action under CERCLA and will include an FS and ROD specifically addressing the MEC at Site 9. ICs proposed as part of the response action under the IRP, presented as part if this ROD, are not intended as the final remedy for MEC at Site 9." The following paragraph has been added at the end of paragraph 5, Table A-2, page A-7 of the ROD: "OEW/UXO response actions performed under the MMRP will resemble a response action under the IRP and will follow the CERCLA process."
Comments provided by Mark Ripperda on 5 July 2007 in an email to Gregg Ikehara				
1			The key language we're having an issue with is that the MMRP response will be a CERCLA action, not resemble a CERCLA action. Thus, please change the responses to: Section 1.4.2: "Site 9 has been added to the list of Andersen AFB sites being addressed under the Air Force's Military Munitions Response Program (MMRP). MEC response actions performed under the MMRP will be performed under CERCLA and will include an FS and ROD specifically addressing the MEC at Site 9. ICs proposed as part of the response action under the IRP, presented as part of this ROD, are not intended as the final remedy for MEC at Site 9". Please also note the underlined 'of' replacing 'if' in the first response.	The following text has been added to the last paragraph of Section 1.4.2: "Site 9 has been added to the list of Andersen AFB sites being addressed under the Air Force's Military Munitions Response Program (MMRP). OEW/UXO response actions performed under the MMRP will be performed under CERCLA and will include an FS and ROD specifically addressing the OEW/UXO at Site 9. ICs proposed as part of the response action under the IRP, presented as part of this ROD, are not intended as the final remedy for OEW/UXO at Site 9."

Item	Page	Section	Comments	Response to Comments
2			Table A-2: "MEC response actions performed under the MMRP will follow the CERCLA process".	The following text has been added to Table A-2: "OEW and UXO response actions performed under the MMRP will follow the process of the Comprehensive Environmental Response, Compensation, and Liability Act, and will include a Feasibility Study and ROD specifically addressing the OEW and UXO at Site 9."
			Note that your responses intermixed MEC and OEW/UXO. Please just pick one and stick with it throughout the document. Since MEC is the more current term, no need to use OEW/UXO just because that was used in the RI.	Comment acknowledged. The terms OEW and UXO have been retained throughout the document as a matter of consistency.

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APPENDIX A

LAND USE CONTROLS (LUCs) FOR SITES 6, 9, AND 12

APPENDIX A. LAND USE CONTROLS (LUCs) FOR SITES 6, 9, AND 12

In support of the remedies selected for the Record of Decision (ROD) for Sites 6, 9, and 12, the United States Air Force (USAF) will implement the following actions to ensure that current and future land use activities remain compatible with the land use restrictions that are imposed by the ROD, and that they remain protective of human health and the environment. The following tables (A-1 through A-3) provide a summary of each of the sites with respect to the following: (1) site risks relevant to the selected remedy, (2) a description of the property including current and anticipated future property ownership, land use, and restrictions, (3) a description of onsite structures, (4) a description of LUC objectives, (5) a list of the engineering and institutional controls (ICs) and other specific measures that are required to implement LUCs consistent with the selected remedy, and (6) specific corrective actions to address non-compliant LUC events.

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TABLE A-1 SUMMARY TABLE FOR IDENTIFYING LAND USE CONTROL (LUC) OBJECTIVES AND IMPLEMENTING LUCs AT SITE 6, ANDERSEN AFB, GUAM

Risk Summary: Site conditions pose no unacceptable risks to ecological receptors or to occasional users/trespassers. Portions of the site pose potential unacceptable cancer and non-cancer risks to resident adults and children exposed to surface and subsurface soil.

Contaminants of Concern (COCs): Surface soil – aluminum and chromium
Subsurface soil – aluminum, antimony, and chromium

Selected Remedy: Institutional Controls (ICs)

LUC Objectives: The selected remedy does not include the removal of any contaminated soil. This will result in contaminated surface and subsurface soil remaining onsite at concentrations that could pose potential unacceptable risks to future resident adults and children. The residual concentrations would not pose unacceptable risks to ecological receptors or occasional users/trespassers and other human receptors that are exposed to site soils on an infrequent basis. As such the LUCs shall:

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1. Control direct human (resident adults and children) exposure to contaminated surface and surface soils within the area defined in Figure A-1.
2. Prevent the future development and/or use of the designated property and vicinity for residential housing, elementary and secondary schools, child care facilities and playgrounds, or any other activities that would result in children being exposed to the soils at the site.

Property Ownership: The site is owned by the USAF and is located within the Main Base portion of Andersen Air Force Base (AFB), Guam.

Site Constraints: Site access is limited to persons with access to the Main Base. The site is located within an industrial area of the Base that is not generally accessed. In addition the site is restricted from future residential development due to it's proximity to the active Base Sanitary Landfill (BSL) and the Munitions Storage Area (MSA). There is no fencing or other engineering controls currently at the site and none would be required as there are no risks to occasional users/trespassers or ecological receptors. The land will be restricted from future residential development through implementation of LUCs that will be amended into the Base General Plan (BGP) within sixty (60) days of ROD approval. The USAF will amend the BGP with one of the following sections: (1) a new section entitled "Prohibited and Permitted Uses at Environmental Restoration Sites or (2) text to an existing section of the BGP that addresses LUC restrictions at Andersen AFB. This section shall state that residential use and certain types of industrial/recreational development such as elementary and secondary schools, child care facilities, playgrounds, medical facilities, or similar activities are prohibited. The USAF will utilize its BGP as an administrative LUC to prevent uses that are inconsistent with the approved ROD.

Area Subject to Controls: 4.6 acres. The area subject to the LUCs (Figure A-1) is presently uncontrolled and does not require any engineering controls such as fencing. However the corners defining the "restricted" LUC area should be clearly marked with appropriate signage. Recommended verbiage for the signage is provided in the Engineering Controls section of this table.

Current Onsite Structures/Facilities: There is a radio antennae, with associated cables, currently located near the center of the site. However there are no other permanent surface or underground structures/cables/pipelines located within the designated LUC area.

Future Land Use Restrictions: The designated LUC area is restricted from residential use as long as the site conditions are not suitable for unrestricted use and unlimited exposure. In addition the site is appropriate for "restricted" industrial use; however, no permanent facilities or structures should be constructed within the designated LUC area that would present a potential exposure pathway for child receptors (i.e. prohibit the development and use of property for elementary and secondary schools, childcare facilities, recreational facilities, or playgrounds, at or near the site).

LUCs

Prepare and Maintain a Land Use Management Control Plan (LUMCP): The USAF will prepare and maintain a LUCMP specific to the designated LUC area at Site 6 that will serve as the operational "road map" for defining, implementing, and reporting on LUCs at Site 6. The LUCMP will be maintained at the Base Civil Engineer Squadron (CES) to assure that activities within the designated LUC area are implemented in accordance with the remedy selected in the approved ROD. The LUCMP will include: (1) a prohibition on the redevelopment of Site 6 (specifically prohibition of residential use or use that would result in exposures to children) without prior approvals from the USEPA and Guam EPA; (2) limitations and controls on future intrusive activities at the site (e.g., worker requirements, soil management, waste disposal); and (3) a requirement that intrusive activities receive prior approval by the Andersen AFB CES and be documented in the LUCMP. The LUCMP will include protocols for: (1) daily management of the LUCMP process, (2) annual inspections of the site to ensure compliance with the LUCs; (3) specification of annual LUC-compliance reporting requirements; (4) property lease or transfer (note: currently, there are no plans for property lease or transfer); and (5) notification process and relevant corrective actions for LUC non-compliant events. While monitoring/implementing the LUCs at Site 6 activities that are inconsistent with the LUC objectives or designated land use restrictions will be addressed by the USAF as soon as practicable. The USEPA and Guam EPA will be notified of significant inconsistencies or deficiencies within fifteen (15) days after the USAF becomes aware of the situation, at which time the USAF will provide appropriate recommendations for corrective actions. The LUCMP will be reviewed annually to assure that land use restrictions and controls are maintained as per the remedy selected in the ROD. The annual LUCMP monitoring reports will summarize (1) monitoring activities performed in the prior year; (2) notable deficiencies or inconsistencies in maintaining the LUCs; (3) corrective actions taken; and (4) effectiveness of the corrective actions. The annual LUCMP monitoring reports will be used in preparation of the Five-Year Review to evaluate the effectiveness of the remedy. The LUCs will remain in effect indefinitely

as long as COCs in surface and subsurface soil remain at concentrations that prevent unrestricted use and unlimited exposure.

Lease or Transfer of Property: The site is located on the active portion of the Main Base and there are no plans for the USAF to lease or transfer the property. The BGP will be amended to identify the designated LUC area as restricted from future lease or transfer without the prior knowledge and concurrence of the USAF, USEPA and Guam EPA. In the event the USAF may later transfer these procedural responsibilities to another party by contract, property transfer agreement, or through other means, the USAF shall retain ultimate responsibility for remedy integrity. The USAF will provide notice to USEPA and Guam EPA at least six (6) months prior to any transfer or sale of Site 6 so that USEPA and Guam EPA can be involved in discussions to ensure that appropriate provisions are included in the transfer terms or conveyance documents to maintain effective ICs. If it is not possible for the facility to notify USEPA and Guam EPA at least six months prior to any transfer or sale, then the facility will notify USEPA and Guam EPA as soon as possible but no later than 60 days prior to the transfer or sale of any property subject to ICs. In addition to the land transfer notice and discussion provisions above, the USAF further agrees to provide USEPA and Guam EPA with similar notice, within the same time frames, as to federal-to-federal transfer of property. The USAF shall provide a copy of executed deed or transfer assembly to EPA and Guam EPA.

Dig and Construction Permits: In general, no intrusive activities shall occur within the designated LUC area at Site 6. All dig and construction permits relevant to Site 6 will be documented in the LUCMP for Site 6. If intrusive activities are necessary within the designated LUC area they would require prior approval of the Base CES. If intrusive activities are conducted within the designated LUC area, the work would require an approved health and safety plan and procedures for the proper handling and disposal of displaced wastes and/or soils. This requirement shall be subject to an annual review and will remain in effect indefinitely as long as COCs in surface and subsurface soil remain at concentrations that prevent unrestricted use and unlimited exposure.

The Base General Plan (BGP): The BGP will be amended within sixty (60) days of ROD approval to identify the designated LUC area(s) as restricted from transfer/lease and residential development indefinitely as long as site conditions are not suitable for unrestricted use and unlimited exposure. Air Force Instruction (AFI) 32-7062 (*Air Force Comprehensive Planning*) requires that installations develop and maintain a BGP as a central repository for information deemed essential for planning and managing the installation's physical assets, including environmental planning constraints such the LUCs. AFI 32-1021 (*Planning and Programming Military Construction Projects*) requires installations to comply with their BGP to ensure that there are no conflicts with land-use constraints stemming from the LUCs of the Environmental Restoration Program (ERP) that would impact facility planning and construction. Any requests for residential use or invasive activities (i.e. construction) through excavation permits, such as AF Form 103, or the construction review process, as per AFI 32-1001 (*Operations Management*), will be denied, unless the procedures for proposed land use changes described in the approved ROD, and amended to the BGP, are followed. The LUCs amended to the BGP will be monitored, maintained, and reported on through existing land-use management programs, such as the Base Civil Engineering (BCE) Work Clearance Form (AF Form 103) (*Digging*

Permit) and the construction review process (AFI 32-1001). No construction or digging will be permitted without prior approval by the BCE in the form of an approved work clearance (dig permit) or other approvals as required by applicable AFI. The BCE will not approve dig permits for activities inconsistent with the LUCs as amended to the BGP and no changes in the type of land use designated in the ROD shall be implemented within the designated LUC area without the prior knowledge and concurrence of the USAF, USEPA and Guam EPA. These procedures involve a minimum of sixty (60) day notice to USEPA and Guam EPA. These requirements shall be reviewed annually as part of the LUCMP and once every five years as part of the Five-Year ROD Review process. These requirements shall remain in effect indefinitely as long as COCs in surface and subsurface soil remain at concentrations that prevent unrestricted use and unlimited exposure.

Engineering Controls

Survey and Mark LUC Boundaries and Post Signage: The site will require an initial survey to locate and install permanent markers to mark the corners of the designated LUC area (Figure A-1). Warning signs shall be posted along the periphery of the designated LUC area that clearly identify the designated LUC area, specify that no access or digging activities shall be conducted without prior consultation with the CES, and note the potential for health risks related to exposure to the soils. This requirement shall be performed within 120 days after approval of the ROD, and shall be monitored annually as part of the O&M activities described herein. Recommended verbiage for a warning sign for Site 6 is provided below:

WARNING-RESTRICTED AREA- IRP SITE 6
Potentially harmful substances in the soil
Access or invasive activities without prior permission is prohibited
Contact Base Civil Engineer Squadron at Ext - 4692

Fencing: As described in the above text, fencing of the designated LUC area will not be required.

Operations and Maintenance (O&M) Activities: O&M activities will include an annual site inspection/review to: (1) determine that boundary markers and signage are intact, (2) determine that no unapproved structures have been constructed or intrusive activities have been performed, and (3) ensure that the LUCMP is properly maintained and all activities relevant to the designated LUC area (i.e. proper documentation of digging permits, etc.) are properly documented. There are no O&M requirements relevant to maintaining a specific type of vegetative cover. This inspection/review requirement shall be performed on an annual basis, reviewed as part of the Five-Year ROD Review, and remain in effect indefinitely as long as COCs in surface and subsurface soil remain at concentrations that prevent unrestricted use and unlimited exposure.

TABLE A-2 SUMMARY TABLE FOR IDENTIFYING LUC OBJECTIVES AND IMPLEMENTING LUCs AT SITE 9, ANDERSEN AFB, GUAM

Risk Summary: Site 9 is bisected by a cliffline which separates the site into two distinct areas: above the cliffline and below the cliffline. These two areas have unique habitats, land use, and contaminants that required the establishment of separate remedial action objectives (RAOs) for each.

Risks Above the Cliffline: Based on the human health risk assessment (HHRA) conducted above the cliffline there were unacceptable risks to resident adults and children; however, the risks to occasional users/trespassers were within the acceptable risk range. Based on the ecological risk assessment (ERA) conducted above the cliffline lead concentrations could pose a potential risk to the Mariana crow. However, the habitat above the cliffline is not suitable for the Mariana crow. In addition any cleanup of lead-contaminated soil above the cliffline that is protective of residential or industrial receptors would also reduce risks to the Mariana crow into the acceptable range.

Risks Below the Cliffline: Based on the results of the HHRA and ERA conducted below the cliffline there are potential unacceptable risks to future human (resident adults and children) receptors and ecological (Mariana crow and yellow bittern) receptors. The risks posed to occasional users/trespassers were within the acceptable risk range. However, due to the presence of native limestone forest habitat below the cliffline a cleanup protective of human and/or ecological receptors is not recommended. The physical stressors related to implementing a cleanup action below the cliffline would potentially have a greater negative impact than benefit on the habitat. Mobilizing the necessary equipment to the base of the cliffline would require clearing (destruction) of a large area of limestone forest and cleanup activities would disrupt the existing wildlife habitat and the process would destroy more habitat than it would preserve.

COCs: Surface Soil Above the Cliffline – antimony, lead, and benzo(a)pyrene
Subsurface Soil Above the Cliffline – lead
Surface Soil Below the Cliffline – chromium, lead, and benzo(a)pyrene
Subsurface Soil Below the Cliffline – antimony, copper, and lead

Additionally, ordnance and explosive waste (OEW)/unexploded ordnance (UXO) were identified in the detailed site inventory; the OEW/UXO pose potential physical hazards to humans, including occasional users/trespassers that may access this site. Site 9 has been added to the list of Andersen AFB sites being addressed under the Air Force's Military Munitions Response Program (MMRP). OEW and UXO response actions performed under the MMRP will follow the process of the Comprehensive Environmental Response, Compensation, and Liability Act, and will include a Feasibility Study and ROD specifically addressing the OEW and UXO at Site 9. ICs proposed as part of the response action under the IRP, presented as part of the ROD, are not intended as the final remedy for OEW and UXO at Site 9.

Selected Remedy Above the Cliffline: Soil Removal with Treatment (No ICs)
Selected Remedy Below the Cliffline: ICs

LUC Objectives Above the Cliffline: The selected remedy includes soil removal above the cliffline that would be protective of potential future resident adults and children and would reduce COCs to concentrations that would allow for unrestricted land use and unlimited exposures. As such, no LUCs would be required above the cliffline.

LUC Objectives Below the Cliffline: The selected remedy does not include the removal of any contaminated soil below the cliffline. This will result in contaminated surface and subsurface soil remaining onsite at concentrations that could pose potential unacceptable risks to future resident adults and children, as well as ecological receptors. However, the contaminant concentrations would not pose unacceptable risks to occasional users/trespassers and other human receptors that are exposed to site soils on an infrequent basis. As such, ICs shall be required to control direct exposure to contaminated surface and subsurface soil and to eliminate exposure pathways to future resident adults and children. The ICs shall include LUCs and engineering controls. The area designated for LUCs at Site 9 is provided in Figure A-2. As such the LUCs shall:

1. Control direct human (resident adults and children) exposure to contaminated surface and surface soils within the area defined in Figure A-2.
2. Prevent the future development and/or use of the designated area below the cliffline and vicinity for residential housing, elementary and secondary schools, child care facilities and playgrounds, or any other activities that would result in children being exposed to the soils at the site.
3. Control access to the site to mitigate potential physical hazards associated with OEW/UXO.

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Property Ownership: The site is owned by the USAF and is located within the Main Base portion of Andersen AFB, Guam.

Site Constraints: Site access is limited to persons with access to the Main Base. The site is located within a relatively remote area that is not generally accessed. The portion of the site above the cliffline has no imposed land restrictions; however, the portion of the site below the cliffline is restricted from future residential development due to terrain and the presence of native limestone habitat which is being proposed as wildlife sanctuary. There is no fencing or other engineering controls currently at the site and none are required above the cliffline if the soil removal alternative is implemented. The land located below the cliffline shall be restricted from future residential development through implementation of LUCs that will be amended into the BGP within sixty (60) days of ROD approval. The USAF will amend the BGP with one of the following sections: (1) a new section entitled “Prohibited and Permitted Uses at Environmental Restoration Sites or (2) text to an existing section of the BGP that addresses LUC restrictions at Andersen AFB. This section shall state that residential use and certain types of industrial/recreational development such as elementary and secondary schools, child care facilities, playgrounds, medical facilities, or similar activities are prohibited. The USAF will utilize its BGP as an administrative LUC to prevent uses that are inconsistent with the approved ROD.

Area Subject to Controls: 3.7 acres. The area subject to LUCs (Figure A-2) is located entirely below the cliffline and is presently uncontrolled though access is severely limited by the presence of the cliffline. A chain link fence needs to be constructed at access points along the top of the cliffline to restrict access to the designated LUC areas below. In addition, areas at the top of the cliffline that provide access to below the cliffline shall be clearly marked with appropriate signage defining the "restricted" LUC area. As there are no unacceptable risks posed to occasional users/trespassers that would be exposed to contaminated soils below the cliffline, posting signage below the cliffline would only serve to destroy habitat and not provide much resultant benefit. Recommended verbiage for the signage is provided in the Engineering Controls section of this table.

Current Onsite Structures/Facilities: There are no surface or underground structures/cables/pipelines within the designated LUC area.

Future Land Use Restrictions: The designated LUC area is restricted from residential use as long as the site conditions are not suitable for unrestricted use and unlimited exposure. In addition, the presence of the native limestone habitat below the cliffline makes the designated LUC area unsuitable for any kind of land development, construction, or regular use that would impact the habitat. As such, the LUCs would specifically restrict recreational, industrial, and commercial development below the cliffline in addition to residential development.

LUCs

Prepare and Maintain a Land Use Management Control Plan (LUMCP): The USAF shall prepare and maintain a LUCMP specific to the designated LUC area at Site 9 that will serve as the operational "road map" for defining, implementing, and reporting on LUCs at Site 9. The LUCMP will be maintained at the Base CES to assure that activities within the designated LUC area are being implemented in accordance with the remedy selected in the approved ROD. The LUCMP will include: (1) a prohibition on the redevelopment of the below the cliffline portion of Site 9 (specifically prohibition of residential use or use that would result in exposures to children) without prior approvals from the USEPA and Guam EPA; (2) limitations and controls on future intrusive activities at the designated LUC area (e.g., worker requirements, soil management, waste disposal); and (3) a requirement that intrusive activities below the cliffline receive prior approval by the Andersen AFB CES and be documented in the LUCMP. The LUCMP shall include protocols for: (1) daily management of the LUCMP process, (2) annual inspections of the site to ensure compliance with the LUCs; (3) specification of annual LUC-compliance reporting requirements; (4) property lease or transfer (note: currently, there are no plans for property lease or transfer); and (5) notification process and relevant corrective actions for LUC non-compliant events. While monitoring/implementing the LUCs at Site 9 activities that are inconsistent with the LUC objectives or designated land use restrictions shall be addressed by the USAF as soon as practicable. The USEPA and Guam EPA shall be notified of significant inconsistencies or deficiencies within fifteen (15) days after the USAF becomes aware of the situation at which time the USAF shall provide appropriate recommendations for corrective actions. The LUCMP shall be reviewed annually to assure that land use restrictions and controls are maintained as per the remedy selected in the ROD. The annual LUCMP monitoring reports will summarize (1) monitoring activities performed in the prior year,

(2) notable deficiencies or inconsistencies in maintaining the LUCs, (3) corrective actions taken, and (4) effectiveness of the corrective actions. The annual LUCMP monitoring reports will be used in preparation of the Five-Year Review to evaluate the effectiveness of the remedy. The LUCs will remain in effect indefinitely as long as COCs in surface and subsurface soil remain at concentrations that prevent unrestricted use and unlimited exposure.

Lease or Transfer of Property: The site is located on the active Main Base and there are no current plans for the USAF to lease or transfer the property. The BGP will be amended to identify the designated LUC area as restricted from future lease or transfer without the prior knowledge and concurrence of the USAF, USEPA and Guam EPA. In the event the USAF may later transfer these procedural responsibilities to another party by contract, property transfer agreement, or through other means, the USAF shall retain ultimate responsibility for remedy integrity. The USAF will provide notice to USEPA and Guam EPA at least six (6) months prior to any transfer or sale of Site 9 so that USEPA and Guam EPA can be involved in discussions to ensure that appropriate provisions are included in the transfer terms or conveyance documents to maintain effective ICs. If it is not possible for the facility to notify USEPA and Guam EPA at least six months prior to any transfer or sale, then the facility will notify USEPA and Guam EPA as soon as possible but no later than 60 days prior to the transfer or sale of any property subject to ICs. In addition to the land transfer notice and discussion provisions above, the USAF further agrees to provide USEPA and Guam EPA with similar notice, within the same time frames, as to federal-to-federal transfer of property. The USAF shall provide a copy of executed deed or transfer assembly to EPA and Guam EPA.

Dig and Construction Permits: In general, no intrusive activities shall occur within the designated LUC area at Site 9. All dig and construction permits relevant to Site 9 will be documented in the LUCMP for Site 9. If intrusive activities are necessary within the designated LUC area they would require prior approval of the Base CES. If intrusive activities are conducted within the designated LUC area, the work would require an approved health and safety plan and procedures for the proper handling and disposal of displaced wastes, OEW/UXO, and/or soils. This requirement shall be subject to an annual review and will remain in effect indefinitely as long as COCs in surface and subsurface soil remain at concentrations that prevent unrestricted use and unlimited exposure.

The BGP: The BGP will be amended within sixty (60) days of ROD approval to identify the designated LUC area(s) as restricted from transfer/lease and residential development indefinitely as long as site conditions are not suitable for unrestricted use and unlimited exposure. AFI 32-7062 (*Air Force Comprehensive Planning*) requires that installations develop and maintain a BGP as a central repository for information deemed essential for planning and managing the installation's physical assets, including environmental planning constraints such the LUCs. AFI 32-1021 (*Planning and Programming Military Construction Projects*) requires installations to comply with their BGP to ensure that there are no conflicts with land-use constraints stemming from the LUCs of the ERP that would impact facility planning and construction. Any requests for residential use or invasive activities (i.e. construction) through excavation permits, such as AF Form 103, or the construction review process, as per AFI 32-1001 (*Operations Management*), will be denied, unless the procedures for proposed land use changes described in the approved ROD, and amended to the BGP, are followed. The LUCs

amended to the BGP will be monitored, maintained, and reported on through existing land-use management programs, such as the BCE Work Clearance Form (AF Form 103) (*Digging Permit*) and the construction review process (AFI 32-1001). No construction or digging will be permitted without prior approval by the BCE in the form of an approved work clearance (dig permit) or other approvals as required by applicable AFI. The BCE will not approve dig permits for activities inconsistent with the LUCs as amended to the BGP and no changes in the type of land use designated in the ROD shall be implemented within the designated LUC area without the prior knowledge and concurrence of the USAF, USEPA and Guam EPA. These procedures involve a minimum of sixty (60) day notice to USEPA and Guam EPA. These requirements shall be reviewed annually as part of the LUCMP and once every five years as part of the Five-Year ROD Review process. These requirements shall remain in effect indefinitely as long as COCs in surface and subsurface soil remain at concentrations that prevent unrestricted use and unlimited exposure.

Engineering Controls

Survey and Mark LUC Boundaries and Post Signage: The site will require an initial survey to locate and install permanent markers to mark the designated corners of the designated LUC area (Figure A-2). Warning signs shall be posted along the top of the cliff at points of entry. The signs shall clearly identify the designated LUC area below, specify that no access or digging activities shall be permitted without prior consultation with the CES, and note the potential for health risks related to exposure to the soils. This requirement shall be performed within 120 days after approval of the ROD, and shall be monitored annually as part of the O&M activities described herein. Recommended verbiage for a warning sign for Site 9 is provided below:

WARNING-RESTRICTED AREA- IRP SITE 9
Ordnance and potentially harmful substances in the soil below cliff
Access or invasive activities without prior permission is prohibited
Contact Base Civil Engineer Squadron at Ext - 4692

Fencing: As described in the above text, chain link fence shall be installed at access points at the top of the cliffline to the designated LUC area below. The fence shall be constructed as soon as practical after approval of the ROD, and shall be monitored annually as part of the O&M activities described below.

O&M Activities: O&M activities will include an annual site inspection/review to: (1) determine that boundary markers and signage are intact, (2) determine that no unapproved structures have been constructed or intrusive activities have been performed, (3) maintain the chain link fence, and (4) ensure that the LUCMP is properly maintained and all activities relevant to the designated LUC area (i.e. proper documentation of digging permits and maintenance of the fence, etc.) are properly documented. There are no O&M requirements relevant to maintaining a specific type of vegetative cover. This inspection/review requirement shall be performed on an annual basis, reviewed as part of the Five-Year ROD Review, and remain in effect indefinitely as long as COCs in surface and subsurface soil remain at concentrations that prevent unrestricted use and unlimited exposure. Modifications to LUCs resulting from activities associated with the

removal of OEW/UXO under the MMRP will also be reviewed as part of the Five-Year ROD Review.

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TABLE A-3 SUMMARY TABLE FOR IDENTIFYING LUC OBJECTIVES AND IMPLEMENTING LUCs AT SITE 12, ANDERSEN AFB, GUAM

Risk Summary: Site 12 consists of six subsites: 12A, 12B, 12C, 12D, 12E, and 12 F. COPC concentrations in surface and surface soil at subsites 12C, 12D, and 12E pose no unacceptable risks to human or ecological receptors and as such: (1) No Action is warranted and (2) the land is eligible for unrestricted use and unlimited exposure. Subsites 12A, 12B, and 12F contain COCs at concentrations that pose potential unacceptable risks to ecological and/or human receptors.

Risks at Subsite 12A: Based on the HHRA, COC concentrations in surface and subsurface soil pose potential threat to future resident adults and children and occasional users/trespassers. Based on the ERA, COC concentrations in surface soil pose potential threat to soil invertebrates, the Mariana crow, the yellow bittern, and the Mariana fruit bat.

Risks at Subsite 12B: Based on the HHRA, COC concentrations in surface and subsurface soil pose potential threat to future resident adults and children and occasional users/trespassers. Based on the ERA, COC concentrations in surface soil pose potential threat to soil invertebrates, the Mariana crow, and the yellow bittern.

Risks at Subsite 12F: Based on the HHRA, COC concentrations in surface and subsurface soil pose potential threat to future resident adults and children and occasional users/trespassers. Based on the ERA, COC concentrations in surface soil pose potential threat to the Mariana crow and the yellow bittern.

COCs: Surface Soil at Subsite 12A – antimony, arsenic, benzo(a)pyrene, copper, DDE, DDT, dieldrin, lead, and manganese
Subsurface Soil at Subsite 12A – lead

Surface Soil at Subsite 12B – antimony, arsenic, chromium, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, and lead
Subsurface Soil at Subsite 12B – chromium, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene

Surface Soil at Subsite 12F – cadmium and nickel
Subsurface Soil at Subsite 12F – none

Selected Remedy at Subsite 12A: Soil Removal Protective of Ecological Receptors with ICs

Selected Remedy at Subsite 12B: Soil Removal Protective of Ecological Receptors with ICs

Selected Remedy at Subsite 12F: Soil Removal Protective of Ecological Receptors (also protective of resident adults and children so ICs are not required).

LUC Objectives at Subsite 12A: The selected remedy, soil removal protective of ecological receptors with ICs, will effectively remove contaminated soils to reduce ecological risks to

acceptable levels and will also have the benefit of reducing overall contaminant concentrations in surface soil and the potential exposures and risks to human receptors. However, the risks posed to future resident adults and children and occasional users/trespassers would still lie outside the acceptable risk range. As such, ICs shall be required to control direct exposure pathways to future resident adults and children. The ICs shall include LUCs and engineering controls. The area designated for LUCs is provided in Figure A-3. As such the LUCs shall:

1. Control direct human (resident adults and children and occasional users/trespassers) exposure to contaminated surface and surface soils within the area defined in Figure A-3.
2. Prevent the future development and/or use of the designated area below the cliffline and vicinity for residential housing, elementary and secondary schools, child care facilities and playgrounds, or any other activities that would result in children being exposed to the soils at the site.

LUC Objectives at Subsite 12B: The selected remedy, soil removal protective of ecological receptors with ICs, will effectively remove contaminated soils to reduce ecological risks to acceptable levels and will also have the benefit of reducing overall contaminant concentrations in surface soil and the potential exposures and risks to human receptors. However, the risks posed to future resident adults and children and occasional users/trespassers would still lie outside the acceptable risk range. As such, ICs shall be required to control direct exposure pathways to future resident adults and children. The ICs shall include LUCs and engineering controls. The area designated for LUCs is provided in Figure A-4. As such the LUCs shall:

1. Control direct human (resident adults and children and occasional users/trespassers) exposure to contaminated surface and surface soils within the area defined in Figure A-4.
2. Prevent the future development and/or use of the designated area below the cliffline and vicinity for residential housing, elementary and secondary schools, child care facilities and playgrounds, or any other activities that would result in children being exposed to the soils at the site.

LUC Objectives at Subsite 12F: The soil removal protective of ecological receptors with ICs will effectively remove contaminated soils to reduce ecological risks to acceptable levels. This remedy will also remove contaminant concentrations in surface soil to exposure concentrations that will result in acceptable risks to resident adults and children and allow for unrestricted future use. As such, no LUCs would be required and there are no LUC objectives.

Property Ownership: The site is owned by the USAF and is located within the Main Base portion of Andersen AFB, Guam.

Site Constraints: Access to Site 12 is limited to persons with access to the Main Base. The site is located within a relatively remote (and restricted) area along the periphery of the active flightline that is not generally accessed. Subsites A and B shall be restricted from future residential development due to: (1) proximity to the active flightline, (2) proximity to the Weapons Storage Area (WSA), and (3) proximity to the United States Fish and Wildlife "overlay". There is no fencing or other engineering controls currently at the site though the fencing that encloses the flightline helps to restrict access. The land will be restricted from

future residential development through implementation of LUCs that will be amended into the BGP within sixty (60) days of ROD approval. The USAF will amend the BGP with one of the following sections: (1) a new section entitled "Prohibited and Permitted Uses at Environmental Restoration Sites or (2) text to an existing section of the BGP that addresses LUC restrictions at Andersen AFB. This section shall state that residential use and certain types of industrial/recreational development such as elementary and secondary schools, child care facilities, playgrounds, medical facilities, or similar activities are prohibited. The USAF will utilize its BGP as an administrative LUC to prevent uses that are inconsistent with the approved ROD.

Areas Subject to Controls: Subsite 12A – 2.1 acres and subsite 12B – 5.7 acres. The areas within Subsites 12A and 12 B that are subject to LUCs are presented in Figures A-3 and A-4, respectively. Due to the presence of the chain link fence that surrounds the flightline, only minimal additional fencing shall be required to restrict access to the designated LUC areas which lie mostly along and below the cliffline. In addition, areas at the top of the two subsites shall be clearly marked with appropriate signage defining the "restricted" LUC area. Signage shall be placed along and below the cliffline only in disturbed areas outside the native limestone forest. Recommended verbiage for the signage is provided in the Engineering Controls section of this table.

Current Onsite Structures/Facilities: There are no surface or underground structures/cables/pipelines within the designated LUC areas for Subsite 12A or 12B.

Future Land Use Restrictions: The designated LUC areas at Subsites 12A and 12B are restricted from residential use as long as the site conditions are not suitable for unrestricted use and unlimited exposure. In addition, the presence of the native limestone habitat and the USFW "overlay" below the cliffline makes much of the designated LUC areas unsuitable for any future land development, construction, or regular use that would impact the habitat. As such, the LUCs would specifically restrict recreational, industrial, and commercial development below the cliffline in addition to residential development.

LUCs

Prepare and Maintain a Land Use Management Control Plan (LUMCP): The USAF shall prepare and maintain a LUCMP specific to the designated LUC areas at Subsite 12A and 12B that will serve as the operational "road map" for defining, implementing, and reporting on LUCs at Site 12. The LUCMP will be maintained at the Base CES to assure that activities within the designated LUC area are being implemented in accordance with the remedy selected in the approved ROD. The LUCMP will include: (1) a prohibition on the redevelopment in the designated LUC areas (specifically prohibition of residential use, use that would result in exposures to children, use that would impact the native limestone forest, or use that would infringe on the USFW "overlay") without prior approvals from the USEPA and Guam EPA; (2) limitations and controls on future intrusive activities in the designated LUC areas (e.g., worker requirements, soil management, waste disposal); and (3) a requirement that intrusive activities within the designated LUC areas receive prior approval by the Andersen AFB CES and be documented in the LUCMP. The LUCMP will include protocols for: (1) daily management of

the LUCMP process, (2) annual inspections of the site to ensure compliance with the LUCs; (3) specification of annual LUC-compliance reporting requirements; (4) property lease or transfer (note: currently, there are no plans for property lease or transfer); and (5) notification process and relevant corrective actions for LUC non-compliant events. While monitoring/implementing the LUCs at Site 12 activities that are inconsistent with the LUC objectives or designated land use restrictions will be addressed by the USAF as soon as practicable. The USEPA and Guam EPA will be notified of significant inconsistencies or deficiencies within fifteen (15) days after the USAF becomes aware of the situation at which time the USAF will provide appropriate recommendations for corrective actions. The LUCMP will be reviewed annually to assure that land use restrictions and controls are maintained as per the remedy selected in the ROD. The annual LUCMP monitoring reports will summarize (1) monitoring activities performed in the prior year, (2) notable deficiencies or inconsistencies in maintaining the LUCs, (3) corrective actions taken, and (4) effectiveness of the corrective actions. The annual LUCMP monitoring reports will be used in preparation of the Five-Year Review to evaluate the effectiveness of the remedy. The LUCs will remain in effect indefinitely as long as COCs in surface and subsurface soil remain at concentrations that prevent unrestricted use and unlimited exposure.

Lease or Transfer of Property: The site is located on the active Main Base and there are no current plans for the USAF to lease or transfer the property. The BGP will be amended to identify the designated LUC area as restricted from future lease or transfer without the prior knowledge and concurrence of the USAF, USEPA and Guam EPA. In the event the USAF may later transfer these procedural responsibilities to another party by contract, property transfer agreement, or through other means, the USAF shall retain ultimate responsibility for remedy integrity. The USAF will provide notice to USEPA and Guam EPA at least six (6) months prior to any transfer or sale of Site 12 so that USEPA and Guam EPA can be involved in discussions to ensure that appropriate provisions are included in the transfer terms or conveyance documents to maintain effective ICs. If it is not possible for the facility to notify USEPA and Guam EPA at least six months prior to any transfer or sale, then the facility will notify USEPA and Guam EPA as soon as possible but no later than 60 days prior to the transfer or sale of any property subject to ICs. In addition to the land transfer notice and discussion provisions above, the USAF further agrees to provide USEPA and Guam EPA with similar notice, within the same time frames, as to federal-to-federal transfer of property. The USAF shall provide a copy of executed deed or transfer assembly to EPA and Guam EPA.

Dig and Construction Permits: In general, no intrusive activities shall occur within the designated LUC areas at Subsite 12A or 12B. All dig and construction permits relevant to Site 12 will be documented in the LUCMP for Site 12. If intrusive activities are necessary within the designated LUC area they would require prior approval of the Base CES. If intrusive activities are conducted within the designated LUC area the work would require an approved health and safety plan and procedures for the proper handling and disposal of displaced wastes and/or soils. This requirement shall be maintained indefinitely and will be subject to an annual review and will remain in effect indefinitely as long as COCs in surface and subsurface soil remain at concentrations that prevent unrestricted use and unlimited exposure.

The BGP: The BGP will be amended within sixty (60) days of ROD approval to identify the designated LUC area(s) as restricted from transfer/lease and residential development indefinitely

as long as site conditions are not suitable for unrestricted use and unlimited exposure. AFI 32-7062 (*Air Force Comprehensive Planning*) requires that installations develop and maintain a BGP as a central repository for information deemed essential for planning and managing the installation's physical assets, including environmental site constraints such as LUCs. AFI 32-1021 (*Planning and Programming Military Construction Projects*) requires installations to comply with their BGP to ensure that there are no conflicts with land-use constraints stemming from the LUCs of the Environmental Restoration Program (ERP) that would impact facility planning and construction. Any requests for residential use or invasive activities (i.e. construction) through excavation permits, such as AF Form 103, or the construction review process, as per AFI 32-1001 (*Operations Management*), will be denied, unless the procedures for proposed land use changes described in the approved ROD, and amended to the BGP, are followed. The LUCs amended to the BGP will be monitored, maintained, and reported on through existing land-use management programs, such as the BCE Work Clearance Form (AF Form 103) (*Digging Permit*) and the construction review process (AFI 32-1001). No construction or digging will be permitted without prior approval by the BCE in the form of an approved work clearance (dig permit) or other approvals as required by applicable AFI. The BCE will not approve dig permits for activities inconsistent with the LUCs as amended to the BGP and no changes in the type of land use designated in the ROD shall be implemented within the designated LUC area without the prior knowledge and concurrence of the USAF, USEPA and Guam EPA. These procedures involve a minimum of sixty (60) day notice to USEPA and Guam EPA. These requirements shall be reviewed annually as part of the LUCMP and once every five years as part of the Five-Year ROD Review process. These requirements shall remain in effect indefinitely as long as COCs in surface and subsurface soil remain at concentrations that prevent unrestricted use and unlimited exposure.

Engineering Controls

Survey and Mark LUC Boundaries and Post Signage: The two subsites requiring LUCs will require an initial survey to locate and install permanent markers to mark the designated corners of the designated LUC areas (Figures A-3 and A-4). Warning signs shall be posted along the top of the cliff, at points of entry. The signs shall clearly identify the designated LUC area below, specify that no access or digging activities shall be permitted without prior consultation with the CES, and note the potential for health risks related to exposure to the soils. This requirement shall be performed within 120 days after approval of the ROD, and shall be monitored annually as part of the O&M activities described herein. Recommended verbiage for a warning sign for Site 9 is provided below. Recommended verbiage for the warning signs for Site 12 Subsites A and B is provided below:

WARNING-RESTRICTED AREA - IRP SITE 12 AREA A
Potentially harmful substances in the soil
Access or invasive activities without prior permission is prohibited
Contact Base Civil Engineer Squadron at Ext - 4692

Fencing: As described in the above text, chain link fence shall be installed at access points at the top of the two subsites (Areas A and B) to limit access to the designated LUC areas. The fences

shall be constructed as soon as practical after approval of the ROD, and shall be monitored annually as part of the O&M activities described below.

O&M Activities: O&M activities will include an annual site inspection/review to: (1) determine that boundary markers and signage are intact, (2) determine that no unapproved structures have been constructed or intrusive activities have been performed, (3) maintain the chain link fence, and (4) ensure that the LUCMP is properly maintained and all activities relevant to the designated LUC areas (i.e. proper documentation of digging permits and maintenance of the fence, etc.) are properly documented. There are no O&M requirements relevant to maintaining a specific type of vegetative cover. This inspection/review requirement shall be performed on an annual basis, reviewed as part of the Five-Year ROD Review, and remain in effect indefinitely as long as COCs in surface and subsurface soil remain at concentrations that prevent unrestricted use and unlimited exposure.

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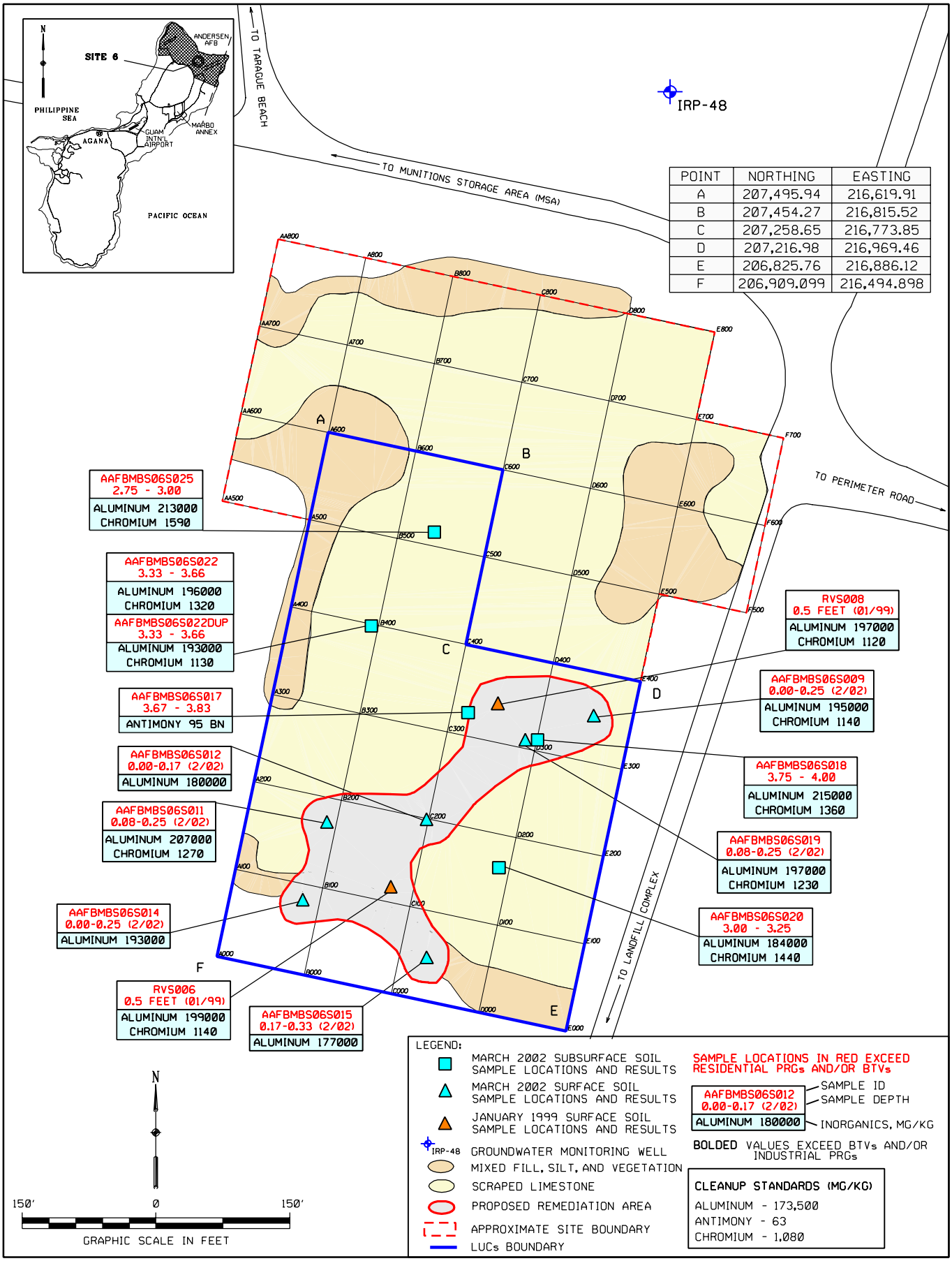
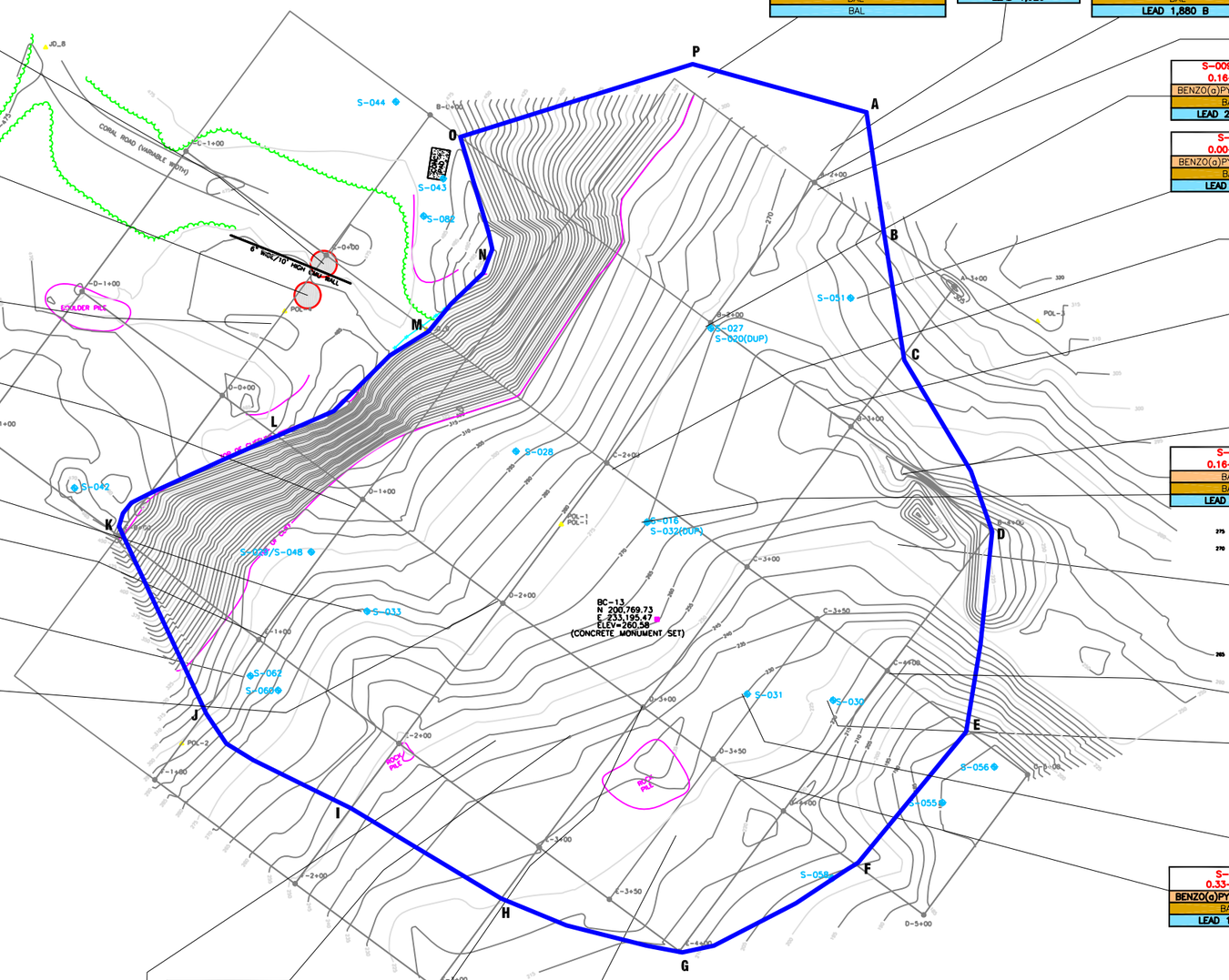


POINT	NORTHING	EASTING
A	207,495.94	216,619.91
B	207,454.27	216,815.52
C	207,258.65	216,773.85
D	207,216.98	216,969.46
E	206,825.76	216,886.12
F	206,909.099	216,494.898

Figure A-1. Proposed Area for Implementation of LUCs at Site 6, Andersen AFB, Guam.



S-037 0.00–0.25	S-038 (DUP) 0.00–0.25
BENZO(a)PYRENE 63	BAL
BAL	DDT 12,950 J
BAL	LEAD 420

S-039 0.00–0.50
BAL
BAL
IRON 350,000 B
LEAD 13,700 J
ANTIMONY 266
CADMIUM 180 J

S-078 0.00–0.25
BENZO(a)PYRENE 273
DIBENZO(a,h)ANTHRACENE 87 J
BAL
BAL

S-021 0.16–0.50
BENZO(a)PYRENE 239 J
DIBENZO(a,h)ANTHRACENE 106 J
BAL
LEAD 1,420

S-025 0.16–0.50
BENZO(a)PYRENE 107
BAL
LEAD 3,000
COPPER 4,180

S-023 0.16–0.50
BAL
BAL
LEAD 3,750

S-063 0.16–0.50
BIS(2–chloroethyl)ETHER 1,540
BAL
BAL

S-012 0.00–0.33
BENZO(a)PYRENE 173 J
DIBENZO(a,h)ANTHRACENE 96 J
BAL
LEAD 8,190 J

POINT	NORTHING	EASTING
A	201,060.26	233,315.53
B	200,990.68	233,325.36
C	200,920.04	233,336.71
D	200,820.69	233,386.96
E	200,706.60	233,373.34
F	200,628.75	233,309.87
G	200,579.60	233,208.38
H	200,609.61	233,106.11
I	200,661.75	233,019.45
J	200,717.49	232,936.78
K	200,827.73	233,386.96
L	200,874.81	232,977.93
M	200,934.83	233,064.74
N	200,974.59	233,099.03
O	201,046.11	233,082.65
P	201,087.90	233,215.88

S-075 0.00–0.25
BENZO(a)PYRENE 69 J
BIS(2–chloroethyl)ETHER 1,380 J
BAL
BAL

S-074 0.00–0.50
BENZO(a)PYRENE 119
BAL
LEAD 1,920

S-007 0.00–0.50
BENZO(a)PYRENE 252 J
DIBENZO(a,h)ANTHRACENE 145 J
BAL
LEAD 1,880 B

S-073 0.16–0.50
BENZO(a)PYRENE 108
BAL
LEAD 1,730

S-009 (DUP) 0.16–0.50	S-008 0.16–0.50
BENZO(a)PYRENE 97 J	BENZO(a)PYRENE 148 J
BAL	BAL
LEAD 2,960 B	LEAD 1,610 B

S-052 0.00–0.25	S-053 (DUP) 0.00–0.25
BENZO(a)PYRENE 81 J	BENZO(a)PYRENE 140 J
BAL	BAL
LEAD 1,690	LEAD 1,460

S-017 0.16–0.50
ND
BAL
LEAD 2,020 B

S-010 0.16–0.50
BENZO(a)PYRENE 73 J
BAL
LEAD 2,790 B

S-011 0.00–0.50
BENZO(a)PYRENE 104 J
BAL
LEAD 1,780 B

S-019 0.16–0.33	S-020 (DUP) 0.16–0.33
BAL	BAL
BAL	BAL
LEAD 872 B	LEAD 1,180

S-066 0.16–0.33
BENZO(a)PYRENE 447 J
DIBENZO(a,h)ANTHRACENE 129 J
INDENO(1,2,3–cd)PYRENE 2,357 J
BAL
LEAD 1,300

S-003 0.16–0.33
BENZO(a)PYRENE 224 J
DIBENZO(a,h)ANTHRACENE 312 J
BAL
LEAD 2,110 B

S-014 0.16–0.50
BENZO(a)PYRENE 1,271 J
BENZO(b)FLUORANTHENE 1,686 J
DIBENZO(a,h)ANTHRACENE 1,135 J
INDENO(1,2,3–c,d)PYRENE 1,083 J
BAL
LEAD 4,700 B

S-015 0.16–0.50
BAL
BAL
LEAD 2,350 B

S-004 0.33–0.67
BENZO(a)PYRENE 127 J
BAL
LEAD 1,620 B

S-006 0.16–0.50
BENZO(a)PYRENE 86 J
BAL
LEAD 2,500 B

S-018 0.16–0.50
BENZO(a)PYRENE 216 J
DIBENZO(a,h)ANTHRACENE 174 J
BAL
CHROMIUM 1,110 J
IRON 254,000 B
LEAD 4,150 B

S-013 0.25–0.50
BENZO(a)PYRENE 182 J
DIBENZO(a,h)ANTHRACENE 126 J
4,4' DDD 4,150 J
IRON 140,000 B
LEAD 5,890 B

S-071 0.16–0.50
BENZO(a)PYRENE 147
BAL
LEAD 2,040

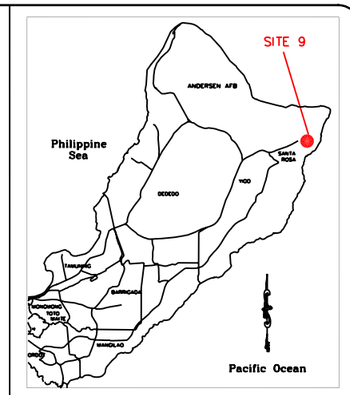
NOTES :

1. VERTICAL AND HORIZONTAL CONTROL WAS BASED FROM 4X4 CONCRETE MONUMENTS AAFB–13, AND AAFB–14, WITH THE FOLLOWING 1945 GRID COORDINATES :
   1. AAFB–13
      N 202,018.67
      E 230,514.98
      EL=602.21
   2. AAFB–14
      N 202,415.88
      E 231,394.57
      EL=609.45
2. CONTOURS ARE AT 5 FEET INTERVALS.
3. CONTOURS SHOULD NOT BE USED FOR ANY CIVIL DESIGN PURPOSES.

1945 GRID

80 40 0 80

GRAPHIC SCALE IN FEET



LEGEND:

SAMPLE LOCATIONS IN RED EXCEED RESIDENTIAL PRGs AND/OR BTVs

S-010 0.17–0.50	SAMPLE ID SAMPLE DEPTH IN FEET
BENZO(a)PYRENE 73 J	SVOCs/PAHs, ug/kg
BAL	PESTICIDES/PCBs, ug/kg
LEAD 2,790 B	INORGANICs, mg/kg

BOLD = BOLDED VALUES INDICATED CONCENTRATIONS EXCEED EPA's INDUSTRIAL PRG's OR BTV's, WHICHEVER IS HIGHER

NON–BOLD = NON–BOLDED VALUES INDICATE CONCENTRATIONS EXCEED EPA's RESIDENTIAL PRG's OR BTV's, WHICHEVER IS HIGHER

ANR = ANALYSIS NOT REQUESTED

BAL = BELOW ACTION LEVELS

B = THE ANALYTE WAS FOUND IN AN ASSOCIATED BLANK, AS WELL AS IN THE SAMPLE

J = CONCENTRATION VALUE IS ESTIMATED

AREA OF MOUNDED STRUCTURES WITH FILL MATERIAL

AREA OF CONCENTRATED DETERIORATED METAL

AREA OF CONCENTRATED TAR AND/OR ASPHALT

AREA OF CONCENTRATED DETERIORATED 55–GALLON DRUMS

SURFACE SOIL SAMPLE LOCATION

SUBSURFACE SOIL SAMPLE LOCATION

MISCELLANEOUS DEBRIS

OEW/UXO

DETERIORATED 55 GALLON DRUM/DRUM REMNANT

AIRCRAFT AND AUTO TIRE

AIRCRAFT PARTS

SYMBOLS/LEGEND :

EDGE OF VEGETATION

A–0+00 GEOPHYSICAL SURVEY POINT

SURVEY CONTROL POINT

500 CONTOUR LINE

BOUNDARY LINE

CLIFF LINE

TRENCH LINE

LUCs BOUNDARY

Figure A-2.
Proposed Area for Implementation of LUCs at Site 9,
Andersen AFB, Guam.

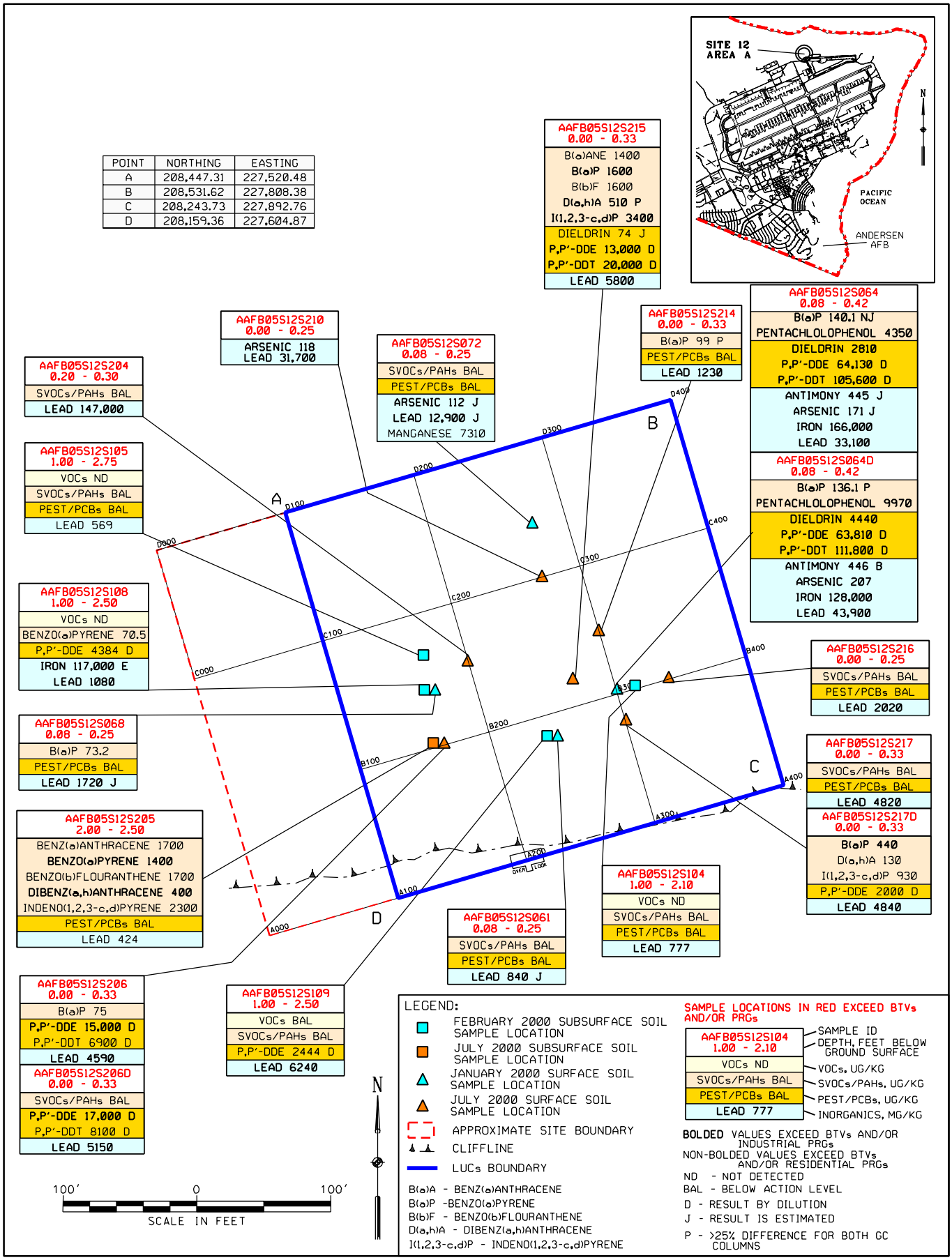
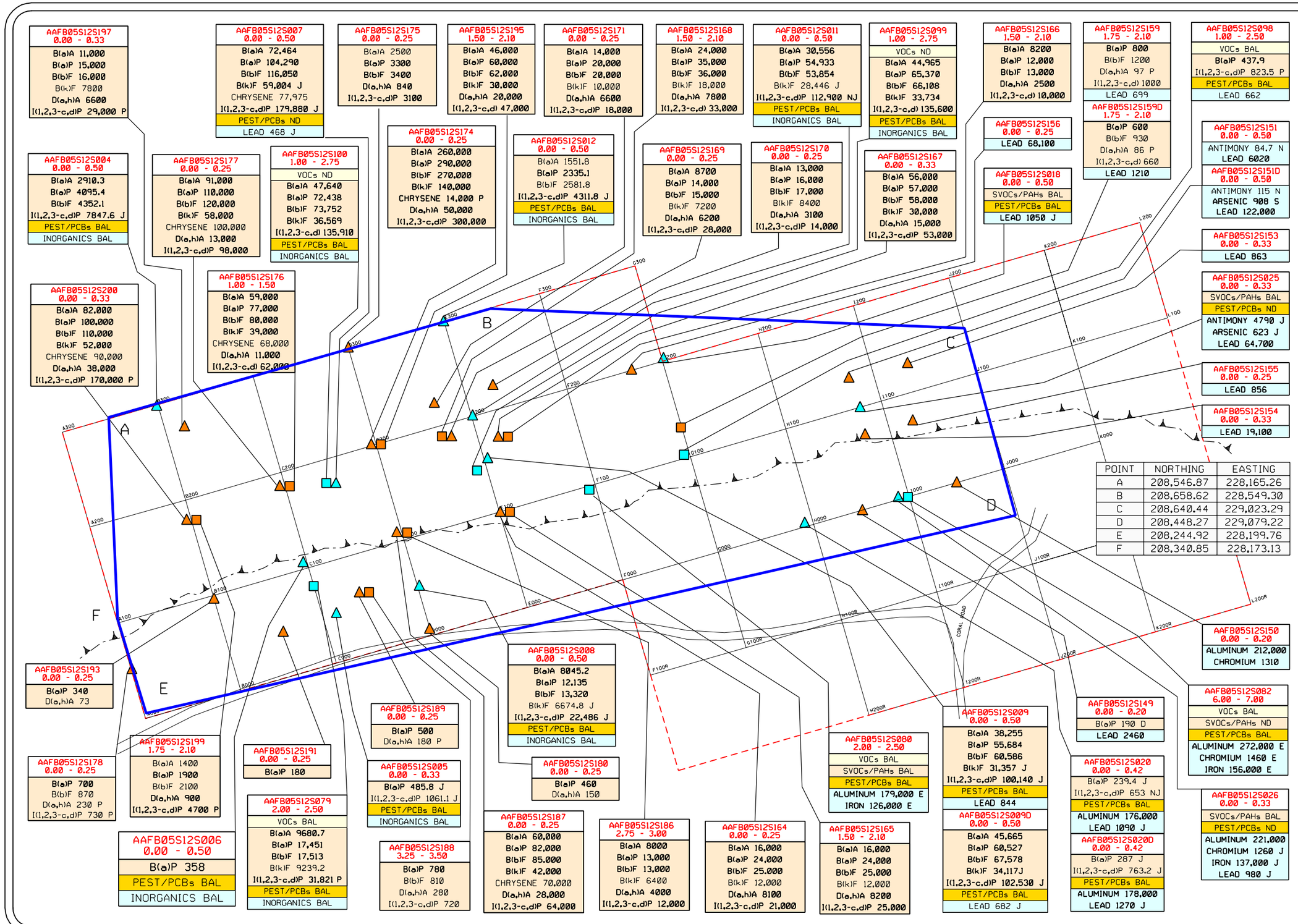
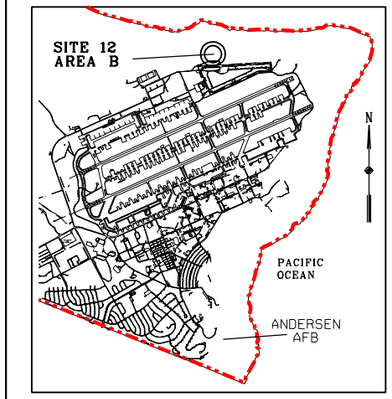


Figure A-3. Proposed Area for Implementation of LUCs at Area A of Site 12, Andersen AFB, Guam.



POINT	NORTHING	EASTING
A	208,546.87	228,165.26
B	208,658.62	228,549.30
C	208,640.44	229,023.29
D	208,448.27	229,079.22
E	208,244.92	228,199.76
F	208,340.85	228,173.13



LEGEND:

- JANUARY/FEBRUARY 2000 SUBSURFACE SOIL SAMPLE LOCATION
- JULY 2000 SUBSURFACE SOIL SAMPLE LOCATION
- JULY 2000 SURFACE SOIL SAMPLE LOCATION
- DECEMBER 1999 SURFACE SOIL SAMPLE LOCATION
- APPROXIMATE SITE BOUNDARY
- CLIFFLINE
- DRUM SAMPLE LOCATION (SEE TABLE 5-9 FOR RESULTS)
- LUCs BOUNDARY

SAMPLE LOCATIONS IN RED EXCEED BTVs AND/OR PRGs

AAFB05S12S090 — SAMPLE ID
1.00 - 1.25 — DEPTH, FEET BELOW GROUND SURFACE
VOCs BAL — VOCs, UG/KG
SVOCs/PAHs BAL — SVOCs/PAHs, UG/KG
PEST/PCBs BAL — PEST/PCBs, UG/KG
INORGANICS BAL — INORGANICS, MG/KG

BOLDED VALUES EXCEED BTVs AND/OR INDUSTRIAL PRGs
NON-BOLDED VALUES EXCEED BTVs AND/OR RESIDENTIAL PRGs
ND - NOT DETECTED
BAL - BELOW ACTION LEVEL
B(a)A - BENZ(a)ANTHRACENE
B(a)P - BENZO(a)PYRENE
B(b)F - BENZO(b)FLOURANTHENE
B(k)F - BENZO(k)FLOURANTHENE
D(a,h)A - DIBENZ(a,h)ANTHRACENE
I(1,2,3-c,d)P - INDENO(1,2,3-c,d)PYRENE
E - RESULT ESTIMATED DUE TO INTERFERENCE
P - >25% DIFFERENCE FOR BOTH GC COLUMNS

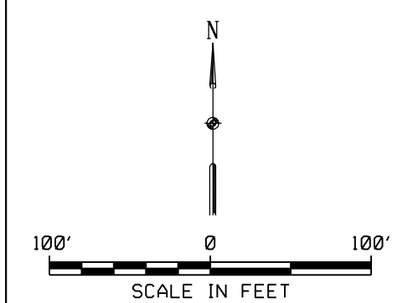


Figure A-4.
Proposed Area for Implementation of LUCs at Area B of Site 12, Andersen AFB, Guam.