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Final

Steps 6 and 7 of the Baseline Ecological Risk Assessment
SWMU 1
Naval Activity Puerto Rico
RCRA/HSWA Permit No. PR21700027203
Ceiba, Puerto Rico

Prepared for

Department of the Navy
Atlantic Division
Naval Facilities Engineering Command
Norfolk, Virginia
Under the
LANTDIV CLEAN Program

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April 5, 2010

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FINAL

STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT SWMU 1

NAVAL ACTIVITY PUERTO RICO
RCRA/HSWA PERMIT NO. PR2170027203
CEIBA, PUERTO RICO

CONTRACT TASK ORDER 108

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DEPARTMENT OF THE NAVY
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TABLE OF CONTENTS

TABLE OF CONTENTS
(continued)

LIST OF TABLES

LIST OF TABLES
(continued)

LIST OF TABLES
(continued)

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ACRONYMS AND ABBREVIATIONS

α	Type I Error Rate
AET	Apparent Effects Threshold
ANOVA	Analysis of Variance
As	Arsenic
ASTM	American Society for Testing and Materials
ATSDR	Agency for Toxic Substances and Disease Registry
AUF	Area Use Factor
AVS	Acid Volatile Sulfide
Baker	Baker Environmental, Inc.
BERA	Baseline Ecological Risk Assessment
bgs	below ground surface
BW	Body Weight
BW_r	Body weight of receptor species
BW_t	Body weight of test species
CAO	Corrective Action Objective
Cd	Cadmium
CD	validation code (analytical result confirmed by gas chromatography/mass spectrometry; analyte identified in an analysis at a secondary dilution)
CEC	Cation Exchange Capacity
cf	cubic foot
CLP	Contract Laboratory Program
CMS	Corrective Measures Study
CNO	Chief of Naval Operations
COC	Chemical of Concern
CRDL	Contract Required Detection Limit
CRQL	Contract Required Quantitation Limit
CTO	Contract Task Order
Cu	Copper
DCQAP	Data Collection Quality Assurance Plan
DDD	1,1-dichloro-2,2-bis(*p*-chlorophenyl)ethylene
DDE	1,1-dichloro-2,2-bis(*p*-chlorophenyl)ethane
DDT	1,1,1-trichloro-2,2-bis(*p*-chlorophenyl)ethane
DI_x	Dietary intake for chemical x
DMP	Data Management Plan
DoN	Department of the Navy
DQO	Data Quality Objective
E2SS3	Estuarine, Intertidal, Scrub-Shrub, Broad-Leaved Evergreen
E2US3	Estuarine, Intertidal, Unconsolidated Shore, Mud
E2US4	Estuarine, Intertidal, Unconsolidated Shore, Inorganic
EA	Environmental Assessment
Eh	Oxidation-Reduction Potential
ERA	Ecological Risk Assessment
FC_{xi}	Maximum concentration of chemical x in food item i
FIR	Food Ingestion Rate
FSAP	Field Sampling and Analysis Plan

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

GC	Gas Chromatography
GPS	Global Positioning System
HASP	Health and Safety Plan
Hg	Mercury
HMW	High Molecular Weight
HOC	Hydrophobic Organic Chemical
HQ	Hazard Quotient
ICM	Interim Corrective Measure
IAS	Initial Assessment Study
ICP	Inductively Coupled Plasma
J	validation code (the analyte was positively detected; however, the concentration value is an estimate)
kg	kilogram
kg/day	kilogram per day
km	kilometer
LOAEL	Lowest Observed Adverse Effect Level
LMW	Low Molecular Weight
MATC	Maximum Acceptable Toxicant Concentration
MDL	Method Detection Limit
MeHg	Methlymercury
MeSe	Methylselenium
MHSPE	Ministry of Housing, Spatial Planning and Environment
mg/kg	milligram per kilogram
mg/kg-BW/day	milligram per kilogram body weight per day
MS	Matrix Spike
MSD	Matrix Spike Duplicate
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NAPR	Naval Activity Puerto Rico
NEESA	Naval Energy and Environmental Support Activity
NFESC	Naval Facilities Engineering Service Center
NJ	validation code (presumptive evidence for the presence of the analyte at an estimated concentration)
NSRR	Naval Station Roosevelt Roads
NAVFAC	Naval Facilities Engineering Command
NOAEL	No Observed Adverse Effect Level
$NOAEL_r$	No Observed Adverse Effect Level of the receptor species
$NOAEL_t$	No Observed Adverse Effect Level of the test species
PAH	Polycyclic Aromatic Hydrocarbon
Pb	Lead
PDF_i	Proportion of diet composed of food item i
PDS	proportion of diet composed of sediment

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

PMP	Project Management Plan
ppt	parts per thousand
PRDNR	Puerto Rico Department of Natural Resources
QA/QC	Quality Assurance/Quality Control
r	Correlation Coefficient
r^2	Coefficient of Determination
R	validation code (the sample result is rejected; the presence of absence of this analyte cannot be verified)
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RPD	Relative Percent Difference
Sb	Antimony
SC_x	95 percent UCL of the mean concentration of chemical x in surface soil/sediment
SDG	Sample Delivery Group
Se	Selenium
SERA	Screening-level Ecological Risk Assessment
SI	Supplemental Investigation
Sn	Tin
SOP	Standard Operating Procedure
SOW	Scope of Work
STL	Severn Trent Laboratories
SSL	Soil Screening Level
SWMU	Solid Waste Management Unit
TEL	Threshold Effects Level
TOC	Total Organic Carbon
TRV	Toxicity Reference Value
U	validation code (the analyte was analyzed for, but not detected at the reported sample quantitation limit)
UCL	Upper Confidence Limit
µg/kg	microgram per kilogram
UJ	validation code (the analyte was analyzed for, but not detected above the reported sample quantitation limit; the reported sample quantitation limit is qualified as estimated)
ULM	Upper Limit of the Mean
UNEP	United Nations Environmental Program
µm	micrometer
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
USEPA	United States Environmental Protection Agency

EXECUTIVE SUMMARY

This document presents Step 5 (field verification), Step 6 (data analysis and evaluation), and Step 7 (risk characterization) of the baseline ecological risk assessment (BERA) for Solid Waste Management Unit (SWMU) 1 – Army Cremator Disposal Site, located at Naval Activity Puerto Rico (NAPR), formerly Naval Station Roosevelt Roads (NSRR), Ceiba, Puerto Rico. The BERA was performed in accordance with the procedures presented in the *Final Steps 3b and 4 of the Baseline Ecological Risk Assessment SWMUs 1 and 2* (Baker, 2007), and focused on those chemical-receptor-pathway combinations where unacceptable risk was indicated by Step 3a of the ERA process (Baker, 2006a). The general risk questions that focused the BERA for SWMU 1 are listed below.

- Are ecological chemicals of concern (COC) concentrations in SWMU 1 surface soil high enough to impair the survival, growth, or reproduction of terrestrial invertebrate communities?

- Are ecological COC concentrations in SWMU 1 surface soil high enough to impair the survival, growth, and reproduction of terrestrial avian omnivore populations?

- Are ecological COC concentrations in SWMU 1 open water sediment high enough to adversely affect the survival, growth, or reproduction of West Indian manatees?

The lines of evidence considered in the evaluation of these risk questions were:

Terrestrial invertebrates:

- Comparison of antimony, cadmium, copper, lead, mercury, tin, zinc, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT concentrations in SWMU 1 surface soil to invertebrate-based screening values

- Comparison SWMU 1 and reference area toxicity test results from 28-day *Eisenia fetida* survival, growth, and reproduction tests

- Evidence of a significant correlation between laboratory toxicity test results and the chemical/physical characteristics of surface soil for those *Eisenia fetida* test endpoints in which an overall significant result was measured

Terrestrial avian omnivores:

- Comparison of cadmium, lead, mercury, zinc, 4'4-DDD, 4,4'-DDE, and 4'4-DDT dietary intakes using tissue data for earthworms maintained in SWMU 1 and reference area surface soil during toxicity testing to ingestion-based TRVs (terrestrial avian omnivores)

West Indian manatees:

- Comparison of arsenic, cadmium, copper, mercury, selenium, and zinc dietary intakes at SWMU 1 using field-collected turtle grass tissue to ingestion-based TRVs

Conclusions from the evaluation of each receptor/receptor group, as well as recommendations for the SWMU are presented below.

Terrestrial Invertebrate Communities

The available analytical data for SWMU 1 (i.e., six surface soil collected during a Supplemental Investigation [SI] conducted in 1992, eighteen surface soil samples collected during a Resource Conservation and Recovery Act [RCRA] Facility Investigation [RFI] conducted in 1996, six surface soil samples collected during an additional data collection investigation conducted in 2004, and fifty-five surface soil samples collected during the BERA field investigation) were used to derive risk estimates (i.e., hazard quotient [HQ] values) for terrestrial invertebrate exposures to ecological COCs in surface soil. HQ values were derived using maximum, 95 percent upper confidence (UCL) of the mean, and arithmetic mean antimony, cadmium, copper, lead, mercury, tin, zinc, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT concentrations:

Ecological COC	Maximum HQ	95 Percent UCL of the Mean HQ	Arithmetic Mean HQ
Pesticides:			
4,4'-DDD	14.54	1.27	0.23
4,4'-DDD	31.32	3.29	0.94
4,4'-DDE	48.10	4.45	0.89
Metals:			
Antimony	2.82	0.37	0.06
Cadmium	0.59	0.07	0.03
Copper	29.25	4.79	2.76
Lead	1.53	0.37	0.17
Mercury	57.00	5.53	2.50
Tin	30.00	3.99	1.14
Zinc	45.08	10.80	4.88

The comparison of 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, antimony, cadmium, copper, lead, mercury, tin, and zinc concentrations in SWMU 1 surface soil to soil screening values indicated that antimony, cadmium, and lead present minimal risks to terrestrial invertebrate communities. HQ values based on 95 percent UCL of the mean concentrations are less than 1.0 (0.07 for cadmium and 0.37 for antimony and lead). However, HQ values for 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, copper, mercury, tin and zinc indicate that these seven chemicals may be impacting terrestrial invertebrate communities at SWMU 1 (HQ values based on 95 percent UCL of the mean concentrations are 1.27, 3.29, 4.45, 4.79, 5.53, 3.99, and 10.08, respectively).

Twelve SWMU 1 and three reference area surface soil samples collected during the BERA field investigation were tested for toxicity using *Eisenia fetida* to further refine potential risks suggested by the comparison of ecological COC concentrations to soil screening values. The SWMU 1 surface soil samples selected for earthworm toxicity testing exhibited a range of ecological COC concentrations, from non-detected values or values below soil screening values to maximum detected concentrations. Toxicity tests were conducted since they can account for effects of multiple chemicals (i.e., additive, synergistic, and antagonistic effects), as well as site-specific factors that may influence the bioavailability of metals (e.g., pH, total organic carbon [TOC], and grain size characteristics). Test endpoints for *Eisenia fetida* were survival, calculated as the percentage of test organisms at test initiation that survived in each replicate at test termination; growth, calculated as weight loss per surviving earthworm in each replicate at test termination, and reproduction, expressed as the number of juveniles and cocoons per surviving earthworm in each replicate at test termination.

The survival, growth (i.e. weight loss), and reproduction data were subjected to hypothesis testing to determine if measured biological responses in SWMU 1 and reference area surface soil samples are equal. Statistical evaluations performed by the testing laboratory indicated that earthworm reproduction (juvenile and cocoon production per surviving earthworm) in SWMU 1 surface soil was not significantly lower than reproduction in each reference area surface soil. It is acknowledged that earthworm reproduction occurred in only three of fourteen SWMU 1 surface soil samples, while reproduction was observed in the negative control and each reference area surface soil sample. This observation could indicate an adverse effect of one or more of the ecological COCs on earthworm reproduction. A significant response was detected by the statistical tests evaluating earthworm survival and growth. However, a clear dose-response relationship could not be established for any of the ecological COCs. Therefore, it was concluded that physical and/or chemical parameters other than ecological COC concentrations were responsible for or influencing the observed biological responses.

Pair-wise linear regressions and multiple regressions were run to further examine the relationship between earthworm survival and weight loss and the chemical/physical characteristics of SWMU 1 surface soil. The pair-wise linear regressions indicated that none of the ecological COCs had a significant influence on earthworm survival and weight loss. However, pH at test initiation, pH at test termination, and TOC had a significant influence on earthworm survival, while pH at test termination and TOC had a significant influence of earthworm weight loss. The regression reports for these variables showed the following relationships:

- Earthworm survival decreased as surface soil pH increased (pH at test initiation and test termination)

- Earthworm survival increased as surface soil TOC concentrations increased

- Earthworm weight loss increased as surface soil pH increased

- Earthworm weight loss decreased as surface soil TOC increased

To further evaluate the relationship between TOC, pH, and ecological COC concentrations in surface soil and earthworm responses in the toxicity tests (survival and weight loss), a multiple regression analysis was performed using NCSS software. Prior to the analysis, the All Possible Regression variable selection routine was run to identify appropriate models to include within the multiple regression analyses. A five variable model was selected for the survival endpoint (TOC, 4,4'-DDE, lead, mercury, and zinc), while a four variable model was selected for the growth endpoint (TOC, copper, mercury, and zinc). Multiple regression analysis indicated that both models are significant. Independent variables within each model also were found to have a significant influence on survival (TOC, 4,4'-DDE, lead, and zinc) and weight loss (TOC, mercury, and zinc). The lack of a dose response in the toxicity test data paired with the significant pair-wise and multiple regression results suggest that the bioavailability and toxicity of the ecological COCs are being influenced by TOC. However, this modifying factor, as well as other factors such as additive, synergistic, or antagonistic effects of co-located ecological COCs, prevent the establishment of a clear relationship between individual ecological COC concentrations in surface soil and earthworm responses in the toxicity tests.

In summary, the three lines of evidence used to evaluate terrestrial invertebrate direct contact exposures to ecological COCs in SWMU 1 surface soil support a conclusion of unacceptable risk. However, clear relationships between ecological COC concentrations in surface soil and earthworm responses in the toxicity tests could not be established.

Terrestrial Avian Omnivore Populations

A single line of evidence was used to evaluate potential risks to terrestrial avian omnivores from dietary exposures to 4,4’-DDD, 4,4’-DDE, 4,4’-DDT, antimony, cadmium, copper, lead, mercury, tin, and zinc in SWMU 1 surface soil. The American robin was used as a representative species for terrestrial avian omnivores at SWMU 1, including the endangered yellow-shouldered blackbird. Dietary intakes were estimated using (1) 95 percent UCL of the mean surface soil concentrations for a combined data set consisting of analytical data from the 1992 SI, 1996 RFI, 2004 additional data collection investigation, and BERA field investigation data set, and (2) 95 percent UCL of the mean tissue data from earthworms maintained in surface soil during toxicity testing (the maximum 4,4’-DDD tissue concentration was used to estimate the dietary intake for this organochlorine pesticide based on the low number of detections in earthworm tissue). Ingestion-based risk estimates (i.e., HQ values) for the American robin were calculated by dividing dietary intakes by literature-based no observed adverse effect level (NOAEL) values (because the American robin was used as a surrogate receptor for the yellow-shouldered blackbird, conclusions regarding the acceptability of risk are based solely on NOAEL-based risk estimates):

Ecological COC	NOAEL-Based Hazard Quotient Value (1)
Pesticides:	
4,4’-DDD	11.37
4,4’-DDD	11.98
4,4’-DDE	14.32
Metals:	
Antimony	<0.01
Cadmium	0.25
Copper	1.19
Lead	3.22
Mercury	0.88
Tin	2.81
Zinc	0.24

(1) NOAEL-based hazard quotient values are based on 95 percent UCL of the mean surface soil and earthworm tissue concentrations

Although antimony, copper, and tin were not identified as ecological COCs for terrestrial avian omnivore food web exposures in Step 3a of the ERA process (Baker, 2006a and 2007), dietary intakes were estimated for these three metals using earthworm tissue concentrations since maximum concentrations were detected in surface soil collected during the BERA field investigation. As evidenced by the table above, 4,4’-DDD, 4,4’-DDE, 4,4’-DDT, copper, lead, and tin NOAEL-based HQ values using 95 percent UCL of the mean surface soil and earthworm tissue concentrations are greater than 1.0. The HQ values indicate that these six chemicals are bioaccumulating in earthworm tissue at concentrations that could impact terrestrial avian omnivore populations that feed exclusively on terrestrial invertebrates within the upland areas at SWMU 1. NOAEL-based risk estimates for American robin dietary exposures to antimony, cadmium, mercury and zinc in SWMU 1 surface soil are less than 1.0 (<0.01, 0.25, 0.88, and 0.24, respectively). The HQ values indicate that these four metals are not bioaccumulating in earthworm tissue at concentrations that could impact terrestrial avian omnivore populations feeding exclusively on terrestrial invertebrates at SWMU 1.

To determine if potential risks presented by copper, lead, tin 4,4’-DDD, 4,4’-DDE, and 4,4’-DDT, to terrestrial avian omnivore populations at SWMU 1 are site-related, risk estimates also were derived for American robin dietary exposures to these six chemicals in Upland Reference Area No. 2 surface soil. Based on the low number of surface soil samples collected at the upland reference area during the BERA field investigation (six surface soil samples) and the low number of upland reference area earthworm tissue samples submitted for analytical testing (three earthworm tissue samples), 95 percent UCL of mean surface soil and earthworm tissue concentrations could not be calculated. Therefore, upland reference area risk estimates were derived using maximum surface soil and earthworm tissue concentrations. In the case of non-detected chemicals (i.e., 4,4'-DDD, 4,4'-DDD, and 4,4'-DDT), risk estimates were derived using maximum reporting limits. To allow for a direct comparison of SWMU 1 HQ values to Upland Reference Area No. 2 HQ values, maximum surface soil and earthworm tissue concentrations also were used to derive risk estimates for American robin dietary exposures at SWMU 1. Maximum NOAEL-based HQ values for American robin dietary exposures at SWMU 1 and Reference Area No. 2 are summarized in the table below. Included within the table are NOAEL-based residual risk estimates, derived by subtracting the Upland Reference Area No. 2 risk estimates from the SWMU 1 risk estimates (the value represents that component of risk which is site-related). Because Upland Reference Area No. 2 risk estimates for organochlorine pesticides are based on maximum reporting limits (non-detected in reference area surface soil and earthworm tissue exposed to reference area surface soil during toxicity testing), 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT risks presented at SWMU 1 were assumed to be entirely site-related (i.e., SWMU 1 risk estimates were used as residual risk estimates).

Ecological COC	NOAEL-Based Hazard Quotient Value (1)		
	SWMU 1	Reference Area	Residual Risk
Pesticides: 4,4'-DDD	12.45	0.04	12.45
4,4'-DDD	46.49	0.06	46.49
4,4'-DDE	28.68	0.10	28.68
Metals: Copper	4.49	0.28	4.21
Lead	10.14	0.19	9.95
Tin	3.98	2.98	1.00

(1) NOAEL-based hazard quotient values are based on maximum surface soil and earthworm tissue concentrations.

As evidenced by the table, maximum NOAEL-based HQ values for American robin dietary exposures to copper, lead, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT in reference area surface soil are less than 1.0, while maximum NOAEL-based HQ values for American robin dietary exposures to these five chemicals in SWMU 1 surface soil exceed 1.0. The HQ values clearly indicate that potential risks presented by copper, lead, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT in SWMU 1 surface soil are site-related. NOAEL-based HQ values for American robin dietary exposures to tin in SWMU 1 and Upland Reference Area No. 2 surface soil exceed 1.0 (3.98 and 2.98, respectively). The HQ values show that potential risks from dietary exposures to tin in SWMU 1 surface soil exceed potential risks at the reference area. The difference represents that component of risk that is site-related.

The single line of evidence used to evaluate terrestrial avian omnivores supports a conclusion of unacceptable risk from dietary exposures to 4,4'-DDD, 4,4'-DDE, and 4,4-DDT, copper, lead, and tin in SWMU 1 surface soil.

<u>West Indian Manatees</u>

Identical to the evaluation of terrestrial avian omnivores, a single line of evidence was used to evaluate potential risks to West Indian manatees that may forage within the open water portion of SWMU 1: comparison of estimated arsenic, cadmium, copper, mercury, selenium, and zinc dietary intakes using maximum sediment and turtle grass tissue analytical data to NOAEL-based screening values. As evidenced by the table below, maximum HQ values for arsenic, cadmium, copper, mercury, selenium, and zinc concentrations are less than 1.0, indicating that these six metals are not bioaccumulating in turtle grass at concentrations that would impact West Indian manatees feeding exclusively within the open water portion of SWMU 1.

Ecological COC	NOAEL-Based HQ Value
Arsenic	0.30
Cadmium	0.21
Copper	0.06
Mercury	0.81
Selenium	0.43
Zinc	0.25

Because the evaluation did not detect any unacceptable risks to West Indian manatees feeding exclusively at SWMU 1, risk estimates for West Indian manatees feeding exclusively at the open water reference area were not derived.

Recommendations

The lines of evidence for terrestrial invertebrates and terrestrial avian omnivores, when evaluated using a weight-of-evidence approach and taking into consideration the uncertainty associated with them, support additional evaluation. Initially, it is recommended that an Interim Corrective Measure (ICM) be performed (i.e., soil removal) to eliminate potential risks to terrestrial invertebrates and terrestrial avian omnivores from exposures to 4’4,-DDD, 4,4’-DDE, 4,4’-DDT, antimony, copper, lead, and/or tin in surface soil. The ICM will focus on these seven chemicals based on their co-location with one another and/or their limited spatial extent above soil screening values. Specifics of the soil removal action, including locations and volumes, will be detailed within the ICM’s Basis of Design Report. Following the ICM, it is recommended that SWMU 1 proceed to a CMS to further address the low-level, wide-spread spatial coverage of mercury and zinc concentrations above soil screening values. As part of the CMS, CAOs for these two metals will be developed. Based on the evaluation of West Indian manatee dietary exposures using measured ecological COC concentrations in turtle grass tissue and sediment, a recommendation of corrective action complete without controls is made for sediments within the Ensenada Honda.

1.0 INTRODUCTION

This document presents Step 5 (field verification), Step 6 (data analysis and evaluation), and Step 7 (risk characterization) of the baseline ecological risk assessment (BERA) for Solid Waste Management Unit (SWMU) 1 – Army Cremator Disposal Site, located at Naval Activity Puerto Rico (NAPR), formerly Naval Station Roosevelt Roads (NSRR), Ceiba, Puerto Rico. This report has been prepared by Baker Environmental, Inc. (Baker) under contract to the Atlantic Division, Naval Facilities Engineering Command (NAVFAC Atlantic), Contract Number N62470-02-D-3052, Contract Task Order (CTO) 0108 and conforms to the provisions of the Resource Conservation and Recovery Act (RCRA) 7003 Administrative Order on Consent (United States Environmental Protection Agency [USEPA] Docket No. RCRA-02-2007-7301).

The BERA at SWMU 1 was performed in accordance with Navy policy for conducting ecological risk assessments (ERAs) (Chief of Naval Operations [CNO], 1999) and the Navy guidance for conducting ERAs (available at http://web.ead.anl.gov/ecorisk/), as well as guidance provided by the USEPA (1997a). The Navy ERA process (see Figure 1-1) consists of eight steps organized into three tiers and represents a clarification and interpretation of the eight-step ERA process outlined in the USEPA ERA guidance for the Superfund program (USEPA, 1997a). Tier 1 of the Navy ERA process represents the screening-level ERA (SERA), which consists of the following steps:

- Step 1 – Screening-Level Problem Formulation
- Step 2 – Screening-Level Exposure Estimate and Risk Calculation

The BERA represents Tier 2 of the Navy ERA process, which consists of the following steps:

- Step 3 – Baseline Problem Formulation
- Step 4 – Study Design/Data Quality Objectives (DQOs)
- Step 5 – Verification of Field Sampling Design
- Step 6 – Site Investigation and Data Analysis
- Step 7 – Risk Characterization

Under Navy policy and guidance, Step 3 is divided into two activities (i.e., Steps 3a and 3b). In Step 3a, the conservative exposure assumptions applied in the SERA are refined and risk estimates are recalculated using the same preliminary conceptual model developed in Step 1. The evaluation of risks in Step 3a may also include consideration of background data and chemical bioavailability. Step 3b (Baseline Problem Formulation) involves an evaluation of the toxicity of site-related chemicals, as well as the refinement of the preliminary conceptual model and assessment endpoints. Step 4 involves the development of measurement endpoints, the study design, and DQOs for the BERA, which may be adjusted based on verification of the field sampling design (Step 5).

Steps 1, 2, and 3a of the Navy ERA process were previously presented in the document entitled *Final Additional Data Collection Report and Screening-Level Ecological Risk Assessment and Step 3a of the Baseline Ecological Risk Assessment at SWMUs 1 and 2* (Baker, 2006a). Based on the determination of potential unacceptable risks to terrestrial invertebrates (from exposures to antimony, cadmium, copper, lead, mercury, tin, zinc, 1,1-dichloro-2,2-

bis(*p*-chlorophenyl)ethylene [4,4'-DDD], 1,1-dichloro-2,2-bis(*p*-chlorophenyl)ethane [4,4'-DDE], and 1,1,1-trichloro-2,2-bis(*p*-chlorophenyl)ethane [4,4-DDT] in surface soil and 4,4'-DDE and 4,4'-DDT in subsurface soil), avian omnivores (from food web exposures to cadmium, lead, mercury, zinc, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT in surface soil), avian herbivores (from food web exposures to lead in surface soil), and the West Indian manatee (*Trichechus manatus*) (from food web exposures to arsenic, cadmium, copper, mercury, selenium, and zinc in Ensenada Honda sediment), Step 3a included a recommendation that SWMU 1 be carried into Step 3b of the Navy ERA process. In response to this recommendation, Steps 3b and 4 of the Navy ERA process were developed and presented in the document entitled *Final Steps 3b and 4 of the Baseline Ecological Risk Assessment for SWMUs 1 and 2* (Baker, 2007).

This report reiterates Steps 1 through 4 of the Navy ERA process at SWMU 1, when appropriate, to provide clarity and presents Step 5 (Verification of Field Sampling Design; conducted after finalization of the Steps 3b and 4 document), Step 6 (Site Investigation and Data Analysis), and Step 7 (Risk Characterization) of the BERA. Step 6 includes both the site investigation and data analysis, in which information collected during the BERA field investigation is used to characterize exposures and ecological effects. Step 7 of the BERA characterizes potential ecological risks at the SWMU using a weight-of-evidence approach. This characterization is used to make one of the following two risk management decisions:

1) No further evaluation or action from an ecological perspective is warranted because the SWMU does not pose unacceptable risk.

2) The SWMU poses unacceptable ecological risks and additional evaluation in the form of corrective measure alternatives development and evaluation (Tier 3; Step 8) is appropriate.

The organization of this document is as follows:

- Section 1. Introduction – Summarizes the risk assessment process and report organization.

- Section 2. BERA Problem Formulation and Study Design/Data Quality Objectives – Provides a description of NAPR and SWMU 1 and reviews Steps 3b and 4 of the BERA.

- Section 3. BERA Field Investigation Summary – Reviews the various field and laboratory investigation activities that were implemented in conjunction with Steps 5 and 6 of the BERA.

- Section 4. Analytical Results and Data Analysis – Presents the analytical data for biotic and abiotic media collected during field investigation activities and provides an evaluation of these data.

- Section 5. Risk Characterization – Characterizes risks to ecological receptors from exposures to ecological chemicals of concern (COCs) identified in Step 3a of the BERA using a weight-of-evidence approach.

- Section 6. Conclusions and Recommendations.

- Section 7. Uncertainties.

- Section 8. References.

Supporting documentation, including field notes and data validation summary reports, is provided within the appendices.

2.0 BERA PROBLEM FORMULATION AND STUDY DESIGN

Step 3b of the Navy ERA process represents the BERA problem formulation, while Step 4 establishes the measurement endpoints, study design, and DQOs for the site investigations necessary to complete the ERA. The SWMU background (i.e., description, history, and environmental setting) is presented, ecological COCs are identified, the toxicity of each COC is evaluated, the site conceptual model is described, the assessment and measurement endpoints are identified, and the BERA study design is outlined. Steps 3b and 4 were originally presented in the *Final Steps 3b and 4 of the Baseline Ecological Risk Assessment for SWMUs 1 and 2* (Baker, 2007). The main components of these steps are presented within this section.

2.1 SWMU 1 Description

NAPR occupies over 8,600 acres on the northern side of the east coast of Puerto Rico (see Figure 2-1), along Vieques Passage, with Vieques Island lying to the east about 10 miles off the harbor entrance. NAPR also occupies the immediately adjacent islands of Piñeros and Cabeza de Perro, as presented on Figure 2-2. The north entrance to NAPR is about 35 miles east along the coast road (Route 3) from San Juan. The closest large town is Fajardo (population approximately 41,000), which is located approximately 10 miles north of NAPR off Route 3. Ceiba (population approximately 18,000) adjoins the western boundary of NAPR (see Figure 2-1). NAPR was commissioned in 1943 as a Naval Operations Base. NAPR continued in this status until 1957 when it was redesignated a Naval Station (NSRR) with the mission of providing full support for Atlantic Fleet weapons training and development activities. NSSR operated as a Naval Station until March 31, 2004 at which time NSRR underwent operational closure. On April 1, 2004, NSSR was re-designated as NAPR. The current primary mission of NAPR is to protect the physical assets remaining, comply with environmental regulations, and sustain the value of the property until final disposition of the property.

SWMU 1, located east of the Navy Lodge, encompasses an area of roughly 116 acres of land (see Figure 2-2). The SWMU is bounded to the north by Kearsage Road leading to the U.S. Customs Pier, Ensenada Honda to the east, estuarine wetlands to the south, and the Navy Lodge and Bowling Alley to the west. In addition to the upland habitat depicted on Figure 2-3, estuarine wetland and open water habitat are included within the boundary of SWMU 1. Based on previous reports, the Army Cremator Disposal Site operated from the early 1940s until the early 1960s and was the main station landfill during this period. The waste material was disposed of by piling, burning, and compacting (A.T. Kearney, Inc., 1988). According to the Naval Energy and Environmental Support Activity (NEESA), an estimated 100,000 tons of waste, including scrap metal, inert ordnance, batteries, tires, appliances, cars, cables, dry cleaning solvent cans, paint cans, gas cylinders, construction debris, dead animals, and residential waste was disposed of at this SWMU (NEESA, 1984). No reliable information exists regarding the amounts of material present in the disposal area that could be hazardous; however, in 1984, an Initial Assessment Study (IAS) team estimated that as much as 1,000 tons of hazardous material could be present (NEESA, 1984)

2.2 Environmental Setting

The sections that follow provide a description of the habitats and biota occurring at NAPR. The description of habitats and biota relies primarily on literature-based information for Puerto Rico and NAPR. This information is supplemented by observations recorded during a habitat characterization conducted within the upland and estuarine wetland habitats at SWMU 1 in May 2000 (the open water portion of the SWMU was not investigated). The habitat characterization report is included as Appendix A.

2.2.1 Terrestrial Habitats

The upland habitat bounded by NAPR is classified as subtropical dry forest (Ewel and Witmore, 1973). Similar to other forested areas of Puerto Rico, this region was previously clear-cut in the early part of the century, primarily for pastureland (Geo-Marine, Inc., 1998). After acquisition by the Navy, a secondary growth of thick scrub, dominated by lead tree (*Leucaena* spp.), Christmas tree (*Randia aculeata*), sweet acacia (*Acacia farnesiana*), and Australian corkwood (*Sesbania grandiflora*) grew in the previously grazed sections (Geo-Marine, Inc., 1998). Secondary growth communities (upland coastal forest communities and coastal scrub forest communities) exist today throughout the station's undeveloped upland.

The upland vegetative communities within and contiguous to SWMU 1 are classified as coastal scrub forest and upland coastal forest communities (see Figure 2-3). The SWMU's coastal scrub forest community is limited to two stratums (shrub and herbaceous). *Panicum maximum* (no common name) and lead tree (*Leucaena leucocephala*) dominate the herbaceous and shrub stratums, respectively. The upland coastal forest community exhibits multiple layers of stratification (herbaceous, shrub, and tree layers). The herbaceous stratum is dominated by *Panicum maximum*, while lead tree, almácigo (*Bursera simaruba*), and Christmas tree dominate the shrub layer. Species found within the tree layer include basket wiss (*Trichostigma octandrum*), guayaba (*Psidium guajava*), and oxhorn bucida (*Bucida buceras*). Maintained grasses, including *Bothriochloa ischaemum*, *Chloris barbata*, and *Digitaria* spp., dominate areas immediately adjacent to road corridors.

Cobana negra (*Stahlia monosperma*), a federally threatened tree species, is known to occur between the boundary of black mangrove communities and coastal upland forest communities. This species is also known to occur in coastal forests of southeastern Puerto Rico (Little and Wadsworth, 1964). A single individual was encountered at NAPR during recent surveys conducted by Geo-marine, Inc. (NAVFAC, 2006). This individual is located within a coastal scrub forest community near the Capehart housing area, west of American Circle (see Figure 2-4). This location is approximately 1.3 miles from SWMU 1. Cobana negra were not observed at SWMU 1 during the May 15 to May 19, 2000 habitat characterization. No other plant species listed under the provisions of the Endangered Species Act of 1973 are known to occur or have the potential to occur at NAPR (Geo-Marine, Inc., 2000 and NAVFAC, 2006).

2.2.2 Aquatic Habitats

Approximately 460 acres at NAPR are covered by palustrine habitat, which includes all freshwater wetlands. These wetlands include wet meadows and marshes, dominated by cattails (*Typha* spp.) and grasses (*Panicum* spp. and *Paspalum* spp.), as well as wet coastal scrub forests. The marine environment surrounding NAPR includes mudflats (161 acres), mangroves (2,700 acres), and seagrass beds (1,900 acres) (Geo-Marine, Inc., 1998). Coral reefs are also located in the offshore marine environment (see Figure 2-3). Coral reef types within the waters surrounding NAPR, as well as their associated acreage cover are provided within the table below (Department of the Navy [DoN], 2007).

Reef Habitat Type	Area (acres)
Colonized Bedrock	266
Linear Reef	84
Patch Reef (Aggregated/Individual)	146/175
Scattered Coral-Rock	5

As evidenced by Figure 2-3, coral reefs are not located within the open water potion of SWMU 1. The nearest reef habitat is located at the mouth of the Ensenada Honda (approximately 1.05 miles from SWMU 1).

Mangroves at NAPR mainly consist of red mangrove (*Rhizophora mangle*), black mangrove (*Avicenia germinans*), and white mangrove (*Laguncularia racemosa*) (Geo-Marine, Inc., 2000 and 2005). Red mangroves tolerate relatively deep water levels, grow in unstable, soft soil, and tolerate a salinity range of 10 to 55 parts per thousand (ppt). They develop large prop roots which usually extend above the water surface. Black and white mangroves generally grow in areas that are not inundated by water. Mangroves at NAPR are natural filters for upland runoff and protect the coastline from storm damage (Lewis, 1986). They also provide habitat for wildlife, fish, and benthic invertebrates. Lewis (1986) reported 112 species of birds that use the NAPR mangroves as habitat for feeding, nesting, and roosting. The red mangrove prop root habitat in Puerto Rico also is used by at least 13 species of fish (including the gray snapper [*Lutijanus griseus*], lane snapper [*Lutijanus synagris*], and gold and black tricolor [*Holocanthus tricolor*]), several crustaceans (including the flat tree oyster [*Isognomon alatus*]), gastropods (including the coffee bean snail [*Melampus coffeus*] and mangrove periwinkle [*Littorina angulifera*]), echinoids (including the long-spined sea urchin [*Diadema antillarum*] and pencil sea urchin [*Eucidaris tribuloides*]), sponges (including the fire sponge [*Tedania ignis*]), ascidians (including the black tunicate [*Acsidia nigra*]), and hydroids (including the feathered hydroid [*Halocordyle disticha*]) (Geo-Marine, Inc., 2005).

The seagrass beds in eastern Puerto Rico are typical of well developed climax meadows found throughout the tropical Atlantic and Caribbean basin, consisting primarily of a dense, continuous cover of turtle grass (*Thalassia testudinum*), with lesser amounts of manatee grass (*Syringodium filiforme*) and a wide diversity of calcareous algae (Reid et al., 2001). Patchy and sparse beds of mixed species, including shoal grass (*Halodule wrightii*), manatee grass, and paddle grass (*Halophila decipiens*), occur in localized areas affected and maintained by different wave regimes, substrate type, and turbidity than what is normally found in association with the climax turtle grass meadows.

The aquatic habitats occurring within and contiguous to SWMU 1 are depicted on Figures 2-3 and 2-5. As evidenced by both figures, an extensive estuarine wetland system is located within and contiguous to SWMU 1. The wetland units depicted on Figure 2-5, identified by the Cowardin Wetland Classification System (Cowardin et al., 1979; see Figure 2-6), were delineated by Geo-Marine, Inc. in December 1999 from 1993 color infrared and 1998 true color aerial photography. Twenty percent of the wetlands delineated by aerial photography were field checked to verify the accuracy of the delineations. Field verification was based on the 1987 Corps of Engineers wetland delineation manual (United States Army Corps of Engineers [USACE], 1987). The estuarine wetland system within and contiguous to SWMU 1 includes both black and red mangrove communities. Red mangroves occur immediately adjacent to the Ensenada Honda (open water habitat), while black mangroves occur between the red mangrove and coastal upland forest community. The red mangrove community is sparsely vegetated (approximately 25 percent; Geo-Marine, Inc., 2000), with large pools of water present. Specific wetland units located within the estuarine wetland system include the following Cowardin classifications: E2SS3 (Estuarine, Intertidal, Scrub-Shrub, Broad-Leaved Evergreen); E2US3 (Estuarine, Intertidal, Unconsolidated Shore, Mud); and E2US4 (Estuarine, Intertidal, Unconsolidated Shore, Organic). As evidenced by Figure 2-5, there are no freshwater wetland units within or contiguous to SWMU 1.

Seagrass beds are prevalent throughout much of the Ensenada Honda, including the open water portion of SWMU 1 (see Figure 2-3). Seagrass meadows within the Ensenada Honda are dominated by a nearly continuous cover of turtle grass with a high abundance of calcareous green algae (*Avranvilla* spp., *Ventricaria ventricosa*, *Caulerpa* spp., *Valonia* spp., and *Udotea* spp.) (Reid et al., 2001). The turtle grass climax meadows of the Ensenada Honda represent potential grazing areas for the West Indian manatee, a federally endangered species in Puerto Rico, and the green sea turtle (*Chelonia mydas*), a federally threatened species in Puerto Rico.

2.2.3 Biota

A description of the biota occurring within Puerto Rico and the landmass encompassed by NAPR is provided in the sections that follow. This description is supplemented by information contained within the habitat characterization report for SWMU 1 (see Appendix A).

2.2.3.1 Mammals

A total of 22 terrestrial mammal species are known historically from Puerto Rico; however, all mammals except bats (13 species) have been extirpated (Mac et al., 1998). The specific bat species known to occur on Puerto Rico are listed below. None of the bats found on Puerto Rico are exclusive to the island, nor are they listed under the provisions of the Endangered Species Act of 1973.

- Fruit-eating bats: Jamaican fruit bat (*Artibeus jamaicensis*), Antillean fruit bat (*Brachyphylla cavernarum*), and red fig-eating bat (*Stenoderma rufum*)

- Nectivorous bats: brown flower bat (*Erophylla sezekoni bombifrons*) and greater Antillean long-tounged bat (*Monophyllus redmani*)

- Insectivorous bats: Antillean ghost-faced bat (*Mormoops blainvillii*), Parnell's mustached bat (*Pteronotus parnellii*), sooty mustached bat (*Pteronotus quadridens*), big brown bat (*Eptesicus fuscus*), red bat (*Lasiurus borealis*), velvety free-tailed bat (*Molossus molossus*), and Brazilian free-tailed bat (*Tadarida brasiliensis*)

- Piscivorous bats: Mexican bulldog bat (*Noctilio leporinus*)

Of the endangered/threatened marine mammals listed in Puerto Rico, only the West Indian manatee is known to occur in the coastal waters surrounding NAPR (DoN, 2007). Manatee populations in Puerto Rico's coastal waters have been documented during three aerial surveys conducted from 1978 to 1979, 1984 to 1985, and in 1993 (United Nations Environmental Program [UNEP], 1995), a radio tracking study of manatee distribution and abundance (Reid and Kruer, 1998), and a year-long study of manatee distribution and abundance (Woods et al., 1984). Historical manatee sightings at NAPR are depicted on Figure 2-7. The figure (reproduced from DoN, 2007) includes information from most of the studies identified above. Feeding manatees are most often recorded within Pelican Cove and the Ensenada Honda (see Figure 2-7). Manatee sightings within the Ensenada Honda include locations within and adjacent to SWMU 1.

Several terrestrial mammals have been introduced to Puerto Rico, including the black rat (*Rattus rattus*), Norway rat (*Rattus norvegicus*), and small Indian mongoose (*Herpestes javanicus*). These nonindigenous mammals have been implicated in the decline of native bird and reptile populations (Mac et al., 1998 and United States Fish and Wildlife Service [USFWS], 1996a).

2.2.3.2 Birds

A total of 239 bird species are native to Puerto Rico (Raffaele, 1989). This total includes breeding permanent residents and non-breeding migrants. In addition, many nonindigenous bird species have been introduced to Puerto Rico, including the shiny cowbird (*Molothrus bonariensis*) and several parrot species, such as the budgerigar (*Melopsittacus undulates*), orange-fronted parrot (*Aratinga canicularis*), and monk parrot (*Myiopsitta monaqchus*). Of the 239 species native to Puerto Rico, 12 are endemic to the island (Raffaele, 1989):

Numerous native and migratory bird species have been reported at NAPR (Geo-Marine, Inc., 1998). A list compiled from literature-based information pre-dating 1990 (see Table 2-1) includes the great blue heron (*Ardea herodias*), snowy egret (*Egretta thula*), little blue heron (*Florida caerulea*), black-crowned night heron (*Nycticorax nycticorax*), belted kingfisher (*Ceryle alcyon*), spotted sandpiper (*Actitis macularia*), greater yellowlegs (*Tringa melanoleauca*), black-bellied plover (*Squatarola squatarola*), clapper rail (*Rallus longirostris*), Royal tern (*Thalasseus maximus*), sandwich tern (*Thalasseus sandvicensis*), least tern (*Stema albifrons*), yellow warbler (*Dendroica petechia*), palm warbler (*Dendroica palmarum*), prairie warbler (*Dendroica discolar*), magnolia warbler (*Dendroica magnolia*), mourning dove (*Zenaida macroura*), red-legged thrush (*Mimocichla plumbea*), common nighthawk (*Chordeiles minor*), and red-tailed hawk (*Buteo jamaicensis*). Endemic species reported from NAPR include the Puerto Rican lizard cuckoo (*Saurothera vieilloti*), Puerto Rican flycatcher (*Myiarchus antillarum*), Puerto Rican woodpecker (*Malanerpes portoricensis*), Puerto Rican emerald (*Chlorostilbon maugaeus*), and yellow-shouldered blackbird (*Agelaius xanthomus*).

The yellow-shouldered blackbird is a federally endangered species. One of the principal reasons for the status of this species is attributed to parasitism by the nonindigenous shiny cowbird, which lays its eggs in blackbird nests and sometimes punctures the host's eggs (USFWS, 1983). Other factors contributing to the status of this species include nest predation by the introduced black rat, Norway rat, and mongoose, as well as habitat modification and destruction (USFWS 1996a). The entire land area of NAPR was declared critical habitat for the yellow-shouldered blackbird in 1976; however, a 1980 agreement with the USFWS exempted certain areas from this categorization (Geo-Marine, Inc., 1998). SWMU 1 is located within the critical habitat designation for the yellow-shouldered blackbird. A study conducted by the Naval Facilities Engineering Service Center (NFESC, 1996) reported that the mangrove forests surrounding NAPR, including the mangrove communities at SWMU 1, should be considered the most important nesting habitat for the yellow-shouldered blackbird. Based on the arboreal feeding behavior of the yellow-shouldered blackbird, potential feeding habitat (shrub and tree layers within the coastal scrub forest and/or upland coastal forest communities) is present at the SWMU (Geo-Marine, Inc., 2000). A survey conducted by the Puerto Rico Department of Natural Resources (PRDNR) reported fifteen yellow-shouldered blackbirds (including five juveniles) at NAPR (PRDNR, 2002). At the time of the survey, the birds were using structures at the NAPR airport for resting cover. Although nesting pairs were not observed (the survey was not conducted during the breeding season), the airport structures contained several inactive nests. The inactive nests and juvenile birds indicate that a small breeding population is present at NAPR. Yellow-shouldered blackbirds were not observed within the SWMU's upland coastal forest and coastal scrub forest communities during the May 2000 habitat characterization (Geo-Marine, Inc., 2000).

Other federally listed bird species that occur or have the potential to occur at NAPR are the Caribbean brown pelican (*Pelecanus occidentalis occidentalis*), roseate tern (*Sterna dougallii dougallii*), and the piping plover (*Charadrius melodus*) (Geo-Marine, Inc., 1998). The piping plover is a rare, non-breeding winter visitor in Puerto Rico (Raffaele, 1989). This species breeds only in North America in three geographic regions (Atlantic Coast population [threatened], Great Lakes population [endangered], and Northern Great Plains population [threatened]; USFWS, 1996b). No piping plover observations were reported at NAPR during the 1990s or during sea turtle nesting surveys conducted in 2002 and 2004 (Geo-Marine, Inc., 2005). No historic evidence is available to indicate whether the roseate tern (threatened in Puerto Rico) has ever nested at NAPR and no roseate tern observations have been noted in or over coastal waters adjacent to NAPR (DoN, 2007). The nearest active roseate tern colony likely occurs on the eastern end of Vieques (more than 20 miles east of NAPR) (DoN, 2007). The Caribbean brown pelican (endangered in Puerto Rico) appears to be a seasonal resident at NAPR and in the surrounding coastal waters (Geo-Marine, Inc., 2005). Small numbers, primarily juveniles, have been seen day-roosting, feeding, and resting irregularly in onshore and near-shore habitats at NAPR; however, no brown pelican nesting colonies have been found at NAPR or on the small cays nearby (Geo-Marine, Inc., 2005). Based on the habitat preferences and observations recorded at NAPR, only the brown pelican has the potential to use the open water habitat at SWMU 1 (i.e., Ensenada Honda) as a food source. It is important to note that the USFWS recently published a proposed rule to remove the brown pelican from the federal list of endangered and threatened wildlife throughout its range, including Puerto Rico (see Federal Register: Volume 73, Number 34, Page 9408 dated February 20, 2008). This proposed rule indicates that special consideration of the brown pelican at NAPR is not warranted.

Several bird species were observed within the upland coastal forest, coastal scrub forest, and/or mangrove communities at SWMU 1 during the May 2000 habitat characterization (see Appendix A). Specific species observed included the green mango (*Anthracothrax viridis*), red-tailed hawk, Puerto Rican woodpecker, loggerhead kingbird (*Tyannus caudifasciatus*), zenaida dove, pearly-eyed thrasher (*Margarops fuscatus*), northern mockingbird (*Mimus polygottos*), greater antillen grackle (*Quiscalus niger*), gray kingbird (*Tyrannus dominicensis*), and yellow warbler.

2.2.3.3 Reptiles and Amphibians

A total of 23 amphibians and 48 reptiles are known from Puerto Rico and the adjacent waters (Mac et al., 1998). Fifteen of the amphibians and 29 of the reptiles are endemic, while four amphibian species and three reptilian species have been introduced (Mac et al., 1998). Puerto Rico's native amphibian species include 16 species of tiny frogs commonly called coquis. On the coastal lowlands, almost all coqui species are arboreal. The only amphibians listed under provisions of the Endangered Species Act of 1973 are the Puerto Rican crested toad (*Peltophryne lemur*) and the golden coqui (*Eleutherodactylus jasperi*). Both species are listed as threatened (USFWS, 2008). Distribution of the golden coqui is restricted to areas of dense bromeliad growth. All specimens to date have been collected from a small semicircular area of a 6-mile radius south of Cayey (approximately 30 miles southwest of NAPR), generally at elevations above 700 meters (USFWS, 1984). The Puerto Rican crested toad occurs at low elevations (below 200 meters) where there is exposed limestone or porous, well drained soil offering an abundance of fissures and cavities (USFWS, 1987). A single large population is known to exist from the southwest coast in Guánica Commonwealth Forest, while a small population is believed to survive on the north coast near Quebradillas, Arecibo, Barceloneta, Vega Baja, and Bayamón (USFWS, 1987). It has also been collected on the southeastern coastal plain near Coamo (USFWS, 1987). Given the habitat preferences and locations of known occurrences, these two species are not expected to occur at NAPR.

Puerto Rico's native reptilian species include 31 lizards, 8 snakes, 1 freshwater turtle, and 5 sea turtles (Mac et al., 1998). Of the five sea turtles, only the green sea turtle, hawksbill sea turtle (*Eretmochelys imbricata*), and loggerhead sea turtle (*Dermochelys coriacea*) nest within Puerto Rico. These three sea turtles species, as well as the leatherback sea turtle (*Caretta caretta)* are listed under the provisions of the Endangered Species Act of 1973 (hawksbill sea turtle and leatherback sea turtle are listed as endangered, while the green sea turtle [Caribbean population] and loggerhead sea turtle are listed as threatened) (USFWS, 2008). Aerial surveys of turtles were performed from March 1984 through March 1995 along the Puerto Rican Coast. This information was summarized by Geo-Marine, Inc. (2005) in the Draft NAPR Disposal Environmental Assessment (EA). Figures 2-8 and 2-9 (reproduced from Geo-Marine, Inc., 2005) present cumulative sea turtle sightings and potential turtle nesting sites at NAPR. Significant turtle observations were made near the mouth of the Ensenada Honda, the northern shore of Pineros Island, Pelican Bay, and the Medio Mundo Passage with the frequency of turtle observations listed as green > hawksbill > loggerhead > leatherback. Based on the life history information for each turtle species (see Baker, 2007) and the availability of forage material (in the form of sea grass), the green sea turtle has the potential to forage within Ensenada Honda, including the open water portion of SWMU 1.

The Puerto Rican boa (*Epicrates inornatus*) is a federally endangered species throughout its entire range (critical habitat has not been designated for this species [USFWS, 1986b]). Four Puerto Rican boa sightings were reported at NAPR prior to 1999 and an additional four occurrences were reported between 2001 and 2003 (Geo-Marine, Inc., 2005). However, no boas were observed during 211 man-hours of surveys conducted within potential boa habitat in 2004 (Tolson, 2004). The Puerto Rican boa uses a variety of habitats but is most commonly found in Karst forest habitat (forested limestone hills). Based on the absence of preferred habitat, there is low probability of occurrence of this species at SWMU 1. The only reptiles species observed with the upland habitat at SWMU 1 during the May 2000 habitat characterization (Geo-Marine, Inc., 2000) were lizards (crested anole [*Anolis cristatellus*], brown lizard [*Anolis cristatellus*], and *Anolis stratulus* [no common name]).

2.2.3.4 <u>Fish and Aquatic Invertebrates</u>

A diverse fish and invertebrate community can be found in the marine environment surrounding NAPR. This can be attributed to the varied habitats that include marine and estuarine open water habitat, mud flats, sea grass beds, and mangrove forests. The fish community is represented by stingrays, herrings, groupers, needlefish, mullets, barracudas, jacks, snappers, grunts, snooks, lizardfishes, parrotfishes, gobies, filefishes, wrasses, damselfishes, and butterflyfish (Geo-Marine, Inc., 1998). The benthic invertebrate community includes sponges, corals, anemones, sea cucumbers, sea stars, urchins, and crabs. A list of known species residing within the estuarine wetland and open water habitats at SWMU 1 is not available. However, numerous fiddler crabs (*Uca* spp.) have been observed within the black and red mangrove communities at and contiguous to SWMU 1 during previous field investigations (Baker, 2006a).

2.3 Ecological Chemicals of Concern

The SERA and Step 3a of the BERA (Baker, 2006a) evaluated the aquatic habitats (estuarine wetland and open water habitat) and terrestrial habitats (upland coastal forest and coastal scrub forest communities) associated with SWMU 1. The assessment endpoints, risk questions, and measurement endpoints selected for the SERA are summarized in Table 2-2a. The ERA used analytical data from the following field investigations (see Table 2-2b and Figure 2-10):

- 1992 Supplemental Investigation (SI): Subsurface soil (0.5 to 1.5-foot depth interval)
- 1996 RCRA Facility Investigation (RFI): Surface soil (0 to 1-foot depth interval)

- 2003 Additional Data Collection Investigation: Surface water and sediment (estuarine wetland and open water habitats)

- 2004 Additional Data Collection Investigation: Surface soil (0 to 1.0-foot depth interval), subsurface soil (1.0 to 2.0-foot depth interval), and sediment (estuarine wetland and open water habitats)

Analytical data from the 1992 SI and 1996 RFI field investigation were presented and discussed within the *Revised Draft RCRA Facility Investigation Report for Operable Unit 3/5* (Baker, 1999), while analytical data from the 2003 and 2004 additional data collection field investigations were presented and discussed within the *Final Additional Data Collection and Screening-Level Ecological Risk Assessment and Step 3a of the Baseline Ecological Risk Assessment at SWMUs 1 and 2* (Baker, 2006a). As noted in Table 2-2b, three samples collected during the 1996 RFI and identified as sediment (i.e., 1SD01 through 1SD03) were re-designated and evaluated as surface soil in the SERA and Step 3a of the BERA (Baker, 2006a) based on observations made in the field during the 2003 additional data collection investigation (i.e., they were collected from vegetated swales containing upland vegetation). Although re-designated and evaluated as surface soil, the sample identification numbers assigned to these samples during the 1996 RFI were not changed. A summary of the SERA and Step 3a evaluation is provided below. Results are also summarized in Table 2-2c for those receptors/receptor groups quantitatively evaluated.

Antimony, cadmium, copper, lead, mercury, tin, zinc, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT in surface soil and 4,4'-DDE and 4,4'-DDT in subsurface soil were identified as ecological COCs in Step 3a of the BERA for terrestrial plants and invertebrates based on the magnitude and frequency of detections above soil screening values, maximum and mean hazard quotient (HQ) values greater than 1.0, and/or results of statistical comparisons to background analytical data. Analytical data for the surface soil and subsurface soil ecological COCs are presented in Tables 2-3 and 2-4, respectively. Screening-level risk estimates for the ecological COCs are summarized in Tables 2-5 (surface soil) and 2-6 (subsurface soil), while ecological COC detections above the soil screening values used in Step 2 of SERA are depicted on Figures 2-11 (surface soil) and 2-12 (subsurface soil).

In addition to terrestrial plants and invertebrates, the SERA and Step 3a of the BERA evaluated potential food web exposures to chemicals in SWMU 1 surface and subsurface soil by upper trophic level terrestrial receptors (i.e., avian herbivores, omnivores, and carnivores). The mourning dove was selected to represent avian herbivores, while the American robin (*Turdus migratorius*) and red-tailed hawk were selected to represent avian omnivores and carnivores, respectively. Cadmium, lead, mercury, zinc, 4'4-DDD, 4,4'-DDE, and 4'4-DDT in surface soil were identified as ecological COCs for terrestrial avian omnivore (American robin) food web exposures based on maximum and/or mean No Observed Adverse Effect Level [NOAEL]-based HQ values greater than 1.0 (maximum HQ values = 168 for cadmium, 103 for lead, 201 for mercury, 129 for zinc, 38.8 for 4,4'-DDD, 49.5 for 4,4'-DDT, and 423 for 4,4'-DDE, while mean HQ values = 1.20 for cadmium, 2.42 for lead, 1.29 for mercury, 2.57 for zinc, 0.89 for 4,4'-DDD, 11.42 for 4,4'-DDE, and 1.14 for 4,4'-DDT). Lead in surface soil also was identified as an ecological COPC for terrestrial avian herbivore food web exposures (maximum and mean NOAEL-based HQ values = 71.9 and 1.34, respectively). No chemical was identified as an ecological COC for terrestrial avian carnivore dietary exposures (see Table 2-2c). Surface soil analytical data for chemicals identified as ecological COCs for terrestrial avian omnivore and herbivore food web exposures are included in Table 2-3. As evidenced by Table 2-2a, terrestrial amphibians and reptiles were qualitatively evaluated in the SERA by examination of exposures and risks to ecological receptors occupying similar trophic levels. Based on the presence of potential risks to terrestrial avian herbivores and omnivores, terrestrial amphibians and reptiles were retained for additional evaluation in Step 3b of the ERA process. Based on the evaluation of the subsurface soil analytical data presented in Table 2-4, no chemical was identified as an ecological COC for terrestrial avian food web exposures to chemicals in SWMU 1 surface soil.

The SERA and Step 3a of the BERA also evaluated lower trophic level aquatic receptor group and upper trophic level receptor exposures to chemicals in SWMU 1 estuarine wetland and Ensenada surface water and sediment. The aquatic receptor groups evaluated for both aquatic habitats were aquatic plants, invertebrates, and fish. The upper trophic level receptors evaluated for estuarine wetland food web exposures were the great blue heron, belted kingfisher, and spotted sandpiper, while the upper trophic level receptors evaluated for Ensenada Honda food web exposures were the double-crested cormorant and West Indian manatee. The SERA and Step 3a of the BERA identified arsenic, mercury, and selenium in Ensenada Honda sediment as ecological COCs for West Indian manatee dietary exposures based on maximum NOAEL-based HQ values greater than 1.0 (HQ values = 28.2 for arsenic, 3.31 for mercury, and 3.58 for selenium). Cadmium, copper, and zinc also were identified as ecological COCs for West Indian manatee dietary exposures based on (1) maximum NOAEL-based HQ values derived using toxicity reference values adjusted to reflect interspecies differences between the test species and the receptor species, and (2) the endangered status of the West Indian manatee (HQ values = 5.66 for cadmium, 1.72 for copper, and 3.43 for zinc). Sediment analytical data for the ecological COCs are presented in Table 2-7. No unacceptable risks were indicated for estuarine wetland and open water plant, benthic invertebrarte, and fish communities. Unacceptable risks also were not indicated for the avian receptors evaluated for estuarine wetland and Ensenada Honda food web exposures (spotted sandpiper, belted kingfisher, great blue heron, and double-crested cormorant). Although aquatic reptiles (i.e., sea turtles [green, hawksbill, leatherback, and loggerhead sea turtles]) were not quantitatively evaluated in the SERA and Step 3a of the BERA, additional evaluation was recommended in Step 3a of the ERA process based on the presence of potentially complete exposure pathways and the status of sea turtles in Puerto Rico (threatened or endangered).

2.4 Conceptual Model

Information on the SWMU's habitat features and the fate and transport of ecological COCs, as well as information on key exposure pathways, routes, and receptor groups were used to refine the preliminary conceptual model developed in Step 1 of the ERA. A graphical representation of the revised conceptual model for SWMU 1 is presented as Figure 2-13. The figure illustrates the primary functional components of the terrestrial and aquatic ecosystems at SWMU 1. The model has been revised to reflect the results of the SERA and Step 3a of the BERA and focuses on the contaminant-receptor combinations where the potential for unacceptable risk has been identified. Components of the revised conceptual model are described in the sections that follow.

2.4.1 Contaminant Fate and Transport and Toxicity Evaluation

The sections that follow include an evaluation of the fate and transport and toxicity of the chemicals identified as ecological COCs in Step 3a of the BERA (antimony, arsenic, cadmium, copper, lead, mercury, selenium, tin, zinc, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT). The toxicity evaluation focus on the chemical-receptor combinations that have the potential for unacceptable impacts (i.e., terrestrial plants and invertebrates: antimony, cadmium, copper, lead, mercury, tin, zinc, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT; terrestrial avian omnivores: cadmium, lead, mercury, zinc, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT; terrestrial avian herbivores: lead; West Indian manatee: arsenic, cadmium, copper, mercury, selenium, and zinc).

2.4.1.1 Antimony

Antimony and its compounds are naturally present in the earth's crust. Although releases to the environment occur from natural processes (e.g., volcanic eruptions), most of the antimony released to the environment is from anthropogenic activities, including metal smelting and refining, coal combustion, and refuse incineration (Agency for Toxic Substances and Disease Registry [ATSDR], 1992).

Antimony displays four oxidation states: Sb^{3-}, Sb^{0}, Sb^{3+}, and Sb^{5+}. The +3 and +5 oxidation states are the most common and stable. Little is known of the adsorptive behavior of antimony, its compounds, and ions. The binding of antimony to soil and sediment is primarily correlated with the iron, manganese, and aluminum content as it co-precipitates with hydroxylated oxides of these elements (ATSDR, 1992). Some forms of antimony may bind to inorganic and organic ligands. Mineral forms are unavailable for binding. Some studies suggest that antimony is fairly mobile under diverse environmental conditions, while others suggest that it is strongly adsorbed to soil (ATSDR, 1992).

Uptake from soil by plants is minor and appears to be correlated with the amount of available antimony (that which is soluble or easily exchangeable). Studies have shown that antimony does not biomagnify from lower to higher trophic levels in terrestrial food chains (ATSDR, 1992).

As a natural constituent of soil, antimony is transported into streams and waterways from weathering of soil as well as from anthropogenic sources. The forms of antimony and the chemical and biochemical process that occur in the aquatic environment are not well understood. Antimony in both aerobic freshwater and seawater is largely in the +5 oxidation state, although antimony in the +3 oxidation state does occurs in these waters. Under reducing conditions, trivalent species such as $Sb(OH)_3$, $Sb(OH)_4^{1-}$, and $Sb_2S_4^{4-}$ may be significant (Andreae and Froehlich, 1984). Antimony can be reduced and methylated by microorganisms in the aquatic environment and become mobilized (Andreae et al., 1983 and Austin and Millward, 1988). This reaction is most likely to occur in reducing environments, such as bed sediments. Antimony does not appear to bioconcentrate appreciably in fish and aquatic organisms (ATSDR, 1992).

Antimony in SWMU 1 surface soil has the potential to impact terrestrial plants and invertebrates. Available literature-based toxicological benchmarks for terrestrial plants and invertebrates are listed below in their order of increasing concentration. The lowest of the listed toxicological benchmarks was used in Step 2 of the SERA and Step 3a of the BERA.

- 5.0 milligram per kilogram (mg/kg): Toxicological benchmark for terrestrial plants (Efroymson et al., 1997a)

- 78 mg/kg: Ecological Soil Screening Level (SSL) for soil invertebrates (USEPA, 2005a)

2.4.1.2 Arsenic

Arsenic is a naturally occurring element that exists mainly in rock or soil and cycles biogeochemically via oxidation and reduction (Eisler, 1988). Arsenate (pentavalent, As^{+5}) is the predominant inorganic form in oxygenated water (where it will be chemically bound to soil or sediment particles) and arsenite (trivalent, As^{+3}) is the predominant arsenic form under anaerobic conditions (USEPA, 1981). Arsenite is water soluble and therefore more mobile and is considered to be the more toxic form (USEPA, 1999). Arsenic is readily adsorbed onto sediments with high organic matter and those with high clay content, sulphur, manganese, iron oxides and aluminum hydroxides (USEPA, 1999 and MacDonald, 1994). Adsorption and release also depend on the arsenic concentration, pH, oxidation-reduction potential (Eh), temperature, salinity, and the ionic concentration of other compounds (ATSDR, 2005a and Eisler, 1988). Transportation within the aquatic environment for bound arsenic, therefore, is largely a function of suspended sediment dynamics or larger-scale erosive events. Changes in the oxidative state and/or biological interactions can release arsenic back into the water column.

In soils, arsenic uptake is dependent upon the form of arsenic available and the physical and chemical properties of the soil, including organic carbon and clay content. Higher organic material and clay content favor binding within the soil as immobile forms, and thus less potential for uptake (USEPA, 1999). Arsenic is generally not bioavailable to aquatic organisms under aerobic conditions (MacDonald, 1994). Arsenic may be bioaccumulated by lower trophic level organisms; however, data does not indicate that significant biomagnification occurs (USEPA, 1999), especially in aquatic food chains. Once within the mammalian body, arsenic readily moves through the body and does not preferentially accumulate in any organs (USEPA, 1999). Arsenic is metabolized (methylated) readily in the liver of mammals to less toxic forms and is subsequently rapidly eliminated (USEPA, 1999). As such, the potential for bioaccumulation in mammalian tissues is minimal. Identified impacts to aquatic organisms include growth, reproduction, behavioral, mutagenic, and carcinogenic effects (MacDonald, 1994).

Based on the SERA and Step 3a of the BERA (Baker, 2006a), arsenic in SWMU 1 sediment (i.e., Ensenada Honda sediment) has the potential to impact the West Indian manatee via dietary (food web) exposures. A literature search, conducted as part of the SERA and Step 3a of the BERA, identified studies that have investigated the toxicological effects of arsenic ingestion by mammals. Neiger and Osweiler (1989; as cited in USEPA 2005b) investigated the effect of arsenic on growth in dogs (*Canis familiaris*). A dose of 1.04 milligrams per kilogram-body weight per day (mg/kg-BW/day) had no effect on body weight. This dose, selected by the USEPA as the TRV for mammalian ecological SSL development, represents the highest bounded NOAEL below the the lowest bounded LOAEL for reproduction, growth, or survival (USEPA, 2005b). Neiger and Osweiler (1989) reported adverse effects (i.e., reduced body weight) at a dose of 1.66 mg/kg-BW/day. This dose is considered a chronic lowest observed adverse effect level (LOAEL). The study by Neiger and Osweiler (1989) forms the basis of the NOAEL (1.04 mg/kg-BW/day) and LOAEL (1.66 mg/kg-BW/day) developed for West Indian manatee dietary exposures to arsenic in SWMU 1 open water sediment (see Section 2.5.4).

2.4.1.3 Cadmium

Cadmium is a naturally occurring element found in phosphate rock. It is used in many industrial applications, including alloy manufacturing, batteries, plastics, paints, fuels, and agricultural products, including fertilizers. It exhibits low vapor pressure and is found in two valence states: Cd^{+0} (metallic/elemental) or Cd^{+2} (divalent). Cadmium is persistent in the environment and is generally stable in soil (ATSDR, 1999a). Terrestrial transformation processes include precipitation, complexation, ion exchange, and dissolution (USEPA, 1999). In the aquatic environment, cadmium is found as a component of organic compounds and as inorganic sulfides, oxides, and halides. Photodegradation and biological degradation are generally not important. Cadmium sorbs to sedimentary particles and precipitates with aluminum, manganese, and iron oxides (MacDonald, 1994 and ATSDR, 1999a). The bioavailability of cadmium is dependent on the chemical and physical properties of the aquatic environment, including redox potential, water hardness, and pH (MacDonald, 1994). The presence of acid volatile sulfide (AVS) in sediment (a complexing agent that is found under reducing conditions) has been identified as an important factor governing the bioavailability of cadmium (Di Toro et al., 1991 and Ankley et al., 1996).

Freshwater aquatic species are generally more sensitive to the toxic effects of cadmium than marine species; toxicity in freshwater environments is inversely proportional to the water hardness (USEPA, 1999). Survival, growth, reproduction, and behavioral impacts have been noted for marine invertebrates (MacDonald, 1994). Diatoms and aquatic plants also show impaired growth and development. Cadmium can cross the placental barrier in mammals and is a reproductive toxin in fish and other aquatic life. Other adverse effects in upper trophic level aquatic organisms include interference with the kinetics of other metals and decreased oxygen utilization, as well as bone marrow, heart, kidney, and vascular impacts (USEPA, 1999). Though elimination from the body does occur, cadmium can concentrate in tissues and thus can bioaccumulate in food chains. An inverse relationship between cadmium uptake via dietary exposures and uptake of iron and calcium has been noted (USEPA, 1999). Vertebrates tend to accumulate cadmium in the kidney and liver (Eisler, 1985).

Based on the SERA and Step 3a of the BERA (Baker 2006a), cadmium in SWMU 1 surface soil has the potential to impact terrestrial plants and invertebrates. Available literature-based toxicological benchmarks for terrestrial plants and invertebrates are listed below in their order of increasing concentration. The lowest of the listed toxicological benchmarks was used in Step 2 of the SERA and Step 3a of the BERA.

- 4 mg/kg: Toxicological benchmark for terrestrial plants (Efroymson et al., 1997a)
- 20 mg/kg: Toxicological benchmark for earthworms (Efroymson et al., 1997b)
- 32 mg/kg: Ecological SSL for terrestrial plants (USEPA, 2005c)
- 140 mg/kg: Ecological SSL for soil invertebrates (USEPA, 2005c)

Cadmium in SWMU 1 surface soil also has the potential to impact terrestrial avian omnivores via dietary (food web) exposures. A literature search, conducted as part of the SERA and Step 3a of the BERA, identified studies that have investigated the toxicological effects of cadmium ingestion by birds. The USEPA (2005c) derived an avian toxicity reference value (TRV) in accordance with procedures presented in the ecological SSL guidance (USEPA, 2003). The TRV (1.47 mg/kg-BW/day), derived by calculating the geometric mean of literature-based NOAEL values for growth and reproduction endpoints, was used as the chronic NOAEL value for terrestrial avian omnivore dietary exposures to cadmium in SWMU 1 surface soil (see Section 2.5.4). A chronic LOAEL for avian omnivore dietary exposures (6.36 mg/kg-BW/day) was derived by calculating the geometric mean of all literature-based LOAEL values listed in USEPA (2005c) for growth and reproduction.

Finally, cadmium in SWMU 1 sediment (i.e., Ensenada Honda sediment) has the potential to impact the West Indian manatee via dietary (food web) exposures. A literature search, conducted as part of the SERA and Step 3a of the BERA, identified studies that have investigated the toxicological effects of cadmium ingestion by mammals. A 2-week study investigating the effect of cadmium on growth in rats indicated that a dose of 0.77 mg/kg-BW/day (oral in water) had no effect on body weight change (Yuhas et al., 1979 as cited in USEPA, 2005c). This dose, selected by the USEPA as the TRV for mammalian ecological SSL development, represents the highest bounded NOAEL below the lowest bounded LOAEL for reproduction, growth, or survival (USEPA, 2005c). Yuhas et al. (1979) reported adverse effects (i.e., reduced body weight) at a dose of 7.70 mg/kg-BW/day. This dose is considered a chronic LOAEL. The study by Yuhas et al. (1979) forms the basis of the NOAEL (0.77 mg/kg-BW/day) and LOAEL (7.70 mg/kg-BW/day) developed for West Indian manatee food web exposures to cadmium in SWMU 1 open water sediment (see Section 2.5.4).

2.4.1.4 Copper

Copper is a common metallic element found in crustal rocks and minerals. Natural sources of copper in the environment include weathering of copper-bearing minerals, copper sulfides, and native copper. Anthropogenic sources include corrosion of brass and copper pipe by acidic waters, the use of copper compounds as aquatic algicides, runoff and groundwater contamination from agricultural uses of copper as fungicides, and atmospheric fallout from industrial sources.

Copper exists in four oxidation states: Cu^0, Cu^{1+}, Cu^{2+}, and Cu^{3+} (Eisler, 1998a). Copper's movement in soil is determined by a host of physical and chemical interactions with soil components. In general, copper will absorb to organic matter, carbonate minerals, clay minerals, or hydrous iron and manganese oxides (ATSDR, 2004). Sandy soils with low pH have the greatest potential for leaching. The cupric ion (Cu^{2+}) is the one generally encountered in water and it is the most readily available and toxic inorganic species of copper. Toxicity in freshwater systems is inversely proportional to water hardness. Copper may form associations with organic matter and precipitates of hydroxides, phosphates, and sulfides. Formation of these complexes tends to facilitate transport to sediments. Bioavailabilty in sediment is controlled by the degree of complexation with AVS and adsorption to organic matter (USEPA, 2000a). Copper is an essential micronutrient, and, therefore, is readily accumulated by aquatic organisms. However, no evidence exists to suggest that copper is biomagnified in aquatic ecosystems (Jaagumagi, 1990).

Copper is taken up by mammals primarily through dietary exposure. Most organisms retain only a small proportion of copper ingested with their diet. Once ingested, copper travels through the gastrointestinal tract, where some of it is absorbed into the blood and becomes associated with plasma albumin and amino acids. Albumin-bound copper is eventually transported to the liver where 80 percent is bounded to metallothionein, with the remainder incorporated into enzyme compounds. In mammals, copper is excreted via the bile.

Based on the SERA and Step 3a of the BERA (Baker 2006a), copper in SWMU 1 surface soil has the potential to impact terrestrial plants and invertebrates. Available literature-based toxicological benchmarks for terrestrial plants and invertebrates are listed below in their order of increasing concentration. The lowest of the listed toxicological benchmarks was used in Step 2 of the SERA and Step 3a of the BERA.

- 50 mg/kg: Toxicological threshold for earthworms (Efroymson et al., 1997b)
- 70 mg/kg: Ecological SSL for terrestrial plants (USEPA, 2007a)
- 80 mg/kg: Ecological SSL for soil invertebrates (USEPA, 2007a)
- 100 mg/kg: Toxicological threshold for terrestrial plants (Efroymson et al., 1997a)

Copper in SWMU 1 surface soil also has the potential to impact terrestrial avian omnivores. A literature search, conducted as part of the SERA and Step 3a of the BERA, identified studies that have investigated the toxicological effects of copper ingestion by birds. An 84-day study using leghorn chickens (*Gallus domesticus*) indicated that a dose of 4.05 mg/kg-BW/day (oral in diet) had no effect on egg production (Ankari et al., 1998 as cited in USEPA, 2007a). This dose, selected by the USEPA as the TRV for avian ecological SSL development, represents the highest bounded NOAEL below the lowest bounded LOAEL for reproduction, growth, or survival (USEPA, 2007a). Ankari et al. (1998) reported impaired egg production at a dose of 12.1 mg/kg-BW/day. This dose is considered a chronic LOAEL. The study by Ankari et al. (1998) forms the basis of the NOAEL (4.05 mg/kg-BW/day) and LOAEL (12.1 mg/kg-BW/day) developed for avian dietary exposures to copper in SWMU 1 surface soil (see Section 2.5.4).

Copper in SWMU 1 sediment (i.e., Ensenada Honda sediment) also has the potential to impact the West Indian manatee via dietary (food web) exposures. A literature search, conducted as part of the SERA and Step 3a of the BERA, identified studies that have investigated the toxicological effects of copper ingestion by mammals. A 4-week survival and growth study using the pig (*Sus scrofa*) indicated that a dose of 5.6 mg/kg-BW/day (oral in diet) had no effect on survival and body weight change (Allcroft et al., 1961 as cited in USEPA, 2007a). This dose, selected by the USEPA as the TRV for mammalian ecological SSL development, represents the highest bounded NOAEL below the lowest bounded LOAEL for reproduction, growth, or survival (USEPA, 2007a). Allcroft et al. (1961) reported adverse effects on survival and growth at a dose of 9.34 mg/kg-BW/day. This dose was considered a chronic LOAEL. The study by Allcroft et al. (1961) forms the basis of the NOAEL (5.6 mg/kg-BW/day) and LOAEL (9.34 mg/kg-BW/day) developed for West Indian manatee dietary exposures to copper in SWMU 1 open water sediment (see Section 2.5.4).

2.4.1.5 Lead

Lead exists in three oxidation states: elemental (Pb^0), divalent (Pb^{+2}), and tetravalent (Pb^{4+}). In the environment, lead primarily exists as Pb^{2+}. Lead is dispersed throughout the environment primarily as the result of anthropogenic activities. Anthropogenic sources include mining and smelting of ore, manufacture of lead-containing products, combustion of coal and oil, and waste incineration. Many anthropogenic sources of lead, most notably leaded gasoline, lead-based paint, lead solder in food cans, lead-arsenate pesticides, and shot and sinkers, have been eliminated or strictly regulated due to lead's persistence and toxicity (ATSDR, 2005b).

The fate of lead in soil is affected by the adsorption at mineral interfaces, the precipitation of sparingly soluble solid forms of the compound, and the formation of relatively stable organic-metal complexes with soil organic matter (ATSDR, 2005b). These processes are dependent on such factors as soil pH, soil type, particle size, organic matter content, the presence of inorganic colloids and iron oxides, and cation exchange capacity. Most lead is retained strongly in soil, and very little is transported through runoff to surface water or leaching to groundwater except under acidic conditions; however, lead may enter surface waters as a result of erosion of lead-containing soil particles.

Lead exists in three forms in water: (1) dissolved (e.g., Pb^{2+}, $PbOH^{1+}$, $PbCO_3$), which generally results from atmospheric deposition and runoff; (2) dissolved bound (e.g., colloids or strong complexes); and (3) particulate (Eisler, 1998b). Particulate and bound forms are common in urban runoff and ore-mining effluents. Lead is most soluble and bioavailable under conditions of low pH, low organic content, low concentrations of suspended sediments, and low concentrations of the salts of calcium, iron, manganese, zinc, and cadmium (Eisler, 1998b). Common forms of dissolved lead are lead sulfate, lead chloride, lead hydroxide, and lead carbonate, but the distribution of salts is highly dependent on the pH of the water. The speciation of lead differs in fresh water and sea water. In fresh water, lead may partially exist as the divalent cation (Pb^{2+}) at pH values below 7.5, but complexes with dissolved carbonate to form insoluble $PbCO_3$ under alkaline conditions (ATSDR, 2005b). Lead chloride and lead carbonate are the primary complexes formed in seawater.

Most lead entering water is precipitated to sediment in the form of carbonate and hydroxide complexes. Factors affecting the degree of sorption in sediments include pH, organic carbon content, cation exchange capacity, and the presence of other constituents such as metal oxides, aluminum silicates, carbonates, and AVS. Lead can be mobilized and released from sediment with sudden pH decreases or ionic composition changes. Sorption is higher in sediments containing clay, and lower in sediments containing a higher percentage of sand (Eisler, 1998b). The amount of bioavailable lead in sediment is controlled, in large part, by the concentration of AVS and organic matter. Some Pb^{2+} in sediment may be transformed to tetralkyl lead compounds, including tetramethyl lead, through chemical and microbial processes. However, most organolead compounds result from anthropogenic inputs. In water, tetralkyl lead compounds are subject to photolysis and volatilization. Lead is accumulated by aquatic organisms equally from water and through dietary exposure (USEPA, 2000a). Lead does not biomagnify to a great extent in food chains, although accumulation by plants and animals has been extensively documented (Eisler, 1998b).

Based on the SERA and Step 3a of the BERA (Baker 2006a), lead in SWMU 1 surface soil has the potential to impact terrestrial plants and invertebrates. Available literature-based toxicological benchmarks for terrestrial plants and invertebrates are listed below in their order of increasing concentration. The lowest of the listed toxicological benchmarks was used in Step 2 of the SERA and Step 3a of the BERA.

- 50 mg/kg: Toxicological threshold for terrestrial plants (Efroymson et al., 1997a)
- 120 mg/kg: Ecological SSL for terrestrial plants (USEPA, 2005d)
- 500 mg/kg: Toxicological threshold for earthworms (Efroymson et al., 1997b)
- 1,700 mg/kg: Ecological SSL for soil invertebrates (USEPA, 2005d)

Lead in SWMU 1 surface soil also has the potential to impact terrestrial avian herbivores and omnivores via dietary (food web) exposures. A literature search, conducted as part of the SERA and Step 3a of the BERA, identified studies that have investigated the toxicological effects of lead ingestion by birds. A 4-week study investigating the effect of lead on leghorn chicken reproduction indicated that a dose of 1.63 mg/kg-BW/day (oral in diet) had no effect on egg production (Edens and Garlich, 1983 as cited in USEPA, 2005d). This dose, selected by the USEPA as the TRV for avian ecological SSL development, represents the highest bounded NOAEL below the lowest bounded LOAEL for reproduction, growth, or survival. Edens and Garlich (1983) reported impaired egg production at a dose of 3.26 mg/kg-BW/day. This dose is considered a chronic LOAEL. The study by Edens and Garlich (1983) forms the basis of the NOAEL (1.63 mg/kg-BW/day) and LOAEL (3.26 mg/kg-BW/day) developed for terrestrial avian dietary exposures to lead in SWMU 1 surface soil (see Section 2.5.4).

2.4.1.6 Mercury

Mercury is a naturally occurring element found in cinnabar, a sulfide mineral. Industrial applications and uses include paint manufacturing, paper industry, electrical equipment, batteries, thermometers, and at one time, pesticides (MacDonald, 1994). Transport pathways to the aquatic environment include waste dumping and incineration, mining, smelting, and coal combustion. It is persistent in the environment and is found in three states naturally: Hg^0 (metallic/elemental), Hg^{+1} (mercurous), and Hg^{+2} (mercuric [Hg(II)]). Elemental mercury is unique among metals in being liquid at ambient temperature and being quite volatile. It partitions strongly to air in the environment and is not found in nature as a pure, confined liquid. Of the two ionic forms of mercury (mercurous and mercuric mercury), the mercuric form is more environmentally stable, and therefore predominates. Mercuric mercury is the dominant form in surface water (ATSDR, 1999b). In sediment, mercury is generally found adsorbed to particulate matter. Sorption to particulates immobilizes mercury and is dependent on the presence of organic matter, complexing agents (sulfides) and clay fractions. Bacterial metabolism and chemical reduction can mobilize sorbed mercury from particulate matter to more volatile forms. Ionic mercury (i.e., mercuric mercury) can be transformed to methylmercury (MeHg) by anaerobic, sulfur-reducing bacteria, which produce MeHg as a byproduct of their natural sulfur chemistry (Gilmour and Henry, 1991, Gilmour et al., 1992, and Zillioux et al., 1993). The major site of methylation in aquatic systems is the sediment, but methylation also occurs in the water column (Wright and Hamilton, 1992, Parks et al., 1989, and Gilmour and Henry, 1991). Once MeHg is produced, it can either be demethylated via biotic and abiotic mechanisms (Sellers et al., 1996) or enter into the food web. The rate of mercury methylation is influenced by a number of environmental factors that affect both the availability of mercuric ions for methylation and the growth of the methylating microbial populations:

- Bacterial methylation rates appear to increase under anaerobic conditions (oxygen-poor environments exhibit a reducing electrochemical potential that favors sulfur metabolism by sulfur-reducing bacteria).

- Sulfate stimulates formation of methylmercury (sulfate is used by sulfur-reducing bacteria in their metabolic process).

- Increasing water temperature enhances bacterial activity, thereby increasing the formation of methylmercury.

- The presence of organic matter can stimulate growth of microbial populations (and reduce oxygen levels), thereby increasing the formation of MeHg.

- Increasing hydrogen ion concentrations increase the formation of MeHg (Xun et al., 1987 and Winfrey and Rudd, 1990) by enhancing mercury uptake by bacteria (Kelly et al., 2003).

- Sulfide inhibits MeHg formation by binding with inorganic mercury ions and forming an insoluble mercury-sulfide complex, thereby limiting the bioavailability of inorganic mercury to sulfur-reducing bacteria.

MeHg is the most bioavailable and toxic form of mercury. Based on the relationship between MeHg production and total mercury concentration, the proportion of mercury as MeHg in sediment and associated organisms has been found to be proportional to the distance from the mercury source (Hill et al., 1996). In addition, organisms at lower trophic levels usually contain the lowest proportion of total mercury as MeHg (May et al., 1987 and Watras and Bloom, 1992), while organisms higher in the food chain (i.e., piscivorous fish, birds, mammals) contain a higher proportion of total mercury as MeHg (generally over 90 percent of the total mercury [Huckabee et al., 1979, Watras and Bloom, 1992, Bloom, 1990, and Grieb et al., 1990]). Several studies have been identified which investigated total mercury and MeHg concentrations in seagrass species. Season variations in both total mercury and MeHg concentrations have been identified and concentrations are generally greater in the older plant material and in the root mat (Ferrat et al., 2002, Capiomont et al., 2000, and Pannhorst and Weber, 1999). Partitioning of MeHg as a function of total mercury does not appear to be a factor between above ground (shots, leaves, stems) and below ground (roots and rhizomes) portions of the plants (6.9% MeHg in above ground eelgrass tissue, 6.4% MeHg in below ground tissue [Pannhorst and Weber, 1999]).

A variety of adverse biological effects have been attributed to mercury. Enzymatic impacts have been noted in aquatic plants (Ferrat et al., 2002). Mercury is a known teratogen, mutagen, and carcinogen. The reproduction, growth, metabolism, blood chemistry, and oxygen exchange of marine and freshwater organisms is adversely affected by mercury. Mercury readily bioaccumulates and elimination from mammalian systems is slow (USEPA, 1999). Retention times appear to be longer for MeHg than for inorganic forms. Biological half-lives of 2 to 3 years in fish have been reported (USEPA, 1999).

Based on the SERA and Step 3a of the BERA (Baker, 2006a), mercury in SWMU 1 surface soil has the potential to impact terrestrial plants and invertebrates. Available literature-based toxicological benchmarks for terrestrial plants and invertebrates are listed below in their order of increasing concentration. The lowest of the listed toxicological benchmarks was used in Step 2 of the SERA and Step 3a of the BERA.

- 0.1 mg/kg: Toxicological benchmark for earthworms (Efroymson et al., 1997b)
- 0.3 mg/kg: Toxicological benchmark for terrestrial plants (Efroymson et al., 1997a)

Mercury in SWMU 1 surface soil also has the potential to impact terrestrial avian omnivores via dietary (food web) exposures. A literature search, conducted as part of the SERA and Step 3a of the BERA, identified studies that have investigated the toxicological effects of mercury ingestion by birds. Studies by Heinz (1975, 1976a, 1976b, and 1979 as referenced in USEPA [1997b]), in which three generations of mallard ducks (*Anas platyrhynchos*) were dosed with MeHg dicyandiamide, indicated that the lowest dose tested (0.078 mg/kg-BW/day) resulted in adverse effects on reproduction and behavior. This value was designated as a chronic LOAEL (USEPA, 1997b). USEPA (1997b) estimated a chronic NOAEL (0.026 mg/kg-BW/day) by applying a LOAEL-to-NOAEL uncertainty factor of three to the chronic LOAEL. A second study using Japanese quail (1-year reproductive study with mercuric chloride) indicated that a dose of 0.45 mg/kg-BW/day (oral in diet) had no effect on fertility and egg hatchability, while a dose of 0.9 mg/kg-BW/day had adverse effects on reproductive indices (Sample et al., 1996). The 0.45 mg/kg-BW/day dose is considered a chronic NOAEL, while the 0.9 mg/kg-BW/day dose is considered a chronic LOAEL. These two studies, one using inorganic mercury (mercuric chloride) and one using MeHg (methylmercury dicyandiamide) form the basis of the NOAEL and LOAEL values developed for avian dietary exposures to mercury in SWMU 1 surface soil (see Section 2.5.4).

Finally, mercury in SWMU 1 sediment (i.e., Ensenada Honda sediment) has the potential to impact the West Indian manatee via dietary (food web) exposures. A literature search, conducted as part of the SERA, identified studies that have investigated the toxicological effects of mercury ingestion by mammals. A 93-day study using mink indicated that a dose of 0.025 mg/kg-BW/day (administered orally as MeHg chloride) caused mortality, weight loss, and behavior abnormalities (Wobeser et al., 1976 as referenced in Sample et al., 1996). This dose is considered a chronic LOAEL. No adverse effects were observed at a dose of 0.015 mg/kg-BW/day; therefore, this dose is considered a chronic NOAEL. A second study using mink (6-month reproductive study with mercuric chloride) indicated that a dose of 1.0 mg/kg-BW/day (oral in diet) had no effect on fertility and kit survival (Aulerich et al., 1974, as referenced in Sample et al., 1996). This dose is considered a chronic NOAEL. A chronic LOAEL of 10 mg/kg-BW/day was estimated by applying a factor of ten to the chronic NOAEL value (Sample et al., 1996). These two studies, one using inorganic mercury (mercuric chloride) and one using MeHg (methylmercury chloride) form the basis of the NOAEL and LOAEL values developed for West Indian manatee dietary exposures to mercury in SWMU 1 sediment (see Section 2.5.4).

2.4.1.7 Selenium

Selenium is a naturally occurring, non-metal element commonly found in rocks and soil. Four stable valence states of selenium are found naturally, elemental (Se^0), selenides (Se^{-2}), alkali selenites (Se^{+4}), and selenates (Se^{+6}). Elemental selenium and selenides are insoluble, while the selenites and selenates are water soluble (ATSDR, 2003). Commercial and industrial uses include use as a nutritional supplement, in the glass industry, and as a component of paints, inks, rubber, pigments, pharmaceuticals, pesticides, and fungicides. In the environment, selenium is not often found in the pure form. Important factors regulating the form of selenium include pH, redox potential, and the presence of metal oxides. Much of the selenium in rocks is combined with sulfide minerals or with silver, copper, lead, and nickel minerals (Irwin et al., 1998). Selenium will readily combine with these and other metals directly or in solution and reacts with oxygen to form stable selenium dioxide. Within surface waters, the salts of selenic and selenious acids are prevalent. Depending on the pH of the surface water body, selenium compounds can be highly soluble and do not adsorb to sedimentary particles. Within sediments, organic selenides and selenium oxide are the dominant forms. Natural transport properties include weathering of rock material, volatilization by plants and animals, and volcanic activity. The principle release mechanism of selenium to the environment, however, is coal combustion. Though generally stable in soils, soluble selenium compounds in agricultural fields can be transported from the field in irrigation and drainage waters. Oxidation state, which is dependent upon pH, redox potential, and biological activity, is the principal factor governing the behavior of selenium in the environment. Bacterial and fungal action produces methylselenium (MeSe) and other volatile, organic selenium compounds. In sediments, especially in acidic, reducing, organic-rich environments, selenium forms strong metal selenides complexes which sorb to sediment particles and are relatively immobile and stable (Irwin et al., 1998). Selenium, like mercury, interacts readily with sulphur. Synergistic and antagonistic interactions with mercury have been noted for selenium (Irwin et al., 1998).

Inorganic selenites and selenates, which are more commonly found in alkaline and oxidizing environments, are more bioavailable as they are water soluble (Purkerson et al., 2003). They are readily taken up by plants and converted to various organic compounds (ATSDR, 2003). This uptake is regulated by soil type, pH, organic material, redox potential, and total selenium concentrations. Selenites have been shown to be more concentrated in algae and benthic invertebrates, while equal proportions of the two forms have been measured in fish (ATSDR, 2003). Selenium is identified as a weakly bioaccumulative chemical; however, accumulation is dependent on trophic levels and species (Purkerson et al., 2003). As selenium is also an essential nutrient, it is metabolized by animal species and readily eliminated (Maher et al., 2004). The relative toxicity of selenium compounds has been identified as hydrogen selenides ~ dietary selenomethionine > selenites ~ water selenomethionine > selenate > elemental selenium > metal selenides ~ methylated selenium compounds (Irwin et al., 1998). Chatterjee et al. (2001) investigated selenium concentrations in seagrass species in India. Seasonal variations were noted and total selenium concentrations were found to be greater in roots (0.21 microgram per kilogram [µg/kg]-dry weight) than in stems (0.17 µg/kg-dry weight) and leaves (0.11 µg/kg-dry weight).

Selenium sensitivity is dependent upon species, life stage, nutritional status, and health of individual organisms (Irwin et al., 1998). Younger animals and those consuming low-protein diets appear to be impacted more. Very high amounts of selenium can result in reproductive and survivorship effects in invertebrates, birds, and mammals. Exposure to high levels of selenium compounds caused malformations in birds, but selenium has not been shown to cause birth defects in mammals (ATSDR, 2003). Reproductive impacts have been identified concurrently with no impact on adult survivorship in fish (Irwin et al., 1998). Seed germination and growth inhibition has been noted in plants, yet selenium-deficient soils have also been identified.

Based on the SERA and Step 3a of the BERA (Baker, 2006a), selenium in SWMU 1 sediment has the potential to impact the West Indian manatee via dietary (food web) exposures. A literature search, conducted as part of the SERA, identified studies that have investigated the toxicological effects of selenium ingestion by mammals. A 37-day study using pigs investigated the effects of selenium on growth (Mahan and Moxon, 1984 as cited in USEPA, 2007b). A dose of 0.143 mg/kg-BW/day (oral in diet) had no effect on body weight. This dose, selected by the USEPA as the TRV for mammalian ecological SSL development, represents the highest bounded NOAEL below the lowest bounded LOAEL for reproduction, growth, or survival. A reduction in growth occurred at a dose of 0.215 mg/kg-BW/day. This dose is considered a chronic LOAEL. The study by Mahan and Moxon (1984) forms the basis of the NOAEL (0.143 mg/kg-BW/day) and LOAEL (0.215 mg/kg-BW/day) developed for West Indian manatee dietary exposures to selenium in SWMU 1 open water sediment (see Section 2.5.4).

2.4.1.8 Tin

Tin occurs naturally in the earth's crust and may be released to the environment from natural and anthropogenic sources. Inorganic tin may be released from smelting and refining processes, industrial uses of tin, waste incineration, and burning of fossil fuels (ATSDR, 2005c). In general, organotin compounds are released due to anthropogenic uses (antifouling paints, slimicides on masonry, disinfectants, and biocides for cooling systems, power station cooling towers, pulp and paper mills, breweries, leather processing, and textile mills), but can be produced in the environment by biomethylation of inorganic tin. Of the 260 known organotin compounds, all but a few are manufactured.

Inorganic tin may exist as either divalent (Sn^{2+}) or tetravalent (Sn^{4+}) cationic ions under environmental conditions and cannot be degraded in the environment. It may undergo oxidation-reduction, ligand exchange, and precipitation. In aquatic environments, inorganic tin can be transformed into organometallic forms by microbial methylation (Hallas et al., 1982). Methylation of tin in sediments is positively correlated with increasing organic content. Most commercially used organotin compounds are relatively immobile in environmental media due to their low vapor pressure, low water solubilities, and high affinities for soils and organic sediments (ATSDR, 2005c). Organotins are generally persistent in sediment and may be significantly bioconcentrated by aquatic organisms. There is general agreement that inorganic tin is not highly toxic.

Tin in SWMU 1 surface soil has the potential to impact terrestrial plants and invertebrates. A single toxicological benchmark was identified from the literature (50 mg/kg [toxicological benchmark for plants]; Efroymson et al., 1997a).

2.4.1.9 Zinc

Zinc is an element commonly found in the Earth's crust. It is released to the environment from both natural and anthropogenic sources. The primary anthropogenic sources of zinc in the environment are related to mining and metallurgic operations involving zinc and use of commercial products containing zinc (ATSDR, 2005d).

Zinc occurs in the environment mainly in the +2 oxidation state (ATSDR, 2005d). Zinc sorbs strongly onto soil particles. Mobilization in soils depends on the water solubility of the speciated forms of the compound, as well as soil cation exchange capacity, pH, and redox potential. At pH values below 7, pH and solubility of zinc are inversely related (i.e., decreased pH results in increased solubility, and thus, increased potential for mobility). Low soil cation exchange capacity and oxidizing conditions also increase the mobility of zinc. As pH increases over 7, solubility decreases and zinc absorption to soil increases. Relatively little land-disposed zinc at waste sites is in the soluble form; therefore, mobility is limited by a slow rate of dissolution (ATSDR, 2005d). Consequently, movement toward groundwater is expected to be slow unless zinc is applied to soil in soluble form or accompanied by corrosive substances (i.e., mine tailings). Plants and animals may bioaccumulate zinc, but biomagnification in terrestrial food chains has not been observed (ATSDR, 2005d).

Zinc can occur in both suspended and dissolved forms in surface water. Dissolved zinc may occur as the free (hydrated) zinc ion or as dissolved complexes and compounds with varying degrees of stability. Water hardness, pH, and metal speciation are important factors in controlling the water column concentration of zinc. Zinc partitions to sediments or suspended solids in surface waters through sorption onto hydrous iron and manganese oxides, clay minerals, and organic material, resulting in the enrichment of zinc in suspended and bed sediments. The bioavailability of zinc in sediments appears to be controlled by the AVS concentration (Berry et al., 1996, and Sibley et al., 1996). Zinc is an essential micronutrient and uptake in most aquatic organisms appears to be independent of environmental concentrations (MacDonald, 1994). It has been found to bioaccumulate in some organisms, though there is no evidence of biomagnification (Jaagumagi, 1990).

Based on the SERA and Step 3a of the BERA (Baker, 2006a), zinc in SWMU 1 surface soil has the potential to impact terrestrial plants and invertebrates. Available literature-based toxicological benchmarks for terrestrial plants and invertebrates are listed below in order of increasing concentration. The lowest of the listed toxicological benchmarks was used in Step 2 of the screening-level ERA and Step 3a of the baseline ERA.

- 50 mg/kg: Toxicological threshold for terrestrial plants (Efroymson et al., 1997a)
- 120 mg/kg: Ecological SSL for soil invertebrates (USEPA, 2007c)
- 160 mg/kg: Ecological SSL for terrestrial plants (USEPA, 2007c)
- 200 mg/kg: Toxicological threshold for earthworms (Efroymson et al., 1997b)

Zinc in SWMU 1 surface soil also has the potential to impact terrestrial avian omnivores via dietary (food web) exposures. A literature search, conducted as part of the SERA and Step 3a of the BERA, identified studies that have investigated the toxicological effects of zinc ingestion by birds. The USEPA (2007c) derived an avian TRV in accordance with procedures presented in the ecological SSL guidance (USEPA, 2003). The TRV (66.1 mg/kg-BW/day), derived by calculating the geometric mean of literature-based NOAEL values for growth and reproduction endpoints, was used as the chronic NOAEL value for terrestrial avian omnivore dietary exposures to zinc in SWMU 1 surface soil (see Section 2.5.4). A chronic LOAEL for avian omnivore dietary exposures (171 mg/kg-BW/day) was derived by calculating the geometric mean of all literature-based LOAEL values listed in USEPA (2007c) for growth and reproduction.

Finally, zinc in SWMU 1 sediment (i.e., Ensenada Honda sediment) has the potential to impact the West Indian manatee via dietary (food web) exposures. A literature search, conducted as part of the ERA and Step 3a of the BERA, identified studies that have investigated the toxicological effects of zinc ingestion by mammals. The USEPA (2007c) derived a mammalian TRV in accordance with procedures presented in the ecological SSL guidance (USEPA, 2003). The TRV (75.4 mg/kg-BW/day) was derived by calculating the geometric mean of literature-based NOAEL values for growth and reproduction endpoints. As discussed in Section 2.5.4, ingestion-based HQ values for the West Indian manatee were calculated by dividing maximum dietary intakes by literature-based NOAEL and LOAEL values adjusted to reflect differences in body weights between mammalian test species and the West Indian manatee. Because the TRV used by the USEPA (2007c) to derive a mammalian ecological SSL for zinc is a geometric mean of several literature-based NOAEL values, an adjustment to reflect differences in body weights between a test species and the West Indian manatee could not be performed. Therefore, a chronic NOAEL and LOAEL value based on a single test species was identified from the list of studies used by the USEPA to develop the mammalian ecological SSL for zinc. The values selected (NOAEL of 8.23 mg/kg-BW/day and LOAEL of 82.3 mg/kg-BW/day) came from a study that investigated the effect of zinc on offspring development in pigs (Hill et al., 1983). The NOAEL value from this study represents the minimum NOAEL for reproduction cited by the USEPA (2007c).

2.4.1.10 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT

4,4'-DDT and its primary metabolites (4,4'-DDD and 4,4'-DDE) are manufactured chemicals and are not know to occur naturally in the environment (ATSDR, 2002). Historically, DDT was released to the environment during its production, formulation, and extensive use as a pesticide in agriculture and vector control applications in aquatic environments. 4,4'-DDD also was used as a pesticide, but to a much lesser extent than 4,4'-DDT. 4,4'-DDT was banned for use in the United States after 1972.

4,4'-DDT and its metabolites are very persistent in the environment. When deposited on soil, 4,4'-DDT, 4,4'-DDD, and 4,4'-DDE are strongly absorbed. As a result of their strongly binding to soil, they mostly remain on the surface layers. As such, there is little leaching into the lower soil layers and groundwater. They may photodegrade on the soil surface or biodegrade. 4,4'-DDT biodegrades primarily to 4,4'-DDE under aerobic conditions and 4,4'-DDD under anaerobic conditions. The dominant fate processes in the aquatic environment are volatilization and adsorption to biota, suspended particulate matter, and sediment. 4,4'-DDT bioconcentrates in aquatic organisms and bioaccumulates in the food chain. Accumulation is significantly higher in the pelagic food web than in the benthic food web (ATSDR, 2002).

Based on the SERA and Step 3a of the BERA (Baker, 2006a), 4,4'-DDT, 4,4'-DDD, and 4,4'-DDE in SWMU 1 surface soil have the potential to impact terrestrial plants and invertebrates. Toxicological benchmarks for terrestrial plants and invertebrates are absent from the literature. The Ministry of Housing, Spatial Planning and Environment (MHSPE, 2000) has developed a target and intervention value for total DDT/DDD/DDE for a standard soil consisting of 10 percent organic matter and 25 percent clay (0.01 mg/kg and 4 mg/kg, respectively). The mean of the target and intervention value (i.e., 0.401 mg/kg or 401 μg/kg was used as the soil screening value for 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT in Step 2 of the SERA and Step 3a of the BERA.

In addition to lower trophic level terrestrial receptor groups, 4,4'-DDT, 4,4'-DDD, and 4,4'-DDE in SWMU 1 surface soil have the potential to impact terrestrial avian omnivores via dietary (food web) exposures. A literature search, conducted as part of the SERA and Step 3a of the BERA, identified studies that have investigated the toxicological effects of 4,4'-DDT, 4,4'-DDD, and 4,4'-DDE ingestion by birds. A 30-day study conducted with leghorn chickens indicated that a dose of 0.227 mg/kg-BW/day 4,4'-DDT (oral in diet) had no effect on growth (Cecil et al., 1978 as cited in USEPA, 2007d). This dose, selected by the USEPA as the TRV for mammalian ecological SSL development, represents the highest bounded NOAEL below the lowest bounded LOAEL for reproduction, growth, and survival (USEPA, 2007d). Growth was reduced at a dose of 2.27 mg/kg-BW/day. This dose is considered a chronic LOAEL. The study by Cecil et al. (1978) forms the basis of the NOAEL (0.227 mg/kg-BW/day) and LOAEL (2.27 mg/kg-BW/day) developed for terrestrial avian omnivore dietary exposures to 4,4'-DDT, 4,4'-DDD, and 4,4'-DDE in SWMU 1 surface soil (see Section 2.5.4).

2.4.2 Transport and Exposure Pathways

A transport pathway describes the mechanisms whereby chemicals may be transported from a source of contamination to ecologically relevant media. An exposure pathway links a source of contamination with one or more receptors through exposure to one or more media. Exposure, and thus potential risk, can only occur if each of the following conditions is present (USEPA, 1998):

- A source of contamination must be present.
- Release and transport mechanisms must be available to move the contaminants from the source to an exposure point.
- An exposure point must exist where ecological receptors could contact the affected media.
- An exposure route must exist whereby the contaminant can be taken up by ecological receptors.

2.4.2.1 <u>Sources and Transport Mechanisms</u>

The disposal areas at SWMU 1 represent potential source areas for the release of chemicals to abiotic media (i.e., surface and subsurface soil). Contaminated surface and subsurface soil also represent potential source areas for the release of chemicals to groundwater and/or downgradient surface soil, surface water, and sediment. The primary mechanisms for contaminant transport at SWMU 1 are believed to include the following (Baker, 2006a):

- Overland transport of chemicals with surface soil via surface runoff to downgradient surface soil and estuarine wetland surface water, and sediment.
- Leaching of chemicals from surface soil and/or subsurface soil by infiltrating precipitation and transport to estuarine wetland and Ensenada Honda surface water and sediment with groundwater.
- Uptake by biota from surface soil, subsurface soil, surface water, and sediment and trophic transfer to upper trophic level receptors.

2.4.2.2 Exposure Points and Routes

Based upon the results of Step 3a of the Navy ERA process, the following key exposure pathways were identified for evaluation in the BERA (Baker, 2006a):

- Dermal and ingestion exposures by terrestrial invertebrates to antimony, cadmium, copper, lead, mercury, tin, zinc, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT in surface soil and 4,4'-DDE and 4,4'-DDT in subsurface soil.

- Root uptake exposures by terrestrial plants to antimony, cadmium, copper, lead, mercury, tin, zinc, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT in surface soil and 4,4'-DDE and 4,4'-DDT in subsurface soil.

- Food web-based exposures by upper trophic level terrestrial avian omnivores to cadmium, lead, mercury, zinc, 4,4'-DDD, 4.4'-DDE, and 4,4'-DDT in surface soil.

- Food web-based exposures by upper trophic level terrestrial avian herbivores to lead in surface soil.

- Food web-based exposures by terrestrial amphibians and reptiles to cadmium, lead, mercury, zinc, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT in surface soil (potential impacts to terrestrial amphibians and reptiles were assessed qualitatively in the SERA and Step 3a of the BERA through the use of surrogate receptors [i.e., upper trophic level avian receptors]).

- Food web-based exposures by upper trophic level aquatic mammalian receptors (i.e., West Indian manatee) to arsenic, cadmium, copper, mercury, selenium, and zinc in Ensenada Honda sediment.

A seventh exposure pathway identified in Step 3a of the BERA requiring additional evaluation was exposure by upper trophic level reptilian receptors (sea turtles) to chemicals in Ensenada Honda sediments. Four species of sea turtle potentially inhabit or seasonally visit the coastal waters adjacent to NAPR: green, hawksbill, leatherback, and loggerhead (Geo-Marine, Inc., 2005). Based on the paucity of data concerning the toxicological effects of chemicals for reptiles, a quantitative evaluation of the potential for risk to these species was not be performed in Step 2 of the SERA and Step 3a of the BERA (Baker, 2006a). In lieu of a quantitative evaluation, an examination of the life history information for sea turtles potentially inhabiting or seasonally visiting the coastal waters adjacent to NAPR (i.e., green, hawksbill, leatherback, and loggerhead sea turtles) was performed. In addition, available sea turtle habitat at SWMU 1 was investigated to determine whether potential exposure points and routes exist whereby contaminants may be encountered and subsequently taken up by aquatic reptiles. The results of the qualitative evaluation, presented in the Final Steps 3b and 4 Report (Baker, 2007) concluded that a potentially complete exposure pathway exists for green sea turtles based on the absolute presence of available forage material (in the form of seagrass). However, based on an examination of life history information (i.e., home ranges) and the absence of favorable developmental habitat for juvenile green sea turtles, the magnitude and significance of the pathway was considered negligible and no further evaluation of sea turtles at SWMU 1 was recommended.

2.4.3 Assessment Endpoints and Risk Questions

Assessment endpoints are intended to focus the risk assessment on particular components of the ecosystem that could be adversely affected by contaminants. The assessment endpoints selected in Step 3b of the BERA were:

- *Survival, growth, and reproduction of terrestrial invertebrate communities* – Soil invertebrates promote soil fertility by breaking down organic matter and releasing nutrients. They also improve aeration, drainage, and aggregation of soils, and serve as a forage base for many terrestrial species. The soils at SWMU 1 will support fewer avian invertebrate consumers if chemical concentrations in soils are limiting the survival, growth, and reproduction of soil invertebrates

- *Survival, growth, and reproduction of terrestrial avian omnivore populations* – Avian omnivores are susceptible to bioaccumulative chemicals, especially those that may have the potential to biomagnify through terrestrial food webs. The community also serves as a means of population control for its prey items and as a prey base for terrestrial avian carnivores.

- *Survival, growth, and reproduction of West Indian manatees* – Though herbivorous, West Indian manatees are susceptible to chemicals that may bioaccumulate within their diet of submerged aquatic vegetation. Food web impacts beyond the manatees are not of concern as manatees have no known predators due to a size refuge. Manatees were selected as an assessment endpoint for SWMU 1 based on their known occurrence within the Ensenada Honda (see Figure 2-7) and their Federal status in Puerto Rico (endangered).

Assessment endpoints were not selected for terrestrial amphibians and reptiles. As discussed in the SERA and Step 3a of the BERA (Baker, 2006a), there is a paucity of data concerning the toxicological effects of chemicals for amphibians and reptiles, rendering a quantitative evaluation problematic (USEPA, 2000b and 2003). For the BERA, it is assumed that any terrestrial amphibians and reptiles at SWMU 1 are not exposed to significantly higher concentrations of ecological COCs than the other upper trophic level terrestrial receptor species selected as assessment endpoints. Therefore, a conclusion of acceptable or unacceptable risk to the upper trophic level terrestrial receptors evaluated in the BERA also applies to terrestrial amphibians and reptiles. For terrestrial reptiles, this approach is consistent with USEPA Region III guidance (USEPA, 2006; available at http://www.epa.gov/reg3hwmd/risk/eco/index.htm), which states that "*As a general rule in Region 3, impacts to reptiles do not have to be considered as an assessment endpoint in the screening level ERA. However, the screening ERA would need to state that impacts to reptiles are being assessed qualitatively through the use of surrogate receptors. An exception to this rule is when a threatened or endangered reptile has been identified as a potential receptor on the site. In this situation, it may be appropriate to consider impact on reptiles when identifying assessment endpoints*."

Although antimony, cadmium, copper, lead, mercury, tin, zinc, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT were identified as ecological COCs for terrestrial plant communities, an assessment endpoint was not selected for terrestrial plants. During the habitat characterization conducted at SWMU 1 (Geo-Marine Inc., 2000; see Appendix A), the field biologists made visual observations to characterize the health of the terrestrial plant community. Indications of an altered plant community used in the assessment included the presence of chlorotic leaves (pale foliage due to reduced chlorophyll content), epinasty (deformities of leaves and stems), patches of altered plant growth, absence of plants (bare ground), and changes in species composition. To determine the presence of altered plant communities, a nearby representative site was selected as a control. The control was chosen in order to be representative of the plant communities present at SWMU 1 (upland coastal scrub and upland coastal forest communities). Field observations concluded that the terrestrial plant communities at SWMU 1 are growing healthy and vigorously, with no evidence of stress. Furthermore, there were no noticeable differences in species composition between the control and SWMU 1. The habitat characterization did note that SWMU 1 had more grassy areas within the coastal scrub forest community than the corresponding control, but concluded that this was probably the result of past soil disturbances (e.g., presence of an un-maintained road for access to several monitoring wells). Though all potential impacts on the upland vegetative communities cannot be quantified by visual inspections alone, potential risk to terrestrial plants were considered acceptable based on observations made during the habitat characterization. Therefore, terrestrial plants were excluded from further consideration in Step 3b of the BERA.

Lead in surface soil was identified as an ecological COC for terrestrial avian omnivore and herbivore food web exposures at SWMU 1. However, an assessment endpoint was not selected for avian herbivore food web exposures. This decision was based on the Step 3a risk calculation (Baker, 2006a), which showed that avian omnivores represent the more exposed feeding guild and are at greater risk to lead in surface soil (NOAEL-based HQ of 2.42 for the American robin versus a NOAEL-based HQ of 1.34 for the mourning dove). Because avian omnivores are at greater risk to lead in surface soil, a conclusion of acceptable risk to avian omnivores in the BERA also would apply to avian herbivores. If the BERA concludes that potential risks to avian omnivores from lead in surface soil are not acceptable, corrective action objectives (CAOs) derived for the protection of avian omnivores also would be protective of avian herbivores.

Risk questions ask how the assessment endpoints could be affected by site-related conditions. Risk questions also clarify and articulate relationships that are possible through consideration of available data, information from the scientific literature, and the best professional judgment of risk assessors. Finally, they can form the basis for developing a study design for subsequent steps of the ERA process. The risk questions associated with the assessment endpoints identified above are listed below.

- Are antimony, cadmium, copper, lead, mercury, tin, zinc, 4,4’-DDD, 4,4’-DDE, and 4,4’-DDT concentrations in SWMU 1 surface soil and 4,4’-DDE and 4,4’-DDT concentrations in subsurface soil high enough to impair the survival, growth, or reproduction of terrestrial invertebrate communities?

- Are cadmium, lead, mercury, zinc, 4,4’-DDD, 4.4’-DDE, and 4,4’-DDT concentrations in SWMU 1 surface soil high enough to impair the survival, growth, or reproduction of terrestrial avian omnivore populations?

- Are arsenic, cadmium, copper, mercury, selenium, and zinc concentrations in Ensenada Honda sediment high enough to adversely effect the survival, growth, or reproduction of West Indian manatees?

2.5 BERA Study Design/Data Quality Objectives

Step 4 of the ERA process (Study Design/Data Quality Objectives) established the measurement endpoints, study design, DQOs, and data analysis methods for the additional site investigations necessary to complete the ERA. The components of the Step 4 investigations provide multiple lines of evidence on which to evaluate potential ecological risks or existing ecological impacts from exposures to contaminants in surface soil and Ensenada Honda sediment. These lines of evidence are site-specific, direct measures of potential ecological effects and are thus preferable to the comparison of chemical concentrations to conservative, non-site-specific screening values, and other conservative assumptions, which form the basis for SERAs. The use of multiple lines of evidence reduces the dependence on any one type of data and thus reduces the uncertainty of the analysis, allowing for more confident decisions to be made about the need for, and extent of, corrective actions.

2.5.1 Measurement Endpoints

Measurement endpoints are measures of biological effects (e.g., laboratory toxicity test results) that are related to each respective assessment endpoint (USEPA, 1997a). As outlined in Section 2.4.3, assessment endpoints identified by the refined conceptual model are survival, growth, and reproduction of terrestrial invertebrate communities, terrestrial avian omnivore populations, and West Indian manatees. Measurement endpoints related to these assessment endpoints, which guided the design of the field investigation, are as follows:

<u>Survival, growth, and reproduction of terrestrial invertebrate communities</u>:

- Comparison of antimony, cadmium, copper, lead, mercury, tin, zinc, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT concentrations in surface soil with soil screening values and literature-based effect levels.

- Comparison of results of 28-day laboratory toxicity tests (survival, growth, and reproduction) with the earthworm *Eisenia fetida*, using site and reference surface soil.

- Existence of significant correlations between laboratory toxicity test results and concentrations of antimony, cadmium, copper, lead, mercury, tin, zinc, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT in surface soil or other chemical/physical characteristics of the tested surface soil (e.g., total organic carbon [TOC], pH, and grain size distributions).

<u>Survival, growth, and reproduction of terrestrial avian omnivore populations</u>

- Comparison of modeled dietary intakes of cadmium, lead, mercury, zinc, 4,4'-DDD, 4.4'-DDE, and 4,4'-DDT using measured tissue concentrations in earthworms maintained in site soils during toxicity testing with literature-based ingestion screening values.

<u>Survival, growth, and reproduction of herbivorous West Indian manatees</u>:

- Comparison of modeled dietary intakes of arsenic, cadmium, copper, mercury, selenium, and zinc using field-collected seagrass tissue concentrations with literature-based ingestion screening values.

Although 4,4'-DDE and 4,4'-DDT in subsurface soil were identified as ecological COCs for terrestrial invertebrate direct contact exposures (Baker, 2006a), a measurement endpoint was not selected in Step 4 of the ERA for this exposure pathway. This decision was based on existing analytical data, which show that maximum 4,4'-DDE and 4,4'-DDT concentrations occur in SWMU 1 surface soil (The maximum 4,4'-DDE and 4,4'-DDT concentration detected in SWMU 1 surface soil was 28,000 μg/kg and 43,000J μg/kg, respectively, while the maximum 4,4'-DDE and 4,4'-DDT concentration detected in SWMU 1 subsurface soil was 520 μg/kg and 3,500CD μg/kg, respectively [Baker, 2006a]).

2.5.2 BERA Study Design

In order to address the measurement endpoints listed in Section 2.5.1, the following BERA study design was developed and discussed within the Field Sampling and Analysis Plan (FSAP) section of the Final Steps 3b and 4 Report (Baker, 2007).

- Collection of surface soil for laboratory-based analytical testing of antimony, cadmium, copper, lead, mercury, tin, zinc 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT.

- Collection of surface soil for laboratory-based toxicological testing using the earthworm *Eisenia fetida*. This species was selected as the test organism for the reasons listed below.

    - The terrestrial invertebrate fauna of Puerto Rico includes eighteen endemic earthworm species (Blakemore, 2005).

    - A test method has been developed by the American Society of Testing and Materials [ASTM) using *Eisenia fetida* with two sublethal endpoints (i.e., growth and reproduction), allowing for population-level risk evaluations on terrestrial invertebrates (ASTM Standard E-1676-04: *Standard Guide for Conducting Soil Toxicity or Bioaccumulation Tests with the Lumbricid Earthworm Eisenia Fetida and the Enchytraeid Potworm Enchytraeus Albidus* (ASTM, 2006).

- Collection of earthworm (*Eisenia fetida*) tissue maintained in SWMU 1 surface soil during toxicity testing for laboratory-based analytical testing of cadmium, lead, mercury, zinc, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT. Earthworms are deemed an appropriate species for evaluating bioaccumulation and subsequent food web transfer based on their burrowing activities and feeding habits which expose them to soil contaminants. The collection of earthworm tissue in the field is preferable; however, a sufficient biomass for analytical testing was not encountered during the BERA field investigation.

- Collection of turtle grass tissue samples for laboratory-based analytical testing of arsenic, cadmium, copper, mercury, selenium, and zinc. Turtle grass was selected to evaluate West Indian manatee food web exposures since seagrass meadows within the Ensenada Honda are dominated by a nearly continuous cover of turtle grass (Reid et al., 2001).

  Foraging studies have demonstrated that manatees in NAPR waters feed via two primary strategies: (1) selective grazing of above ground shoots and stems; and (2) rooting behavior and subsequent feeding on the entire plant, including roots and rhizomes [Geo-Marine, Inc., 2005, Reid et al., 2001, and Mignucci-Giannoni and Beck, 1998]). Selective above ground feeding behavior is characteristic of manatees observed in firm bottom habitats, where encrusting algae, coarser sediments, and/or more cohesive sediments are present (Reid et al., 2001). Although coarse and cohesive sediments are present within the open water portions of SWMU 1 and literature-based information indicates that West Indian manatees exhibit selective above ground feeding behavior within the Ensenada Honda (Reid et al., 2001), both above ground and whole-plant turtle grass tissue samples were collected for laboratory-based analytical testing as a measure of conservatism.

- Collection of sediment samples co-located with the above ground and whole-plant turtle grass tissue samples for laboratory-based analytical testing of arsenic, cadmium, copper, mercury, selenium, and zinc. These data were utilized to determine if turtle grass samples were collected from areas that are representative of the sediment concentrations observed within the Ensenada Honda during previous field investigations (2003 and 2004 additional data collection field investigations [Baker, 2006a]).

- Identification of suitable upland and open water reference areas, and the collection of surface soil, sediment, and/or turtle grass tissue samples at these locations for laboratory-based analytical and/or toxicological testing.

2.5.3 Data Quality Objectives

The USEPA defines the DQO process as a "*strategic approach based on the scientific method that is used to prepare for a data collection activity. It provides a systematic procedure for defining the criteria that a data collection design should satisfy, including when to collect samples, where to collect samples, the tolerance level of decision errors for the study, and how many samples to collect*" (Barnthouse and Suter, 1996).

The purpose of the DQO process is to ensure that the type, quantity, and quality of data used in the decision-making process will be appropriate for estimating potential ecological risks. By employing the DQO process, data requirements and error levels acceptable to the investigation can be defined prior to the collection of data. The DQO process is composed of seven steps (USEPA, 2000c and 2000d). These seven steps, as well as the general DQO process that applied to the BERA for SWMU 1 were developed in the Final Steps 3b and 4 Report (Baker, 2007) and are outlined below:

- <u>Step 1 – State the problem</u>: Define the degree and spatial extent of any ecological risks from exposure to site-related chemicals in SWMU 1 surface soil and Ensenada Honda sediment.

- <u>Step 2 – Identify the decision</u>: Is there evidence of unacceptable risk to ecological receptors? Are there sufficient data on which to base this decision?

- <u>Step 3 – Identify the inputs</u>: Analytical chemistry data from relevant media (surface soil, sediment, and vegetation), physical/chemical characteristics of exposure media, and toxicological testing.

- <u>Step 4 – Define the boundaries of the study</u>: Upland and open water portions of SWMU 1.

- <u>Step 5 – Develop a decision rule</u>: Based upon the results of multiple lines of evidence for which data are available, including (1) comparison of measured media concentrations to applicable risk-based screening values; (2) refined food web modeling using measured tissue concentrations; and (3) toxicological testing.

- <u>Step 6 – Specify tolerable limits on decision errors</u>: Acceptable data requirements and error levels associated with the field and analytical portions of this investigation are presented in the Master Plans (Baker, 1995), including the Master Project Management Plan (PMP), Master Data Collection Quality Assurance Plan (DCQAP), Data Management Plan (DMP), and Master Health and Safety plan (HASP). Acceptable data requirements and error levels associated with the *Eisenia fetida* laboratory-based toxicity tests (i.e., test conditions, data, and data interpretation) have been established by ASTM (2006). Specific data requirements and error levels identified by the toxicity testing laboratory are included in their scope of work (SOW), included as Appendix B.

- Step 7 – Optimize the design for obtaining data: Compile and evaluate information and data to focus sampling efforts. Inherently optimized through the iterative nature of the Navy's 8-step ERA process.

2.5.4 Data Evaluation and Interpretation

The specific lines of evidence employed in this investigation and the methods of evaluation developed in the Final Steps 3b and 4 Report (Baker, 2007) are identified and discussed below.

- *Comparison of the spatial and statistical distributions of antimony, cadmium, copper, lead, mercury, tin, zinc, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT concentrations in surface soil to appropriate literature-based toxicological thresholds* – 95 percent upper confidence limit (UCL) of the mean concentrations were calculated from a combined surface soil data set consisting of analytical data used in Step 2 and Step 3a of the ERA process (see Table 2-3) and analytical data generated as part of the BERA field investigation (see Section 3.2.1) using USEPA ProUCL Version 4.0.010 software (USEPA, 2007e and 2007f). 95 percent UCL of the mean concentrations calculated from the combined data sets were then used to derive risk estimates using the HQ method. For a given ecological COC, HQs were calculated by dividing 95 percent UCL of the mean surface soil concentrations by the corresponding soil screening value. HQ values greater than 1.0 indicate the potential for unacceptable risk to terrestrial invertebrate communities. It is noted that the magnitude of detections above soil screening values was considered when evaluating risk estimates (Parker et al., 2003). This was accomplished by calculating HQ values based on maximum concentrations. This consideration ensures that potential effects of "hot spots" are not diluted by calculating 95 percent UCL of the mean concentrations. The spatial extent of detections above the soil screening values also was considered when evaluating risk estimates based on 95 percent UCL of the mean concentrations. .

  The antimony, cadmium, copper, lead, mercury, tin, zinc, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT soil screening values selected for this line of evidence are listed below.

  - Antimony: 78 mg/kg – Ecological SSL for soil invertebrates (USEPA, 2005a)
  - Cadmium: 140 mg/kg – Ecological SSL for soil invertebrates (USEPA, 2005c)
  - Copper: 80 mg/kg – Ecological SSL for soil invertebrates (USEPA. 2007a)
  - Lead: 1,700 mg/kg – Ecological SSL for soil invertebrates (USEPA, 2005d)
  - Mercury: 0.1 mg/kg – Toxicological benchmark for earthworms (Efroymson et al., 1997b)
  - Tin: 50 mg/kg – Toxicological benchmark for terrestrial plants (Efroymson et al, 1997a) (toxicological benchmark for terrestrial invertebrates unavailable from the literature; toxicological benchmark for terrestrial plants used as a surrogate)
  - Zinc: 120 mg/kg – Ecological SSL for soil invertebrates (USEPA, 2007c)

- 4,4’-DDD: 401 µg/kg – Mean of the target and intervention values for total DDT/DDD/DDE) in a standard soil assuming a default organic carbon content of 0.02 (2.0 percent) (MHSPE, 2000).

- 4,4’-DDE: 401 µg/kg – Mean of the target and intervention values for total DDT/DDD/DDE) in a standard soil assuming a default organic carbon content of 0.02 (2.0 percent) (MHSPE, 2000).

- 4,4’-DDT: 401 µg/kg – Mean of the target and intervention values for total DDT/DDD/DDE) in a standard soil assuming a default organic carbon content of 0.02 (2.0 percent) (MHSPE, 2000).

The soil screening values listed above for antimony, cadmium, copper, lead, and zinc were not used in the Step 2 screening-level risk calculation or the Step 3a refinement (Baker, 2006a). The values used for antimony, cadmium, lead, and zinc (5 mg/kg, 4 mg/kg, 50 mg/kg, and 50 mg/kg, respectively) were literature-based toxicological benchmarks for terrestrial plants (Efroymson et al., 1997a). As discussed in Section 2.4.3, potential risks to terrestrial plants at SWMU 1 are considered acceptable based on observations recorded during a habitat characterization. Given that an assessment endpoint was selected for terrestrial invertebrates, soil screening values based on this receptor group are more appropriate for use in the BERA than soil screening values based on terrestrial plants. Although the screening value established for copper in the SERA was invertebrate-based (50 mg/kg [Efroymson et al., 1997b), this value was updated to reflect current information from the literature. The procedure used to select the antimony, cadmium, copper, lead, mercury, tin, zinc, 4,4’-DDD, 4,4’-DDE, and 4,4-DDT screening values listed above is provided below.

Ecological SSLs based on terrestrial invertebrates (documentation is available at http://www.epa.gov/ecotox/ecossl/) or, in the case of chemicals lacking invertebrate-based ecological SSLs, toxicological data eligible for ecological SSL derivation were preferentially selected as soil screening values. Earthworm-based toxicological thresholds developed by Efroymson et al. (1997b) were selected as soil screening values for those chemicals lacking an invertebrate-based ecological SSL or toxicological data eligible for invertebrate-based ecological SSL development. For those chemicals lacking an invertebrate-based ecological SSL, toxicological data eligible for ecological SSL development, and earthworm-based toxicological thresholds from Efroymson et al. (1997a), the following literature-based values, listed in their order of decreasing preference, were selected as soil screening values:

- Ecological SSLs for terrestrial plants (http://www.epa.gov/ecotox/ecossl/)

- Plant-based toxicological data eligible for Eco-SSL derivation

- Toxicological thresholds for plants (Efroymson et al., 1997a).

- Soil standards developed by MHSPE (2000), assuming a minimum default soil organic carbon content of 2.0 percent.

- Background-based soil-screening values reported by Friday (1998).

Background-based soil screening values were given the lowest preference since they do not represent effect-based concentrations.

- *Comparison of Eisenia fetida survival, growth, and reproduction data in SWMU 1 surface soil to Eisenia fetida survival growth, and reproduction in reference surface soil* – Statistical comparisons between site samples and reference samples were performed for each endpoint individually. The tests determined whether organism performance (i.e., *Eisenia* fetida survival, growth, and reproduction) in surface soil collected from SWMU 1 was significantly different (at $\alpha = 0.05$) than organism performance in surface soil collected from the reference area.

- *Existence of patterns in laboratory toxicity test results with chemical burdens and other chemical/physical characteristics of the site media* – The data were reviewed to determine whether there are relationships between biological responses in the toxicity tests and antimony, cadmium, copper, lead, mercury, tin, zinc, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT concentrations in surface soil. This was accomplished with the use of linear regressions. Other factors considered in the analyses included TOC, pH, and grain size distributions.

- *Comparison of mean terrestrial avian omnivore dietary intakes to literature-based toxicity reference values* – 95 percent UCL of the mean cadmium, lead, mercury, zinc, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT concentrations in earthworm tissue were used in place of modeled earthworm tissue concentrations to estimate dietary intakes for terrestrial avian omnivores. Although antimony, copper, and tin were not identified as ecological COCs for terrestrial avian omnivore food web exposures in Step 3a of the ERA process (Baker, 2006a and 2007), dietary intakes also were estimated for these three metals using earthworm tissue concentrations (see Section 3.2.2) since maximum soil concentrations for these three metals were detected in surface soil collected during the BERA field investigation. Dietary intakes were estimated using the following formula modified from USEPA (1993):

$$DI_x = \frac{[[\sum_i [(FIR)(FC_{xi})(PDF_i)]] + [(FIR)(SC_x)(PDS)]][AUF]}{BW}$$

where:

DI_x	=	Dietary intake for chemical x (mg chemical/kg-BW/day)
FIR	=	Mean food ingestion rate (kilograms per day [kg/day], dry weight)
FC_{xi}	=	95 percent UCL of the mean concentration of chemical x in food item i (mg/kg, dry weight)
PDF_i	=	Proportion of diet composed of food item i (unitless, dry weight basis)
SC_x	=	95 percent UCL of the mean concentration of chemical x in soil (mg/kg, dry weight)
PDS	=	Proportion of diet composed of soil (unitless, dry weight basis)
BW	=	mean body weight (kilograms [kg], wet weight)
AUF	=	Area Use Factor (unitless)

The American robin was used as a representative species for terrestrial avian omnivores at SWMU 1. Receptor-specific exposure parameters used for the American robin included a mean food ingestion rate of 0.00383 kg/day-dry weight (Levey and Karasov, 1989) and a mean body weight of 0.0773 kg (USEPA, 1993). Although the American robin is omnivorous, the exposure diet was assumed to be 90.9 percent earthworms and 9.1 percent surface soil (no plant material). The food ingestion rate of the American robin will vary based on the percentage of plant material and invertebrates in the total diet (the food ingestion rate decreases as the percentage of invertebrates increases [Levey and Karasov, 1989]. The food ingestion rate can be weighted to reflect any assumed proportion of plants and investbrates using the following formula:

$$FIR_t = \left[\left(\frac{PD_p}{PD_p + PD_w}\right)(0.59)\right] + \left[\left(\frac{PD_w}{PD_w + PD_p}\right)(0.31)\right]$$

where:

FIR_t	=	Food ingestion rate (g/g-day; wet weight basis)
PD_p	=	Proportion of diet composed of plants (unitless)
PD_w	=	Proportion of diet composed on earthworms (unitless)

In this equation, 0.59 represents the American robin food ingestion rate (g/g-day [wet weight]) for a plant diet, while 0.31 represents the American robin food ingestion rate (g/g-day [wet weight]) for an invertebrate diet (Levey and Karasov, 1989). Because the assumed diet of the American robin does not include plant material, a food ingestion rate of 0.31 g/g-day (wet weight) is calculated by the above formula. This food ingestion rate was converted to units of kg/day (wet weight) by multiplying the value by the body weight of the American robin (0.0773 kg). The resulting food ingestion rate (0.02396 kg/day) was converted to a dry weight value (kg/day) by multiplying the value by the solids content of earthworms (0.16 [USEPA, 1993]). The solids content of earthworms was used in the conversion from wet weight to dry weight since this invertebrate represents the assumed American robin prey item.

Direct ingestion of drinking water is only considered if the salinity of a drinking water source is less than 15 ppt, the approximate toxic threshold for wildlife receptors (Humphreys, 1988). As discussed in the SERA (Baker, 2006a), no potential drinking water sources are located within or contiguous to SWMU 1. As such, ingestion of surface water is not a potential exposure pathway and was not considered in risk calculations for American robin dietary exposures. Finally, it was assumed that the American robin spends 100 percent of its time within the upland portions of SWMU 1 (i.e., an AUF of 1.0 was assumed).

As discussed in Section 2.2.3.2, SWMU 1 is located within the critical habitat designation for the yellow-shouldered blackbird. Aspects of the feeding ecology of the American robin and yellow-shouldered blackbird indicate that the American robin can be protectively used as a surrogate receptor:

- The American robin forages on the ground for soft-bodied invertebrates, whereas the yellow-shouldered black bird is an arboreal feeder that forages within the canopy and sub-canopy of trees (USFWS, 1996a). The invertebrate prey item consumed by the American robin is assumed to be earthworms in the BERA. Because earthworms are in direct contact with soil, they will bioaccumulate soil contaminants at higher concentrations than the arboreal invertebrates consumed by the yellow-shouldered blackbird. Modeled dietary intakes that include earthworm ingestion will result in a conservative estimate of food web exposures for the yellow-shouldered blackbird.

- The diet of the American robin is assumed to include 9.1 percent soil (Levy and Karasov, 1989), whereas soil consumption by the yellow-shouldered blackbird is likely to be negligible based on their arboreal feeding behavior. Modeled dietary intakes that include soil ingestion also will result in a conservative estimate of food web exposures for the yellow-shouldered blackbird.

Ingestion-based HQs for American robin dietary exposures to cadmium, lead, mercury, zinc, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT in surface soil were calculated by dividing dietary intakes by the literature-based NOAEL values listed in Table 2-8. Sample et al. (1996) consider a scaling factor of 1.0 most appropriate for interspecies extrapolation between birds. Therefore, the NOAEL values summarized in Table 2-8 were not adjusted to reflect differences in body weights between avian test species and avian receptor species. As a measure of conservatism, it was assumed that all mercury in SWMU 1 surface soil is present as MeHg. Therefore, mercury HQ values were derived using the NOAEL value from the study using methylmercury dicyandiamide as the test material. Table 2-8 includes LOAEL and maximum acceptable toxicant concentration (MATC) values for each COC. However, because the American robin is being used as a surrogate receptor for the endangered yellow-shouldered blackbird, risk estimates based on LOAEL and MATC values were not calculated or used as lines of evidence in this investigation (conclusions regarding the acceptability of risk for individual chemicals are based solely on HQs derived using NOAEL values). A NOAEL-based HQ value greater than 1.0 indicates the potential for unacceptable risk.

For a given chemical, if an unacceptable risk is indicated by the evaluation, the NOAEL-based HQ value for that chemical will be compared to a NOAEL-based HQ value for American robin dietary exposures at the upland reference area. The reference area risk estimate will be derived using the procedure presented above. The comparison will determine if potential risks presented by ecological COCs in SWMU 1 surface soil exceed potential risks at the reference area.

- *Comparison of maximum West Indian manatee dietary intakes to literature-based toxicity reference values* – Maximum arsenic, cadmium, copper, mercury, selenium, and zinc concentrations in field-collected turtle grass tissue (whole plant and aboveground portions) at SWMU 1 were used in place of modeled values to estimate dietary intakes for the West Indian manatee. Dietary intakes were estimated using the following formula modified from USEPA (1993):

$$DI_x = \frac{[[\sum_i [(FIR)(FC_{xi})(PDF_i)]] + [(FIR)(SC_x)(PDS)]][AUF]}{BW}$$

where:

DI_x	=	Dietary intake for chemical x (mg chemical/kg-BW/day)
FIR	=	Maximum food ingestion rate (kg/day, dry weight)
FC_{xi}	=	Maximum concentration of chemical x in food item i (dry weight)
PDF_i	=	Proportion of diet composed of food item i (mg/kg, dry weight)
SC_x	=	Maximum concentration of chemical x in sediment (mg/kg, dry weight)
PDS	=	Proportion of diet composed of sediment (dry weight basis)
BW	=	mean body weight (kg, wet weight)
AUF	=	Area Use Factor (unitless)

Receptor-specific exposure parameters used for the West Indian manatee included a maximum food ingestion rate of 21.9 kg/day-dry weight (Etheridge et al., 1985) and minimum body weight of: 800 kg (United States Geological Survey [USGS], 2000).

These values were developed in the SERA and Step 3a of the BERA (Baker, 2006a). As the manatee is a strictly herbivorous species, the exposure diet was assumed to be 99 percent plant material (USFWS, 1986a and Odell, 1992) and one percent sediment (from incidental ingestion; USGS, 2000). As discussed in the SERA (Baker, 2006a), no potential drinking water sources are available within the Ensenada Honda. As such, ingestion of surface water is not a potential complete exposure pathway and was not considered in risk calculations for West Indian manatee dietary exposures. It is noted that maximum ecological COC concentrations in turtle grass tissue and sediment, as well as a maximum food ingestion rate and minimum body weight were used to derive dietary intakes for the West Indian manatee based on the endangered status of this species in Puerto Rico.

For the BERA, it was assumed that the West Indian manatee spends 100 percent of its time within the open water portion of SWMU 1 (i.e., an AUF of 1.0 was assumed). This is considered an overly conservative assumption given that West Indian manatees could spend a significant percentage of time foraging off-site in areas not impacted by site-related chemicals or areas where chemical concentrations are expected to be significantly lower. For example, the Florida population of the West Indian manatee ranges over fairly large areas during the summer (covering up to 200 linear kilometers [km] of river or coastline). Unlike the Florida population, which aggregates within the confines of natural or artificial warm water refuges during winter periods (USFWS, 1996c), there is no evidence of periodicity in manatee behavior in Puerto Rico (USFWS, 1986a). As such, it cannot be expected that West Indian manatees would forage exclusively within the Ensenada Honda (represented by approximately 6.2 miles of shoreline) or the portion of the Ensenada Honda within the boundary of SWMU 1 (represented by approximately 0.4 miles of shoreline).

Ingestion-based HQs for the West Indian manatee were calculated by dividing maximum dietary intakes by literature-based NOAEL values adjusted to reflect differences in body weights between mammalian test species and the West Indian manatee. Ingestion-based screening values were adjusted by the following scaling equation (Sample et al., 1996):

$$NOAEL_r = NOAEL_t(BW_t/BW_r)^{1/4}$$

where:

$NOAEL_r$	=	NOAEL of the receptor species (mg/kg-BW/day)
$NOAEL_t$	=	NOAEL of the test species (mg/kg-BW/day)
BW_r	=	Body weight of receptor species (kg)
BW_t	=	Body weight of test species (kg)

Test species NOAEL values, as well as the adjusted values used in the derivation of maximum arsenic, cadmium, copper, mercury, selenium, and zinc HQ values for West Indian manatee dietary exposures are summarized in Table 2-9. As a measure of conservatism, it was assumed that all mercury in SWMU 1 sediment is present as MeHg. Therefore, mercury HQ values were derived using the NOAEL value from the study using MeHg chloride as the test material. Based on the endangered species status of the West Indian manatee, NOAEL values are most appropriate for this receptor. Therefore, risk estimates were not derived using the LOAEL and MATC values listed in Table 2-9 (conclusions regarding the acceptability of risk were based solely on HQ values derived using NOAEL values). A NOAEL-based HQ value greater than 1.0 indicates the potential for unacceptable risk.

For a given chemical, if an unacceptable risk is indicated by the evaluation, the NOAEL-based HQ value for that chemical will be compared to the NOAEL-based HQ value derived for West Indian manatee dietary exposures at the open water reference area. The reference area risk estimate will be derived using the procedure presented above. The comparison will determine if potential risks presented by ecological COCs in SWMU 1 sediment exceed potential risks at the reference area.

Table 2-10 summarizes the decision rules and criteria used in Section 5.0 to outline potential recommendations and actions associated with these lines of evidence. Each line of evidence was not weighted equally. For example, the comparison of antimony, cadmium, copper, lead, mercury, tin, zinc, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT concentrations to literature-based toxicological thresholds doesn't account for site-specific characteristics that may influence the bioavailability of these chemicals to terrestrial invertebrates, nor do these comparisons account for effects of multiple chemicals, including additive, synergistic, or antagonistic effects. Therefore, the comparison of surface soil concentrations to ecological SSLs or literature-based toxicological is typically given little weight. Toxicity testing can account for site-specific characteristics (e.g., pH and TOC) that may influence chemical bioavailability. Toxicity testing can also account for the effects of multiple chemicals. For these reasons, toxicity testing is typically given greater weight when developing recommendations for a site.

3.0 BERA FIELD INVESTIGATION SUMMARY

The sections that follow detail the various investigation activities that were implemented in conjunction with the BERA at SWMU 1 (i.e., verification of field sampling design [Step 5] and BERA field investigation [Step 6]). Any modifications to the FSAP presented within the Final Steps 3b and 4 Report (Baker, 2007) are identified and rational for the modifications are included in the discussion. A copy of the field notes scribed during the Step 5 field verification and Step 6 BERA field investigation activities are provided as Appendix C, while Chain-of-Custody forms that accompanied the samples from the field to the analytical and toxicity testing laboratories and data validators are provided as Appendix D. The evaluation of the analytical data and *Eisenia fetida* toxicity test results is presented in Section 4.0.

3.1 Verification of BERA Field Sampling Design

Prior to mobilization for the BERA field investigation (Step 6), the field sampling design was verified in the field (Step 5 of the Navy ERA process; see Figure 1-1) to ensure that the BERA study design was appropriate and could be implemented at SWMU 1. The testable hypotheses, exposure pathway models, and measurement endpoints also were evaluated for their appropriateness. By verifying the field sampling design prior to conducting the field investigation, well-considered alterations to the study design can be made. It is noted that field verification activities for the BERA at SWMU 1 were conducted concurrently with field verification activities for a BERA at SWMU 2. The BERA for SWMU 2 will be presented in a separate document; therefore, the description of the Step 5 field verification presented within the paragraphs that follow is limited to activities conducted for the BERA at SWMU 1. The evaluation of analytical data generated during field verification sampling activities (see Section 4.0) also is limited to an evaluation of data specific to SWMU 1.

The lines of evidence employed in the BERA at SWMU 1 (see Section 2.5.4) included the comparison of *Eisenia fetida* survival, growth, and reproduction in SWMU 1 surface soil to *Eisenia fetida* survival, growth, and reproduction in reference surface soil. This line of evidence requires that surface soil samples be collected from an area not known to be impacted by contaminant sources, termed a reference area. A second line of evidence identified in Section 2.5.4 involves the comparison of ingestion-based risk estimates (maximum HQs) for West Indian manatee dietary exposures at SWMU 1 to ingestion-based risk estimates for West Indian manatee dietary exposures at a reference area. This line of evidence requires the collection of seagrass tissue samples from a reference area not known to be impacted by contaminant sources. Based on these two lines of evidence, one of the primary objectives of the verification of the BERA field sampling design at SWMU 1 was the identification of an appropriate upland reference area for the collection of surface soil and the identification of an appropriate open water reference area for the collection of turtle grass tissue.

Activities associated with verification of the BERA field sampling design for terrestrial habitats were conducted February 27 to March 1, 2007, and included the collection of surface soil from SWMU 1 and three upland reference areas (Upland Reference Area No. 1, Upland Reference Area No. 2, and Upland Reference Area No. 3). The upland reference areas (see Figure 3-1) were identified based on the lack of apparent contaminant influences and the presence of terrestrial habitat similar to that identified at SWMU 1 (upland coastal forest or coastal scrub forest communities adjacent to estuarine wetland habitat; as determined by field observations and/or examination of Figures 2-3 and 2-5). Upland Reference Area No. 1 was established approximately 0.17 miles north of SWMU 2, Upland Reference Area No. 2 was established north of Kearsage Road, between SWMUs 1 and 2 (approximately 0.11 miles north of SWMU 1 and 0.17 miles south of SWMU 2), while Upland Reference Area No. 3 was established approximately 0.16 miles south of SWMU 1. Although each upland reference area is located adjacent to SWMUs 1 and/or 2, all three reference areas are topographically upgradient of impacted soils at these two SWMUs.

Table 3-1 provides a summary of the surface soil samples collected at SWMU 1 and each of the upland reference areas during verification of the field sampling design. Included within the table are the associated field quality assurance/quality control (QA/QC) samples. As evidenced by the table, six surface soil samples were collected at SWMU 1 (1V-SS01 through 1V-SS06), while four surface soil samples were collected at each upland reference area (Upland Reference Are No. 1: REF-SS01 through REF SS04, Upland Reference Area No. 2: REF-SS05 through REF-SS08, and Upland Reference Area No. 3: REF-SS09 through REF-SS12). Sample locations were georeferenced with a Global Positioning System (GPS) at the time of sampling and are shown on Figures 3-2. All SWMU 1 and upland reference area surface soil samples were collected from the 0 to 1-foot depth interval using dedicated stainless steel hand augers (hand augers were not re-used after initial use). Soil was dispensed from the hand augers directly into aluminum pans, mixed with dedicated stainless steel spoons, and dispensed into sample jars for shipment to the analytical laboratory (Severn Trent Laboratories [STL] located in Savannah, Georgia). The SWMU 1 surface soil samples were analyzed for TOC, grain size, and pH. As outlined in the Final Steps 3b and 4 Report (Baker, 2007), two of the four surface soil samples collected at each upland reference area were analyzed for antimony, cadmium, copper, lead, mercury, tin, zinc, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT (ecological COCs identified in Step 3a of the Navy ERA process for terrestrial invertebrate direct contact exposures [Baker, 2006a]), as well as TOC, pH, and grain size. The remaining two surface soil samples collected at each upland reference area were analyzed for an expanded list of analytes (i.e., polycyclic aromatic hydrocarbons [PAHs], Appendix IX organochlorine pesticides, Appendix IX metals, TOC, pH, and grain size). An expanded set of analytes was requested by the USEPA in their comment letter dated December 8, 2006 on the *Draft Steps 3b and 4 of the Baseline Ecological Risk Assessment for SWMUs 1 and 2* (Baker, 2006b). Analyses were performed on a standard-turn (i.e., 28-days) using the methodology summarized in Table 3-2.

Three open water reference areas (Open Water Reference Area No. 1, Open Water Reference Area No. 2, and Open Water Reference Area No. 3) were previously evaluated during Step 5 of the ERA process for SWMU 45 (Baker, 2008a). The open water reference areas (see Figure 3-1) were identified based on the lack of apparent contaminant influences and the likely presence of seagrass habitat similar to that present at SWMU 45 and SWMU 1 (i.e., turtle grass community). Open Water Reference Area No. 1 was established within Puerca Bay, Open Water Reference Area No. 2 was established within an Embayment of the Ensenada Honda, adjacent to the former Officer's Beach (approximately 1.0 mile from the open water portion of SWMU 1), while Open Water Reference Area No. 3 was established within Pelican Bay. The proposed location of Reference Area No. 3 (Baker, 2006c and 2007) was relocated during the SWMU 45 field verification sampling event due to the presence of a cliff face, which prevented access to the proposed location from land. The new location was established within Pelican Bay, adjacent to Franklin D. Roosevelt Drive (see Figure 3-1). The evaluation of each open water reference area during the SWMU 45 field verification investigation included the collection and analysis of sediment samples for the ecological COCs unique to SWMU 1 West Indian manatee dietary exposures (i.e., arsenic, cadmium, copper, mercury, selenium, and zinc). Therefore, additional evaluation of the open water reference areas was not conducted during verification of the field sampling design at SWMU 1.

Table 3-3 provides a summary of the sediment samples and associated QA/QC samples collected at each open water reference area during the SWMU 45 field verification sampling event. Six sediment samples were collected at Open Water Reference Area No. 1 (REF1-SD01V through

REF1-SD06V) and Open Water Reference Area No. 2 (REF2-SD01V through REF2-SD06V), while two sediment samples were collected at Open Water Reference Area No. 3 (REF3-SD01V and REF3-SD02V). Identical to the surface soil samples collected at SWMU 1 and the upland reference areas, sediment sample locations were georeferenced with a GPS at the time of sampling and are shown on Figures 3-3 (Open Water Reference Area No. 1) and 3-4 (Open Water Reference Area Nos. 2 and 3). All reference area sediment samples were collected from the 0 to 0.5-foot depth interval using dedicated sediment core liners (core liners were disposed of after each use). Sediment was dispensed from the core liners directly into sample jars for shipment to the analytical laboratory (STL-Savannah). Each open water reference area sediment sample included analyses for the ecological COCs unique to SWMU 1 (arsenic, cadmium, copper, mercury, selenium, and zinc), as well as TOC and grain size. Analyses were conducted on a standard turn (i.e., 28 days) using the methodology summarized in Table 3-2.

It is noted that the Final Steps 3b and 4 Report for SWMU 45 and SWMU 1 (Baker, 2006c and 2007, respectively) specified the collection of six sediment samples at each of the proposed reference areas. However, as indicated above, only two sediment samples were collected from Reference Area No. 3. The number of samples collected at this open water reference area was reduced during the SWMU 45 field verification sampling event based on low seagrass coverage (i.e., seagrass cover was less than ten percent).

As outlined in the Final Steps 3b and 4 Report (Baker, 2007), the proposed reference areas were evaluated based on physical, chemical, and biological properties. A given upland reference area was deemed acceptable for use as a source of surface soil during the BERA field investigation (Step 6) for *Eisenia fetida* toxicity testing if the following conditions were met:

- The range of TOC concentrations and grain size characteristics in upland reference area surface soil are similar to the ranges found in surface soil located within the study area (SWMU 1 upland habitat). This criterion was established since *Eisenia fetida* response in toxicity tests can be influenced by these soil characteristics (ASTM, 2006).

- Maximum concentrations of PAHs, Appendix IX metals, and Appendix IX organochlorine pesticides do not exceed the soil screening values summarized in Table 3-4. The soil screening values listed in Table 3-4 were identified from the literature using the sources and procedures previously presented in Section 2.5.4. This criterion ensures that reference soils do not contain ecological COCs at concentrations that could impact *Eisenia fetida* survival, growth, and/or reproduction.

A given open water reference area was deemed acceptable for use as a source of seagrass tissue for the BERA at SWMU 1 if the following conditions were met (Baker, 2007):

- The habitat offered by the reference area is similar to habitat found within the open water portion of SWMU 1 (turtle grass community). This criterion ensures that the reference areas represent potential feeding habitat for West Indian manatees.

- The range of TOC concentrations and grain size characteristics in open water reference area sediment are similar to the ranges found in sediment located within the open water portion of SWMU 1. This criterion was established since TOC and grain size can influence the bioavailability of metals in sediment (John and Leventhal, 1995, NFESC, 2000, Pereira et al., 2008, Warren et al., 1994, and Wood and Shelley, 1999).

- The concentrations of arsenic, cadmium, copper, mercury (total), selenium, and zinc in reference sediment do not exceed the sediment screening values developed in Step 1 of the Navy ERA process (arsenic: 7.24 mg/kg [MacDonald, 1994]; cadmium: 0.68 mg/kg [MacDonald, 1994]; copper: 18.7 mg/kg [MacDonald, 1994]; mercury: 0.13 mg/kg [MacDonald, 1994]; selenium: 1.0 mg/kg [Buchman, 1999]; and zinc: 124 mg/kg [MacDonald, 1994]). This criterion ensures that reference sediments do not contain ecological COCs at concentrations that could impact West Indian manatee survival, growth, and/or reproduction.

For metals detected at concentrations greater than soil or sediment screening values, analytical data were compared to the surface soil and open water sediment background screening values (upper limit of the mean concentrations; mean background concentration plus two standard deviations) established within the *Revised Final II Summary Report for Environmental Background Concentrations of Inorganic Compounds* (Baker, 2008b). A given reference area was still deemed acceptable as a source of surface soil or seagrass tissue for the BERA field investigation if maximum detected concentrations were less than background screening values.

The evaluation of each upland and open water reference area against the physical, biological, and chemical criteria identified above is presented in Sections 4.1.1 (upland reference areas) and 4.1.2 (open water reference areas). Based on this evaluation, Upland Reference Area No. 2 was deemed most appropriate for the collection of surface soil for *Eisenia fetida* toxicity testing, while Open Water Reference Area No. 2 was deemed most appropriate for the collection of turtle grass tissue.

3.2 BERA Field Investigation

Sampling activities associated with the BERA field investigation (Step 6) were conducted from April 28, 2007 to April 30, 2007. Surface soil samples were collected from an upland reference area (Upland Reference Area No. 2) and SWMU 1 in support of the *Eisenia fetida* toxicity tests. Earthworms maintained in surface soil during toxicity testing also were collected from test chambers at test termination for whole-body analyses (insufficient earthworm tissue was encountered in the field during surface soil collection activities). In addition to surface soil and earthworm tissue, above ground and whole-plant turtle grass tissue samples were collected from the open water portion of SWMU 1. Co-located sediment samples also were collected at each turtle grass tissue sampling location. The earthworm and seagrass tissue analytical data were used in place of modeled tissue concentrations to estimate dietary intakes for American robin and West Indian manatee food web exposures, respectively. Finally, turtle grass tissue and co-located sediment samples were collected from Open Water Reference Area No. 2 during the BERA field investigation at SWMU 45 (conducted from January 28, 2007 to January 31, 2007). Surface soil, sediment and turtle grass sampling activities are described in the sections that follow. Analytical results for the surface soil, sediment, earthworm tissue, and turtle grass tissue samples collected during the BERA field investigation are presented and discussed in Section 4.0.

3.2.1 Surface Soil Sampling in Support of Earthworm Toxicity Tests

A total of fifty-five surface soil samples, designated 1B-SS01 through 1B-SS55, were collected from the upland habitat at SWMU 1 in support of the 28-day *Eisenia fetida* survival, growth, and reproduction tests (see Table 3-5). Sample locations were identified by establishing four 10-foot by 10-foot sampling grids centered around each of eleven sampling points previously sampled during the 1996 RFI or 2004 additional data collection field investigation (1SS04, 1SS06, 1SS07, 1SD01, 1SD02, 1SS09, 1SS10, 1SS11, 1SS12, 1SS13, and 1SS16 [see Figure 3-5]). Ecological COC concentrations at these eleven sampling points span the range of concentrations detected in surface soil collected during the 1996 RFI and 2004 additional data collection field investigation (see Table 2-3). At each historical sampling point, a total of five surface soil samples were collected (one from each of four 10-foot by 10-foot sampling grids and one from the grid's center point [approximate location of the historical sampling point]). The location sampled within a grid was determined in the field and was biased toward potential depositional areas (i.e., depressions/low points). BERA sampling locations and their corresponding historical sampling location (i.e. locations sampled during the 1996 RFI or 2004 additional data collection field investigation) are identified within the table below.

Historical Sample Location	BERA Sample Location
1SS04	1B-SS01, 1B-SS02, 1B-SS03, 1B-SS04, and 1B-SS05
1SS06	1B-SS06, 1B-SS07, 1B-SS08, 1B-SS09, and 1B-SS10
1SS10	1B-SS11, 1B-SS12, 1B-SS13, 1B-SS14, and 1B-SS15
1SS16	1B-SS16, 1B-SS17, 1B-SS18, 1B-SS19, and 1B-SS20
1SS09	1B-SS21, 1B-SS22, 1B-SS23, 1B-SS24, and 1B-SS25
1SD02	1B-SS26, 1B-SS27, 1B-SS28, 1B-SS29, and 1B-SS30
1SS11	1B-SS31, 1B-SS32, 1B-SS33, 1B-SS34, and 1B-SS35
1SS07	1B-SS36, 1B-SS37, 1B-SS38, 1B-SS39, and 1B-SS40
1SD01	1B-SS41, 1B-SS42, 1B-SS43, 1B-SS44, and 1B-SS45
1SS13	1B-SS46, 1B-SS47, 1B-SS48, 1B-SS49, and 1B-SS50
1SS12	1B-SS51, 1B-SS52, 1B-SS53, 1B-SS54, and 1B-SS55

In addition to the SWMU 1 surface soil samples, a total of six surface soil samples, designated 1B-REF-SS01 through 1B-REF-SS06 (see Table 3-5), were collected from Upland Reference Area No. 2 (see Figure 3-6) for use as potential reference surface soil samples for *Eisenia fetida* toxicity testing.

The SWMU 1 and upland reference area surface soil samples were collected from the 0 to 1.0-foot depth interval using dedicated stainless steel spoons. Surface soil was dispensed from the stainless steel spoons directly into one-gallon sample containers. At a given sampling location, once the one-gallon sample container was filled, the contents were homogenized with the same stainless steel spoon used for sample collection and a portion was transferred to sample jars for submittal to the analytical laboratory (STL-Burlington, STL-Pittsburgh, or STL-Savannah) for the following quick-turn (i.e., 48-hour) analysis using the methodology presented in Table 3-6: antimony, cadmium, copper, lead, mercury, tin, zinc, 4,4'-DDD, 4,4'-DDE, and 4,4-DDT. The remaining soil was held in the one-gallon sample container on ice until the quick-turn results were available from the analytical laboratory.

Upon receipt of the unvalidated analytical results in the field, fourteen SWMU 1 surface soil samples were selected from the sample portions held on ice and submitted to the toxicity testing laboratory (Fort Environmental Laboratories located in Stillwater, Oklahoma) for 28-day *Eisenia fetida* survival, growth, and reproduction toxicity tests. Ecological COC concentrations in the SWMU 1 surface soil samples submitted for toxicity testing (1B-SS09, 1B-SS13, 1B-SS15, 1B-SS18, 1B-SS19, 1B-SS29, 1B-SS33, 1B-SS37, 1B-SS39, 1B-SS46, 1B-SS48, 1B-SS49, 1B-SS50, and 1B-SS51) span the range of concentrations measured in the quick-turn samples (i.e., non-detected concentrations or concentrations less than soil screening values to maximum detected concentrations). In addition to the fourteen SWMU 1 surface soil samples, three of the reference area surface soil samples collected from Upland Reference Area No. 2 were selected for toxicity testing (IB-REF-SS03, 1B-REF-SS05, and 1B-REF06). The reference area surface soil samples selected for toxicity testing met the antimony, cadmium, copper, lead, mercury, tin, zinc, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT criteria specified in Section 3.1 (i.e., ecological COC concentrations do not exceed the soil screening values listed in Table 3-4). These three samples also exhibited similar physical characteristics as those observed in surface soils collected from

SWMU 1 and submitted for toxicity testing (apparent, based on professional judgment). Each SWMU 1 and upland reference area surface soil sample submitted for toxicity testing was analyzed for TOC, pH, and grain size using the methodology presented in Table 3-6.

3.2.2 Earthworm Toxicity Testing

Direct toxicity to terrestrial invertebrates was evaluated using 28-day *Eisenia fetida* survival, growth, and reproduction tests. Tests were conducted in accordance with ASTM Standard E1676-04: *Standard Guide for Conducting Soil Toxicity or Bioaccumulation Tests with the Lumbricid Earthworm Eisenia Fetida and the Enchytraeid Potworm Enchytraeus Albidus* (ASTM, 2006). Test endpoints for *Eisenia fetida* were survival, calculated as the mean percentage of test organisms at test initiation that survived in each replicate at test termination; growth, calculated as the mean weight loss per surviving earthworm in each replicate at test termination, and reproduction, expressed as the mean number of juveniles and cocoons per surviving earthworm in each replicate at test termination.

Each reference area and SWMU 1 surface soil sample was tested using eight replicate chambers, with ten earthworms per replicate (eighty earthworms per sample). The toxicity testing laboratory's SOW (Appendix B) and ASTM Standard E1676-04 specify the acceptable laboratory control performance criteria and testing procedures for the *Eisenia fetida* toxicity tests. The laboratory control data indicate that earthworm performance exceeded the minimum acceptability criteria specified by ASTM Standard E1676-04 (mean survival greater than 90 percent in each laboratory control replicate). Furthermore, no protocol deviations were observed or recorded during the performance of the toxicity tests. The toxicity test report summarizing the toxicity evaluations using *Eisenia fetida* is included as Appendix E. The results of the toxicity tests are presented and discussed in Section 4.2.2.

3.2.3 Earthworm Tissue

Earthworms maintained in surface soil during toxicity testing were used to evaluate terrestrial avian omnivore food web exposures to ecological COCs in SWMU 1 surface soil. One composite tissue sample was prepared for each surface soil sample tested for toxicity (fourteen SWMU 1 surface soil samples and three Upland Reference Area No. 2 surface soil samples [see Table 3-5]) by combining all surviving earthworms from each replicate at test termination. Surviving earthworms were transferred to vessels containing damp filter paper for depuration. After depuration, earthworms were transferred to sample containers, frozen, and shipped to the analytical laboratory (STL-Savannah). Each earthworm tissue sample was analyzed for antimony, cadmium, copper, lead, mercury, tin, zinc, 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, and percent lipids using the methodology summarized in Table 3-6. It is noted that the Final Step 3b and 4 Report (Baker, 2007) specified that earthworm tissue samples would only be analyzed for cadmium, lead, mercury, zinc, 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, and percent lipids. Although antimony, copper, and tin were not identified as ecological COCs for terrestrial avian omnivore food web exposures in Step 3a of the BERA (Baker, 2006a), these three metals were added to the earthworm tissue analyte list because maximum concentrations were detected in surface soil samples collected during the BERA field investigation.

3.2.4 Turtle Grass Tissue and Co-Located Sediment Sampling

Foraging studies indicate that manatees in the off-shore environment at NAPR feed by either selective grazing of above ground shoots and stems or by feeding on the entire plant, including roots and rhizomes (see Section 2.5.2). For this reason, both above ground and whole-plant seagrass composite samples were collected from the open water portion of SWMU 1. As turtle grass is the dominant submerged aquatic vegetation within the Ensenada Honda (see Section 2.2.2) and West Indian manatees preferentially feed on turtle grass, even when it is not the dominant species, this species was targeted for seagrass sampling.

Table 3-5 includes a sampling summary of the turtle grass tissue samples collected at SWMU 1. As evidenced by Table 3-5, a total of six composite tissue samples were collected from three locations within the open water portion of SWMU 1 (one above ground plant composite sample and one whole-body-plant composite per sample location). As the ecological COCs identified in Step 3a of the BERA for West Indian manatee dietary exposures (i.e., arsenic, cadmium, copper, mercury, selenium, and zinc) exhibited a fairly uniform concentration distribution throughout the open water portion of SWMU 1 (see Table 2-7), specific locations were not targeted for sampling based on analytical chemistry. Instead, sample locations (depicted on Figure 3-7) were selected in the field based on the presence of turtle grass. The composite sea grass tissue samples were designated 1B-SG01-AG, 1B-SG01-WP, 1B-SG02-AG, 1B-SG02-WP, 1B-SG03-AG, and 1B-SG03-WP. Samples with the "AG" designation within the sample identification correspond to the above ground tissue samples, while samples with the "WP" designation correspond to the whole-plant tissue samples. All samples were collected from shallow water less than two meters in depth, as this depth represents prime foraging habitat for West Indian manatees. Water depths greater than two meters are generally used for resting and traveling rather than for foraging (Reid et al., 2001). Above ground composite samples were collected by shearing the plants at the sediment-water interface, while whole-plant composite samples were collected using a shovel. For a given sample location and type (i.e., above ground or whole-plant), a sufficient volume of plant material was collected to fill a one-gallon freezer bag. Prior to distribution to the freezer bags, plant material was rinsed with laboratory-grade deionized water to remove any sediment. After rinsing, the sea grass samples were frozen in a freezer overnight, packed on ice, and shipped to the analytical laboratory (STL-Savannah). Each turtle grass tissue sample was analyzed for arsenic, cadmium, copper, mercury, selenium, and zinc on a standard turn (i.e., 28 days) using the methodology summarized in Table 3-6.

A single sediment sample (0 to 6 inches below ground surface [bgs]) was collected at each SWMU 1 turtle grass sampling location using dedicated sediment core liners. The co-located open water sediment samples were designated 1B-OWSD01 through 1B-OWSD03. Sample designations correspond to their co-located turtle grass samples. For example, 1B-OWSD01 represents the sediment sample co-located with turtle grass samples 1B-SG01-AG and 1B-SG01-WP. Each co-located sediment sample was analyzed for arsenic, cadmium, copper, mercury, selenium, and zinc, TOC, pH, and grain size using the methodology summarized in Table 3-6. Analytical data were evaluated to determine if the turtle grass tissue samples were collected from areas representative of the range of sediment concentrations observed within the open water portion of SWMU 1 during the 2003 additional data collection field investigation). The evaluation is presented in Section 4.2.4.1.

In addition to the SWMU 1 turtle grass and sediment samples, three above ground and three whole-plant turtle grass tissue samples (designated REF2-VEG-AB01, REF2-VEG-WB01, REF2-VEG-AB02, REF2-VEG-WB02, REF2-VEG-AB03, and REF2-VEG-WB03), as well as three sediment samples (designated REF2-VEG-SED01, REF2-VEG-SD02, and REF2-VEG-SED03) were collected from Open Water Reference Area No. 2 during the BERA field investigation at SWMU 45 (Baker 2008a; see Table 3-7 and Figure 3-8). Turtle grass samples with the "AG" designation within the sample identification correspond to the above ground tissue samples, while samples with the "WB" designation correspond to the whole-plant tissue samples. Identical to sediment samples collected at SWMU 1, the Open Water Reference Area No. 2 sediment samples were co-located with the turtle grass samples (e.g., REF2-VEG-SD01 represents the open water reference area sediment sample co-located with turtle grass tissue samples REF2-VEG-AB01 and REF2-VEG-WB01). Although the reference area turtle grass and co-located sediment samples were collected during the SWMU 45 BERA field investigation, each sample was analyzed for the ecological COCs unique to SWMU 1 West Indian manatee dietary exposures (i.e., arsenic, cadmium, copper, mercury, selenium, and zinc). This approach, outlined in the Final Step 3b and 4 Report for SWMUs 1 and 2 (Baker, 2007), was used to avoid re-sampling of Reference Area No. 2 during the BERA field sampling activities at SWMU 1. In addition to arsenic, cadmium, copper, mercury, selenium, and zinc, reference area sediment samples were analyzed for TOC and grain size. Analyses were performed in accordance with the methodology summarized in Table 3-6.

3.3 Quality Assurance/Quality Control Sampling

QA/QC samples were collected to: (1) ensure that dedicated sampling equipment was free of contamination (equipment rinsate blanks); (2) evaluate field methodologies (duplicate samples); (3) establish field background conditions (field blanks); and (4) evaluate laboratory processes by analyzing and comparing matrix spike/matrix spike duplicate (MS/MSD) samples. QA/QC samples collected during verification of the BERA field sampling design are included within Tables 3-1 and 3-3, while QA/QC samples collected during the BERA field investigation are summarized in Tables 3-5 and 3-7.

3.4 Data Evaluation and Validation

Analytical data generated during BERA field activities (verification of BERA field sampling design and BERA field investigation) are presented and discussed in Section 4.0. The analytical data were subjected to independent, third party data validation. Copies of the data validation narratives provided by the data validators (Environmental Data Quality Inc. of Exton, Pennsylvania and DataQual Environmental Services, LLC of St. Louis, Missouri) are included as Appendix F. The validation was performed in accordance with USEPA Region II Standard Operating Procedure (SOP) HW-22, Revision 2 (USEPA, 2001), USEPA Region II SOP HW-23, Revision 0 (USEPA, 1995), and USEPA Region II SOP HW-2, Revision 13 (USEPA, 2005e) for the PAH, organochlorine pesticide, and inorganic (metals, pH, and TOC) data, respectively. The criteria used to evaluate the analytical data included: data completeness, Chain-of-Custody documentation, holding times, initial and continuing calibrations, surrogate compound recoveries, MS/MSD recoveries and reproducibility, inductively coupled plasma (ICP) interference check sample results, blanks (e.g., method, field, and equipment blanks), laboratory control sample results, internal standard performance results, ICP serial dilution results, laboratory and field duplicate results, qualitative identification, and sample quantitation/reporting limits. The sections that follow summarize the analytical and data quality problems identified by the data validator that resulted in data qualification actions.

3.4.1 Verification of BERA Field Sampling Design

Surface soil samples were collected from SWMU 1 and three upland reference areas during verification of the BERA field sampling design conducted February 27, 2007 through March 1, 2007 (see Section 3.1). Laboratory analyses were performed by STL-Savannah and analytical results were reported within Sample Delivery Groups (SDGs) SWMU24740-1, SWMU24740-2, and SWMU24740-3. Analytical and data quality problems identified by the data validator (Environmental Data Quality, Inc.) are listed below for each SDG, while definitions of data qualifiers used by the data validator are summarized in Table 3-8. As discussed in Section 3.1, field verification sampling activities at SWMU 1 were conducted concurrently with field verification sampling activities conducted in support of a BERA at SWMU 2. Although the data validation narratives included as Appendix F identify analytical and data quality issues for all data generated during the SWMUs 1 and 2 field verification sampling event, only those analytical and data quality issues specific to data generated in support of the BERA at SWMU 1 are identified and discussed below.

This section includes a summary of analytical and data quality problems and Appendix F includes a data validation narrative for one SDG (PRN20478) that contains analytical data for open water reference area sediment samples collected during verification of the field sampling design at SWMU 45. The open water sediment samples were collected on September 20 and September 21, 2007 and analyzed by STL-Savannah. Analytical; and data quality problems associated with SDG PRN20478 were identified by DataQual Environmental Services, LCC. This information is included within this document as the field verification analytical data for the open water reference sediment samples are relevant to SWMU 1 (i.e., analytical data were evaluated in order to determine an appropriate reference area for the collection of turtle grass during the BERA field investigation at SWMU 1).

SDG SWMU24740-1

SDG SWMU24740-1 is relevant to the pH and TOC analytical results for SWMU 1 surface soil samples (1V-SS01 through 1V-SS06). Based on the validator's evaluation of relevant criteria, no analytical or data quality problems were identified that resulted in qualification actions.

SDG SWMU24740-2

SDG SWMU24740-2 is relevant to the PAH, organochlorine pesticide, metal, pH, and TOC analytical results for upland reference area surface soil samples (REF-SS01 through REF-SS12) and associated field QA/QC samples (i.e., field duplicates and MS/MSD samples). PAH, organochlorine pesticide, and metal analytical results for aqueous QA/QC samples (i.e., equipment rinsate and field blanks) associated with these surface soil samples are reported under SDG SWMU24740-3. Analytical and data quality problems associated with SDG SWMU24740-2 and the data qualification actions taken by the data validator are listed below.

- The ICP serial dilution for barium was outside the control limits. Positive barium results for REF-SS01, REF-SS01D, REF-SS02, REF-SS05, REF-SS06, REF-SS09, and REF-SS10 (surface soil samples analyzed for this metal) were qualified as estimated "J".

- The percent solids value for one upland reference area surface soil sample (REF-SS02) was less than 50 percent but greater than 10 percent (i.e., 42.1 percent). Reported results for all metals in this surface soil sample not previously qualified by evaluation of other criteria were qualified as estimated "J" (detected results) or "UJ" (non-detected results).

- Analytes reported at concentrations below their respective sample quantitation limits by the analytical laboratory were qualified as estimated "J".

SDG SWMU24740-3

SDG SWMU24740-3 is relevant to PAH, organochlorine pesticide, and metal analytical results for two equipment rinsate blanks (1V-ER01 [collected from a stainless steel spoon] and 2V-ER02 [collected from a stainless steel bucket auger]) and one field blank ([1V-FB01 [laboratory-grade deionized water]). Analytical and data quality problems associated with SDG SWMU24740-3 and the data qualification actions taken by the data validator are listed below.

- Analytes reported at concentrations below their respective sample quantitation limits by the analytical laboratory were qualified as estimated "J".

SDG PRN20478

SDG PRN20478 is relevant to the arsenic, cadmium, copper, mercury, selenium, and zinc analytical results for sediment samples and associated field QA/QC samples (i.e., field duplicates and MA/MSD samples) collected from Open Water Reference Area Nos. 1, 2, and 3 during verification of the field sampling design at SWMU 45, as well. This SDG includes analytical data for one associated equipment rinsate blank (45B-ER01V [collected from a sediment core liner]) and one associated field blank (45B-FB01V [laboratory-grade deionized water]). Analytical and data quality problems associated with SDG PRN20478 and the data qualification actions taken by the data validator (DataQual Environmental Services, LLC) are listed below. It is noted that SDG PRN20478 includes analytical data specific to the BERA at SWMU 45. Although these data are included within the validation narrative (see Appendix F), only analytical and data quality problems associated with the open water reference area sediment samples and their associated field QA/QC samples are presented.

- The field duplicate pair REF3-SD01V and REF3-SD01VD exhibited non-compliant reproducibility for zinc (absolute difference greater than plus or minus two times the contract required detection limit (CRDL) but less than plus or minus four times the CRDL). USEPA Region II guidelines (USEPA, 2005e) require qualification of results greater than or equal to the method detection limit (MDL) but less than five times the CRDL as estimated "J" for detected results and estimated "UJ" for non-detected results. The zinc results for the field and duplicate sample (both detections) were greater than the MDL but less than five times the CRDL and therefore, were qualified as estimated "J" by the data validator.

- A preparation blank exhibited zinc contamination that resulted in detected zinc results in six samples (REF2-SD01V, REF2-SD03V, REF2-SD04V, REF2-SD04VD, REF2-SD05V, and REF-SD06V) to be qualified as non-detect "U" at the reporting limit.

- Percent solids values for five samples (REF1-SD01V, REF1-SD05V, REF2-SD01V, REF2-SD02V, and REF2-SD06V) were less than 50 percent but greater than 10 percent. Reported results for all analytes (i.e., arsenic, cadmium, copper, mercury, selenium, and zinc) in these five samples were qualified as estimated "J" (detected results) or "UJ" (non-detected results).

3.4.2 BERA Field Investigation

Surface soil samples were collected at SWMU 1 and Upland Reference Area No. 2 during the BERA field investigation conducted April 28, 2007 to May 3, 2007 (see Section 3.2.1). In addition to the surface soil samples, sea grass tissue samples (above ground and whole-plant) and sediment samples were collected from the open water portion of SWMU 1 (see Section 3.2.3). Earthworm tissue samples also were collected from toxicity test chambers following a 28-day exposure to SWMU 1 surface soil (see Section 3.2.2). Laboratory analyses were performed by STL and reported within SDGs C7E010111 (STL-Pittsburgh), 119805 (STL-Burlington), SWMU26275-1 (STL-Savannah), SWMU26275-2 (STL-Savannah), SWMU26275-3 (STL-Savannah), SWMU26318 (STL-Savannah), and SWMU28224-2 (STL-Savannah). Analytical and data quality problems identified by the data validators (Environmental Data Quality, Inc. and DataQual Environmental Services, LLC) that resulted in data qualification actions are listed below for each SDG. Definitions of data qualifiers used by the data validator are summarized in Table 3-8.

This section includes a summary of analytical and data quality problems and Appendix F includes data validation narratives for two SDGs that contain analytical data for turtle grass tissue and sediment collected from Open Water Reference Area No. 2 during the BERA field investigation at SWMU 45 (see Baker, 2008a and Section 3.2.3). Laboratory analyses were performed by STL Savannah and reported within SDGs 680-23974-1 (turtle grass analytical data) and 680-23902-1 (sediment analytical data).

<u>SDG C7E010111</u>

SDG C7E01111 is relevant to the quick-turn antimony, cadmium, copper, lead, mercury, tin, zinc, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT analytical results for Upland Reference Area No. 2 surface soil samples (1B-REF-SS01 through 1B-REF-SS06), SWMU 1 surface soil samples (1B-SS01 through 1B-SS12), and associated field QA/QC samples (i.e., field duplicates and MS/MSD samples). Analytical results for aqueous QA/QC samples (i.e., equipment rinsate and field blanks) associated with these surface soil samples are reported under SDG SWMU26275-3. Analytical and data quality problems associated with SDG C7E01111 and the data qualification actions taken by the data validator (Environmental Data Quality, Inc.) are listed below.

- A MS/MSD sample (1B-REF-SS04MS/MSD) exhibited unacceptable percent recoveries for antimony (matrix spike [MS] percent recovery of 37 percent and a matrix spike duplicate [MSD] percent recovery of 32), copper (MS percent recovery of 132 percent and MSD percent recovery of 73 percent), lead (MS percent recovery of 49 percent and MSD percent recovery of 75 percent), tin (MS percent recovery of 77 percent and MSD percent recovery of 75 percent), and zinc (MSD percent recovery of 64 percent). USEPA Region II guidelines (USEPA, 2005e) require qualification of detected and non-detected results for analytes with a percent recovery between 10 and 74 percent. USEPA Region II guidelines (USEPA, 2005e) also require qualification of detected results for analytes with a percent recovery between 126 percent and 200 percent. Based on the percent recoveries identified above, all positive results reported for antimony, copper, lead, tin, and zinc were qualified as estimated "J" and all non-detected results were qualified as estimated "UJ".

- 4,4'-DDD was detected in surface soil sample 1B-SS011 at a concentration greater than the sample quantitation limit. Poor precision was observed for this analyte on the dual chromatographic columns used for sample analysis (greater than 100 percent difference between results). In accordance with USEPA Region II guidelines for pesticides detected at concentrations greater than the sample quantitation limit (USEPA, 1995), the reported result for 4,4'-DDD in surface soil sample IB-SS11 was qualified as rejected "R".

- 4,4'-DDD was detected in surface soil samples IB-SS04 and 1B-SS06 at concentrations less than sample quantitation limits. Poor precision was observed for this analyte on the dual chromatographic columns used for sample analysis (greater than 50 percent difference between results in both samples). In accordance with USEPA Region II guidelines for pesticides detected at concentrations less than sample quantitation limits (USEPA, 1995), the reported results for 4,4'-DDD in surface soil samples 1B-SS04 and 1B-SS06 were replaced with the sample quantitation limit and qualified as non-detect "U".

- 4,4'-DDD was detected in surface soil sample 1B-SS09 and 4,4'-DDT was detected in surface soil samples IB-SS11 and IB-SS12 at concentrations greater than sample quantitation limits. Poor precision was observed for these analytes on the dual chromatographic columns used for sample analysis (greater than 25 percent difference, but less than 70 percent difference between results). In accordance with USEPA guidelines for pesticides detected at concentrations greater than sample quantitation limits (USEPA, 1995), the reported result for 4,4'-DDD in surface soil sample IB-SS09 and the reported result for 4,4'-DDT in surface soil samples 1B-SS11 and 1B-SS12 were qualified as estimated "J".

- 4,4'-DDD was detected in surface soil sample IB-SS12 at a concentration greater than the sample quantitation limit. Poor precision was observed for this analyte on the dual chromatographic columns used for sample analysis (greater than 70 percent difference, but less than 100 percent difference between results). In accordance with USEPA Region II guidelines for pesticides detected at concentrations greater than sample quantitation limits (USEPA, 1995), the reported result for 4,4'-DDD in surface soil sample IB-SS12 was qualified as tentatively identified, estimated "NJ".

- Analytes reported at concentrations below their respective sample quantitation limits by the analytical laboratory were qualified as estimated "J".

<u>SDG 119805</u>

SDG 119805 is relevant to the quick-turn antimony, cadmium, copper, lead, mercury, tin, zinc, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT analytical results for SWMU 1 surface soil samples 1B-SS13 through 1B-SS30. Field QA/QC analytical results for field duplicates and MS/MSD samples associated with the SWMU 1 surface soil samples are included with this SDG. Analytical results for aqueous QA/QC samples (i.e., equipment rinsate and field blanks) associated with the SWMU 1 surface soil samples are reported under SDG SWMU26275-3. Analytical and data quality problems associated with SDG 119805 and the data qualification actions taken by the data validator (Environmental Data Quality, Inc.) are listed below.

- A preparation blank exhibited antimony contamination that resulted in the reported antimony result in surface soil sample 1B-SS17 to be qualified as non-detect "U" at the sample quantitation limit.

- A MS sample (1B-SS14MS) exhibited unacceptable percent recoveries for cadmium (percent recovery of 141 percent) and tin (percent recovery of 175). USEPA Region II guidelines (USEPA, 2005e) require qualification of detected results for analytes with a percent recovery between 126 percent and 200 percent. Therefore, all positive results for cadmium and tin were qualified as estimate "J" by the data validator to indicate that results are biased high. This same matrix spike also exhibited an unacceptable percent recovery for antimony (MS percent recovery of 53 percent). In accordance with USEPA Region II guidelines for analytes with percent recoveries between 10 and 74 percent (USEPA, 2005e), positive antimony results for associated samples (IB-SS13, IB-SS14, 1B-SS14D, 1B-SS15, 1B-SS18, 1B-SS19, 1B-SS21, 1B-SS24, 1B-SS25, and 1B-SS28) were qualified as estimated "J" to indicate that results are biased low.

- The field duplicate pair 1B-SS14 and 1B-SS14D exhibited non-compliant reproducibility for copper (relative percent difference [RPD] of 182 percent). The field duplicate pair 1B-SS24 and 1B-SS24D also exhibited non-compliant reproducibility for lead (RPD of 177 percent. USEPA Region II guidelines (USEPA, 2005e) require rejection of detected results greater than or equal to five times contract required sample quantitation limits (CRQL) for analytes with a RPD greater than or equal to 120 percent. Therefore, the reported results for copper in 1B-SS14 and 1B-SS14D and lead in 1B-SS24 and IB-SS24D were rejected (R qualifier).

- 4,4'-DDT was positively reported in surface soil samples 1B-SS14D and 1B-SS29 at concentrations greater than sample quantitation limits. Poor precision was observed for this analyte on the dual chromatographic columns used for sample analysis (greater than 25 percent difference, but less than 70 percent difference between results. In accordance with USEPA guidelines for pesticides detected at concentrations greater than sample quantitation limits (USEPA, 1995), the reported result for 4,4'-DDT in surface soil samples 1B-SS14D and 1B-SS29 were qualified as tentatively identified, estimated "NJ".

- 4,4"-DDT was positively reported in surface soil sample 1B-SS13 at a concentration greater than the sample quantitation limit. Poor precision was observed for this analyte on the dual chromatographic columns used for sample analysis (161.4 percent difference between results). However, the validator indicated that sample chromatograms show enhanced responses indicative of interferences. In accordance with USEPA guidelines for pesticides detected at concentrations greater than sample quantitation limits (USEPA, 1995), the reported result for 4,4'-DDT in surface soil sample 1B-SS13 was qualified as tentatively identified, estimated "NJ" (when the reported percent difference is greater than 100 percent, but less than 200 percent between results and interferences are detected in either column, data are qualified with "NJ").

- 4,4'-DDT was positively reported in surface soil samples IB-SS14 and IB-SS15 at concentrations greater than sample quantitation limits. Poor precision was observed for this analyte on the dual chromatographic columns used for sample analysis (greater than 70 percent difference, but less than 100 percent difference between results). In accordance with USEPA guidelines (USEPA, 1995), the reported results for 4,4'-DDT in surface soil samples 1B-SS14 and 1B-SS15 were qualified as tentatively identified, estimated "NJ".

- Surface soil samples 1B-SS14, IB-SS14D, 1B-SS15, 1B-SS16, AB-SS18, 1B-SS19, 1B-SS21, and 1B-SS24 were re-analyzed at dilution because the responses for 4,4'-DDE and/or 4,4'-DDT exceeded the linear range of the gas chromatography (GC) instrument. The results for the affected pesticide compounds were reported from the dilution analysis, while all other results were reported from the initial analyses.

- Analytes reported at concentrations below their respective quantitation limits by the analytical laboratory were qualified as estimated "J".

<u>SDG SWMU26275-1</u>

SDG SWMU26275-1 is relevant to the quick-turn antimony, cadmium, copper, lead, mercury, tin, zinc, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT analytical results for SWMU 1 surface soil samples (1B-SS31 through 1B-SS48) and associated field QA/QC samples (i.e., field duplicates and MS/MSD samples). Analytical results for aqueous QA/QC samples (i.e., equipment rinsate and field blanks) associated with these surface soil samples are reported under SDG SWMU26275-3. Analytical and data quality problems associated with SDG SWMU26275-1 and the data qualification actions taken by the data validator (Environmental Data Quality, Inc.) are listed below.

- A field blank (1B-FB01) exhibited copper contamination that resulted in detected copper results in three surface soil samples (1B-SS43, IB-SS44, and IB-SS44D) to be qualified as estimated "J".

- An MS/MSD sample (1B-SS34MS/MSD) exhibited unacceptable percent recoveries for tin (MS percent recovery of 139 and MSD percent recovery greater than 200). USEPA Region II guidelines (USEPA, 2005e) require rejection of detected results for analytes with a percent recovery greater than or equal to 200 percent. Therefore, all positive results for tin in associated samples (1B-SS31, IB-SS32, IB-SS33, IB-SS34, 1B-SS34D, 1B-SS35, 1B-SS36, 1B-SS37, 1B-SS38, 1B-SS39, and 1B-SS40) were rejected (R qualifier). A second MS/MSD sample exhibited unacceptable percent recoveries for copper (MS percent recovery of 132), lead (MS percent recovery of 57 percent), and tin (MS percent recovery of 136 and MSD percent recovery of 134). USEPA Region II guidelines (USEPA, 2005e) require qualification of detected results for analytes with a percent recovery between 126 percent and 200 percent. USEPA Region II guidelines (USEPA, 2005e) also require qualification of detected results for analytes with a percent recovery between 10 percent and 74 percent. Therefore, all positive results for copper, lead, and tin in associated samples (1B-SS45, 1B-SS46, 1B-SS47, and IB-SS48) were qualified as estimated "J" to indicate that results are biased high.

- A laboratory duplicate exhibited non-compliant reproducibility for tin (absolute difference greater than four times the CRQL). USEPA Region II guidelines (USEPA, 2005e) require rejection of non-detected results less than five times the CRQL for analytes with an absolute difference greater than four times the CRQL. The non-detected tin results reported for associated surface soil samples (1B-SS41, 1B-SS42, 1B-SS43, 1B-SS44, and 1B-SS44D) are greater than five times the CRDL and therefore, were rejected (R qualifier).

- A field duplicate pair (1B-SS34 and 1B-SS34D) exhibited non-compliant reproducibility for mercury (RPD of 73.2 percent). USEPA Region II guidelines (USEPA, 2005e) require qualification of detected results greater than or equal to five times the CRQL for analytes with an RPD greater than or equal to 35 percent, but less than 120 percent. The detected mercury results for 1B-SS34 and 1B-SS34D are greater than or equal to five times the CRQL and therefore, were qualified as estimated "J".

- 4,4'-DDD was detected in surface soil sample 1B-SS37 at a concentration greater than the quantitation limit. Poor precision was observed for these analytes on the dual chromatographic columns used for sample analysis (greater than 25 percent difference, but less than 70 percent difference between results). In accordance with USEPA Region II guidelines for pesticides detected at concentrations greater than sample quantitation limits (USEPA, 1995), the reported result for 4,4'-DDD in surface soil sample IB-SS37 was qualified as estimated "J".

- Six surface soil samples (1B-SS33, 1B-SS34, 1B-SS34D, 1B-SS46, 1B-SS47, and 1B-SS48 were re-analyzed at dilution because the responses for one or more of the pesticide compounds exceeded the linear range of the GC instrument. The results for the affected pesticide compounds were reported from the dilution analyses, while all other results were reported from the initial analyses.

- Analytes reported at concentrations below their respective quantitation limits by the analytical laboratory were qualified as estimated "J".

SDG SWMU26275-2

SDG SWMU26275-2 is relevant to the quick-turn antimony, cadmium, copper, lead, mercury, tin, zinc, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT analytical results for SWMU 1 surface soil samples (1B-SS49 through 1B-SS55) and associated field QA/QC samples (i.e., field duplicates and MS/MSD samples). Analytical results for aqueous QA/QC samples (i.e., equipment rinsate and field blanks) associated with these surface soil samples are reported under SDG SWMU26275-3. Analytical and data quality problems associated with SWMU26275-2 and the data qualification actions taken by the data validator (Environmental Data Quality, Inc.) are listed below.

- An MS sample (1B-SS34MS) exhibited unacceptable percent recoveries for copper (percent recovery of 132), mercury (percent recovery of 128 percent), and tin (percent recovery of 136 percent). USEPA Region II guidelines (USEPA, 2005e) require qualification of detected results for analytes with a percent recovery between 126 percent and 200 percent. Therefore, all positive results for copper, mercury, and tin were qualified as estimated "J" to indicate that results are biased high. This same MS sample exhibited an unacceptable percent recovery for lead (percent recovery of 57 percent). USEPA Region II guidelines (USEPA, 2005e) require qualification of detected results for analytes with a percent recovery between 10 percent and 74 percent. Therefore, all positive results for lead were qualified as estimated "J" to indicate that results are biased low.

- Analytes reported at concentrations below their respective sample quantitation limits by the analytical laboratory were qualified as estimated "J".

- Two surface soil samples (1B-SS49 and 1B-SS50) were re-analyzed because the responses for one or more of the pesticide compounds exceeded the linear range of the GC instrument. The results for the affected pesticide compounds were reported from the dilution analyses, while all other results were reported from the initial analyses.

SDG SWMU26275-3

SDG SWMU26275-3 is relevant to the arsenic, cadmium, copper, mercury, selenium, and zinc analytical results for SWMU 1 open water sediment samples (1B-OWSD01, 1B-OWSD02, 1B-OWSD03, and 1B-OWSD03D), antimony, cadmium, copper, lead, mercury, tin, zinc, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT analytical results for one equipment rinsate blank (1B-ER01 [collected from a stainless steel spoon]), and antimony, arsenic, cadmium, copper, lead, mercury, selenium, tin, zinc, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT analytical results for two field blanks (1B-FB01 [laboratory-grade deionized water] and 1B-FB02 [potable water]). Analytical and data quality problems associated with SWMU26275-2 and the data qualification actions taken by the data validator (Environmental Data Quality, Inc.) are listed below.

- The percent solids value for each SWMU 1 open water sediment sample was less than 50 percent but greater than 10 percent (values ranged from 26.4 percent for 1B-OWSD01 to 32.8 percent for 1B-OWSD03). Reported results for all metals detected in each sediment sample were qualified as estimated "J" to indicate that results are biased low.

- Analytes reported concentrations below their respective sample quantitation limits by the analytical laboratory were qualified as estimated "J".

SDG 119836

SDG 119836 is relevant to TOC, pH, and grain size analytical results for SWMU 1 open water sediment samples. This SDG was not submitted to a data validator for evaluation of potential analytical and data quality problems. Therefore, a data validation narrative for this SDG is not provided within Appendix F.

SDG SWMU26318

SDG SWMU26318 is relevant to the arsenic, cadmium, copper, mercury, selenium, and zinc analytical results for sea grass tissue samples collected from the open water portion of SWMU 1 (1B-SG01-AG, 1B-SG01-WP, 1B-SG02-AG, 1B-SG02-WP, 1B-SG03-AG, and 1B-SG03-WP). Analytical and data quality problems associated with SWMU26275-2 and the data qualification actions taken by the data validator (Environmental Data Quality, Inc.) are as follows:

- Analytes reported at concentrations below their respective sample quantitation limits by the analytical laboratory were qualified as estimated “J”.

SDG SWMU28224-2

SDG SWMU28224-2 is relevant to the antimony, cadmium, copper, lead, mercury, tin, zinc, 4,4’-DDD, 4,4’-DDE, 4,4’-DDT, and percent lipids analytical results for earthworm tissue maintained in SWMU 1 surface soil during toxicity testing. Analytical and data quality problems associated with SWMU28224-2 and the data qualification actions taken by the data validator (Environmental Data Quality, Inc.) are listed below.

- 4,4’-DDE was detected in earthworm tissue samples 1B-SS33, 1B-SS48, and 1B-SS49 at concentrations greater than sample quantitation limits. Poor precision was observed for these analytes on the dual chromatographic columns used for sample analysis (greater than 25 percent difference, but less than 70 percent difference between results). In accordance with USEPA guidelines for pesticides detected at concentrations greater than sample quantitation limits (USEPA, 1995), the reported results for 4,4’-DDE in earthworm tissue samples 1B-SS33, 1B-SS48, and 1B-SS49 were qualified as estimated “J”.

- 4,4’-DDE was detected in earthworm tissue samples 1B-SS09, 1B-SS13, 1B-SS15, 1B-SS18, IB-SS29, and 1B-SS46 and 4,4’-DDD was detected in earthworm tissue sample 1B-SS46 at concentrations less than sample quantitation limits. Poor precision was observed for this analyte on the dual chromatographic columns used for sample analysis (greater than 50 percent difference between results in both samples). In accordance with USEPA Region II guidelines for pesticides detected at concentrations less than sample quantitation limits (USEPA, 1995), the reported results for 4,4’-DDD in earthworm tissue samples 1B-SS09, 1B-SS13, 1B-SS15, 1B-SS18, IB-SS29, and 1B-SS46 and the reported result for 4,4’-DDD in earthworm tissue sample 1B-SS46 were replaced with sample quantitation limits and qualified as non-detect “U”.

- Earthworm tissue sample 1B-SS19 was re-analyzed at dilution for 4,4’-DDE and 4,4’-DDT and earthworm tissue sample IB-SS46 was reanalyzed at dilution for 4,4’-DDE because the responses exceeded the linear range of the GC instrument. The results for the affected pesticide compounds were reported from the dilution analysis, while all other results were reported from the initial analyses.

- Analytes reported at concentrations below their respective sample quantitation limits by the analytical laboratory were qualified as estimated “J”.

SDG 680-23974-1

SDG 680-23974-1 is relevant to arsenic, cadmium, copper, mercury, selenium and zinc analytical results for Open Water Reference Area No. 2 turtle grass tissue samples (REF2-VEG-AB01 through REF2-VEG-AB03 and REF2-VEG-WB01 through REF2-VEG-WB03). Arsenic, cadmium, selenium, and mercury analytical results were validated by Environmental Data Services, Inc, while copper and zinc analytical results were validated by DataQual Environmental Services, LLC. Analytical and data quality problems associated with 680-23974-1 and the data qualification actions taken by the data validators are listed below. It is noted that analytical results, data qualification actions, and the data validation narrative for arsenic, cadmium, mercury, and selenium were previously presented in the Final Steps 6 and 7 Report for SWMU 45 (Baker, 2008a). As the reference area turtle grass analytical data for these four metals also are relevant to SWMU 1, this information is provided within this report.

- A preparation blank exhibited copper and zinc contamination that resulted in all reported concentrations greater than MDLs but less than sample quantitation limits to be qualified as non-detect “U” at the sample quantitation limits.

- Analytes reported at concentrations below their respective sample quantitation limits by the analytical laboratory were qualified as estimated “J”.

SDG 680-23902-1

SDG 680-23902-1 is relevant to arsenic, cadmium, copper, mercury, selenium, and zinc analytical results for Open Water Reference Area No. 2 sediment samples (REF2-VEG-SED01 through REF2-VEG-SED03). The open water reference area sediment samples were co-located with the turtle grass tissue samples reported in SDG 680-23974-1. Arsenic, cadmium, selenium, and mercury analytical results were validated by Environmental Data Services, Inc. while copper and zinc analytical results were validated by DataQual Environmental Services, LLC. Analytical and data quality problems associated with 680-23902-1 and the data qualification actions taken by the data validators are listed below. It is noted that analytical results, data qualification actions, and the data validation narrative for arsenic, cadmium, mercury, and selenium were previously presented in the Final Steps 6 and 7 Report for SWMU 45 (Baker, 2008a). As the open water reference area sediment samples for these four metals also are relevant to SWMU 1, this information is provided within this report.

- A CRDL standard exhibited a high recovery for copper (145 percent). USEPA Region II guidelines (USEPA, 2005e) require qualification of detected copper results greater than two times sample quantitation limits to be qualified as estimated, “J”. Therefore, the reported positive result for copper in open water reference area sediment sample REF2-VEG-SED03 was qualified as estimated. “J”.

- A designated MS/MSD sample in the same SDG (i.e., 45B-VEG-SED01) exhibited unacceptable percent recoveries for zinc (MS percent recovery of 29 and MSD percent recovery of 34). USEPA Region II guidelines (USEPA, 2005e) require qualification of detected results for analytes with a percent recovery between 10 percent and 74 percent. Therefore, all positive results for copper in associated samples (REF2-VEG-SED01, REF2-VEG-SED02, and REF2-VEG-SED03) were qualified as estimated “J” to indicate that results are biased low.

4.0 ANALYTICAL AND TOXICITY TEST RESULTS AND DATA ANALYSIS

Step 6 of the ERA process is the Site Investigation and Analysis Phase. The site investigation was conducted as outlined in Section 3.0. This section presents the surface soil, earthworm tissue, open water sediment, and turtle grass tissue analytical data, earthworm toxicity test results, and dietary intake modeling results (terrestrial avian omnivore [American robin] and West Indian manatee) for the BERA at SWMU 1.

4.1 Verification of the BERA Field Sampling Design

Prior to mobilization for the BERA field investigation (Step 6), the field sampling design was verified in the field to ensure that the BERA study design was appropriate and could be implemented at SWMU 1. As discussed in Section 3.1, a primary objective of the verification of the BERA field sampling design was the identification of an appropriate upland reference area for the collection of surface soil for earthworm toxicity testing and the identification of an appropriate open water reference area for the collection of sediment and turtle grass tissue. To meet this objective, potential upland and open water reference areas (see Figure 3-1 and 3-3, respectively) were evaluated in Step 5 of the ERA process (verification of the BERA field Sampling Design). The evaluation of each reference area (upland and open water) is presented within the sections that follow.

4.1.1 Upland Reference Areas

Surface soil was collected at SWMU 1 and three upland reference areas (Upland Reference Area No. 1, Upland Reference Area No. 2, and Upland Reference Area No. 3) on February 27 and February 28, 2007 during Step 5 of the ERA process. As discussed in Section 3.1), Upland Reference Area No. 1 was established approximately 0.17 miles north of SWMU 2, Upland Reference Area No. 2 was established north of Kearsage Road, between SWMUs 1 and 2 (approximately 0.11 miles north of SWMU 1 and 0.17 miles south of SWMU 2), while Upland Reference Area No. 3 was established approximately 0.16 miles southwest of SWMU 1 (see Figure 3-1).

Table 3-1 provided a summary of the surface soil samples collected at SWMU 1 and the upland reference areas. As evidenced by Table 3-1, six surface soil samples were collected at SWMU 1, while four surface soil samples were collected at each upland reference area. The SWMU 1 surface soil samples were analyzed for TOC, pH, and grain size. Two of the four surface soil samples collected at each upland reference area were analyzed for the ecological COCs identified in Step 3a of the ERA (i.e., antimony, cadmium, copper, lead, mercury, tin, zinc, 4,4’-DDD, 4,4’-DDE, and 4,4’-DDT), as well as TOC, pH, grain size. The remaining two surface soil samples collected at each upland reference area were analyzed for PAHs, Appendix IX organochlorine pesticides, Appendix IX metals, TOC, pH, and grain size. Analytical results for surface soil collected at SWMU 1 are presented within Table 4-1, while analytical results for surface soil collected at Upland Reference Area Nos. 1, 2, and 3 are presented within Tables 4-2, 4-3, and 4-4, respectively. Analytical data for associated QA/QC field samples (i.e., equipment rinsate and field blanks) are presented in Table 4-5.

The proposed upland reference areas were evaluated based on biological and chemical properties. As outlined in Section 3.1, a given upland reference area was deemed acceptable for use as a source of surface soil for earthworm toxicity testing if the following conditions were met:

- The range of TOC concentrations and grain size characteristics in upland reference area surface soil are similar to the ranges found in surface soil located within the study area (SWMU 1 upland habitat).

- Maximum concentrations of PAHs, Appendix IX metals, and Appendix IX organochlorine pesticides do not exceed the soil screening values summarized in Table 3-4 or, in the case of metals, the background surface soil screening values established within the *Revised Final II Summary Report for Environmental Background Concentrations of Inorganic Compounds* (Baker, 2008b).

An evaluation of the upland reference areas against these criteria is presented within the sections that follow.

4.1.1.1 Physical Properties of Surface Soil

TOC concentrations measured in SWMU 1 surface soil (see Table 4-1) ranged from 25,000 mg/kg (1V-SS05) to 59,000 mg/kg (1V-SS04). With the exception of 1V-SS04, reported TOC concentrations were fairly uniform (25,000 mg/kg in 1V-SS05, 26,000 mg/kg in 1V-SS02, 31,000 mg/kg in 1V-SS03, 38,000 mg/kg in 1V-SS06, and 39,000 mg/kg in IV-SS01). Reported TOC concentrations in Upland Reference No. 1 surface soil showed considerable variability, with concentrations ranging from 9,400 mg/kg (REF-SS03) to 71,000 mg/kg (REF-SS01), with two values reported at 38,000 mg/kg (REF-SS02 and REF-SS03). TOC concentrations in surface soil collected at Upland Reference Area Nos. 2 and 3 showed lower variability. Upland Reference Area No. 2 TOC concentrations ranged from 9,800 mg/kg (REF-SS06) to 26,000 mg/kg (REF-SS07), while TOC concentrations in Upland Reference Area No. 3 ranged from 13,000 mg/kg (REF-SS09) to 34,000 mg/kg (REF-SS010). With the exception of REF-SS10, TOC concentrations in Upland Reference Area No. 3 surface soil samples were less than or equal to 17,000 mg/kg. The data indicate that TOC concentrations in Upland Reference Area Nos. 2 and 3 surface soils are generally lower than TOC concentrations measured in SWMU 1 and Upland Reference Area No. 1 surface soils.

The particle size distribution data presented in Tables 4-1 through 4-4 indicate that surface soils collected at Upland Reference Area No. 3 are most similar to SWMU 1 surface soils. Both locations showed similar sand content (15.6 percent to 40.1 percent at SWMU 1 and 21.9 percent to 37.5 percent at Upland Reference Area No. 3) and silt/clay content (21.3 percent to 70.8 percent at SWMU 1 and 44.3 percent to 77.2 percent at Upland Reference Area No. 3). Upland Reference Area No. 2 surface soils were generally finer grained with greater silt/clay and lower sand content, while Upland Reference Area No. 1 surface soils exhibited a higher sand and lower silt/clay content. The gravel content of all three reference area surface soil samples were considerable lower than the gravel content measured in the majority of the SWMU 1 surface soil samples.

The analytical data presented in Tables 4-1 through 4-4 indicate that Reference Area No. 1 surface soils are most similar to SWMU 1 surface soils with regard to TOC, while Reference Area No. 3 surface soils are most similar to SWMU 1 surface soils with regard to particle size distributions. ASTM (2006) does not specify acceptable TOC and grain size requirements for *Eisenia fetida*, but states that, "*A reference soil should be collected from the field in a clean area and represent the test soil as much as possible in soil characteristics (for example, percent organic matter, particle size distribution, and pH).*" Although the TOC content of surface soils collected at Upland Reference Area No. 1 were most similar to SWMU 1, this location was not deemed acceptable for use as a source of surface soil for *Eisenia fetida* toxicity testing based on considerable differences in particle size distributions (lower silt/clay and higher sand content when compared to SWMU 1). Upland reference Area No. 3 also was deemed unacceptable based on considerable differences in TOC content (TOC concentrations in Upland Reference Area No. 3 surface soil samples were generally less than or equal to 17,000 mg/kg, while TOC concentrations in SWMU 1 surface soil samples exceeded 26,000 mg/kg). Although Upland Reference Area No. 2 surface soil samples exhibited lower TOC and higher silt/clay content than SWMU 1, surface soils from this location were deemed most appropriate for *Eisenia fetida* toxicity testing (differences between Upland Reference Area No. 2 and SWMU 1 were not as considerable as differences between Upland Reference Area No. 1 and SWMU 1 TOC content and Upland reference Area No. 3 and SWMU 1 particle size distributions).

4.1.1.2 Comparison of Analytical Data to Screening Values

As outlined in the final Step 3b and 4 Report (Baker, 2006a) and Sections 3.1 and 4.1.1 herein, a given upland reference area was considered acceptable as a source of surface soil for *Eisenia fetida* toxicity testing in Step 6 of the BERA if PAHs, organochlorine pesticides, and metals were not detected at concentrations greater than the surface soil screening values summarized in Table 3-4. A comparison of the upland reference area analytical data to soil screening values is provided below.

Upland Reference Area No. 1

Three PAHs (benzo[b]fluoranthene, fluoranthene, and pyrene) and one pesticide (4,4'-DDT) were detected in Upland Reference Area No. 1 surface soil collected during verification of the field sampling design (see Table 4-2). The sum of low molecular weight (LMW) PAHs ranged from 11.5 µg/kg in REF-SS01D to 23.7 µg/kg in REF-SS02, while the sum of high molecular weight (HMW) PAHs ranged from 11.7 µg/kg in REF-SS01D to 24.8 µg/kg in REF-SS02 (reporting limit used for non-detected PAHs). Maximum sums are less than the LMW and HMW PAH screening values listed in Table 3-4 (29,000 µg/kg for LMW PAHs and 18,000 µg/kg for HMW PAHs, respectively [USEPA, 2007g]). 4,4'-DDT was detected in three surface soil samples (0.52J µg/kg in REf-SS03, 2J µg/kg in REF-SS03D, and 0.91J µg/kg in REF-SS04). Detected concentrations are less than the soil screening value established for this organochlorine pesticide (401 µg/kg [MHSPE, 2000]). Maximum reporting limits for the non-detected organochlorine pesticides also are less than soil screening values.

Twelve metals (arsenic, barium, cadmium, chromium, cobalt copper, lead, mercury, nickel, selenium, vanadium, and zinc) were detected in Upland Reference Area No. 1 surface soil. As evidenced by the table below, maximum detected arsenic, barium, cadmium, chromium, cobalt copper, lead, mercury, nickel, selenium, and zinc concentrations, as well as maximum reporting limits for the non-detected metals (antimony, beryllium, silver, thallium, and tin) are less than soil screening values:

Chemical	Maximum Concentration (mg/kg)	Soil Screening Value (mg/kg)
Antimony	0.87UJ	78.0
Arsenic	4.8	18.0
Barium	18J	330
Beryllium	0.13UJ	40.0
Cadmium	0.1J	140
Chromium	9.2	57.0
Cobalt	3.5	13.0
Copper	18	80.0
Lead	8.3	1,700

Chemical	Maximum Concentration (mg/kg)	Soil Screening Value (mg/kg)
Mercury	0.068J	0.1
Nickel	3.7	280
Selenium	0.36J	4.1
Silver	0.22UJ	560
Thallium	0.22UJ	1.0
Tin	22J	50.0
Zinc	60	120

Vanadium was detected in Upland Reference Area No. 1 surface soil samples REF-SS01, REF-SS1D, and REF-SS02 at concentrations greater than the soil screening value of 10 mg/kg (27 mg/kg in REF-SS01 and REF-SS01D and 17J mg/kg in REF-SS02). However, detected concentrations are less than the maximum background concentration (230 mg/kg) and upper limit of the mean (ULM) background concentration (259 mg/kg) established for surface soil at NAPR (Baker, 2008b), indicating that vanadium detections in Upland Reference Area No. 1 surface soil are representative of background levels.

Upland Reference Area No. 2

Nine PAHs (benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[g,h,i]perylene, benzo[k]fluoranthene, chrysene, fluoranthene, phenanthrene, and pyrene) and two organochlorine pesticides (4,4'-DDD and 4,4'-DDT) were detected in Upland Reference Area No. 2 surface soil (see Table 4-3). The sum of LMW PAHs (18 µg/kg in REF-SS05 and 18.1 µg/kg in REF-SS06 [reporting limit used for non-detected LMW PAHs]) and HMW PAHs (24.7 µg/kg in REF-SS05 and 27.8 µg/kg in REF-SS06 [reporting limit used for non-detected HMW PAHs]) are less than the LMW and HMW PAH soil screening values listed in Table 3-4 (29,000 µg/kg for LMW PAHs and 18,000 µg/kg for HMW PAHs [USEPA, 2007g]). 4,4'-DDD was detected in one surface soil sample (0.62J µg/kg in REF-SS05), while 4,4'-DDT was detected in three surface soil samples (0.52J µg/kg in REF-SS03, 2J µg/kg in REF-SS03D, and 0.91J µg/kg in REF-SS04). Detected concentrations are less than the soil screening value established for these two organochlorine pesticides (401 µg/kg [MHSPE, 2000]). Maximum reporting limits for the non-detected organochlorine pesticides also are less than soil screening values.

Thirteen metals were detected in Upland Reference Area No. 2 surface soil (arsenic, barium, beryllium, cadmium, chromium, cobalt copper, lead, mercury, nickel, selenium, vanadium, and zinc). As evidenced by the table below, maximum detected arsenic, barium, beryllium, cadmium, chromium, lead, mercury, nickel, selenium, and zinc, as well as maximum reporting limits for the non-detected metals (i.e., antimony, silver, thallium, and tin) are less than soil screening values:

Chemical	Maximum Concentration (mg/kg)	Soil Screening Value (mg/kg)
Antimony	0.52U	78.0
Arsenic	3.3	18.0
Barium	110J	330
Beryllium	0.32	40.0
Cadmium	0.15J	140
Chromium	35	57.0
Lead	12	1,700
Mercury	0.057	0.1
Nickel	28	280

Chemical	Maximum Concentration (mg/kg)	Soil Screening Value (mg/kg)
Selenium	0.67J	4.1
Silver	0.13U	560
Thallium	0.13U	1.0
Tin	13U	50.0
Zinc	65	120

Cobalt, copper, and vanadium were detected in each Upland Reference Area No. 2 surface soil sample that was analyzed for these three metals at concentrations greater than soil screening values. However, maximum concentrations (33 mg/kg for cobalt, 110 mg/kg for copper, and 180 mg/kg for vanadium) are less than maximum background concentrations (50.2J mg/kg for cobalt, 180 mg/kg for copper, and 230 mg/kg for vanadium) and ULM background concentrations (46.2 mg/kg for cobalt, 168 mg/kg for copper, and 259 mg/kg for vanadium) established for surface soil (Baker, 2008b), indicating that detections in Upland Reference Area No. 2 surface soil are representative of background levels.

Upland Reference Area No. 3

PAHs were not detected in surface soil collected at Upland Reference Area No. 3 (see Table 4-4). The maximum sum of LMW and HMW weight PAH concentrations (12.4 µg/kg and 12.6 µg/kg, respectively in REF-SS010 [reporting limit used for non-detected PAHs]) are less than soil screening values listed in Table 3-4 (29,000 µg/kg for LMW PAHs and 18,000 µg/kg for HMW PAHs). 4,4'-DDT was detected in a single surface soil sample collected at Upland Reference Area No. 3 (0.41J µg/kg in REF-SS012). This single detection is less than the soil screening value established for this organochlorine pesticides (401 µg/kg [MHSPE, 2000]. With the exception of kepone and toxaphene, reporting limits for the non-detected organochlorine pesticides also are less than soil screening values. The kepone and toxaphene reporting limits for REF-SS09 (210 µg/kg) exceed the soil screening value established for these organochlorine pesticides (100 µg/kg [Friday 1998]).

Thirteen metals were detected in Upland Reference Area No. 3 surface soil (arsenic, barium, beryllium, cadmium, chromium, cobalt copper, lead, mercury, nickel, selenium, vanadium, and zinc). As evidenced by the Table below, maximum detected arsenic, barium, beryllium, cadmium, lead, mercury, nickel, selenium, and zinc, as well as maximum reporting limits for the non-detected metals (i.e., antimony, silver, thallium, and tin) are less than soil screening values:

Chemical	Maximum Concentration (mg/kg)	Soil Screening Value (mg/kg)
Antimony	0.52U	78.0
Arsenic	3.3	18.0
Barium	110J	330
Beryllium	0.32	40.0
Cadmium	0.15J	140
Lead	12	1,700
Mercury	0.057	0.1
Nickel	28	280
Selenium	0.67J	4.1
Silver	0.13U	560
Thallium	0.13U	1.0
Tin	13U	50.0
Zinc	65	120

Cobalt and vanadium were detected in each Upland Reference Area No. 3 surface soil sample at concentrations greater than soil screening values (13 mg/kg for cobalt and 10 mg/kg for vanadium). In addition, copper was detected in two surface soil samples (100 mg/kg in REF-SS09 and 110 mg/kg in REF-SS010), while chromium was detected in a single surface soil sample (58 mg/kg in REF-SS09) at concentrations greater than soil screening values (80 mg/kg for copper and 57 mg/kg for chromium). Maximum cobalt and copper concentrations (30 mg/kg and 110 mg/kg, respectively) are less than maximum background concentrations (50.2J mg/kg for cobalt and 180 mg/kg for copper [Baker, 2008b]) and ULM background concentrations (46.2 mg/kg for cobalt and 168 mg/kg for copper [Baker, 2008b]), indicating that cobalt and copper detections in Upland Reference Area No. 3 surface soil samples are representative of background levels. However, the vanadium detection in REF-SS09 (260 mg/kg) and the chromium detection in REF-SS09 (58 mg/kg) exceed maximum background concentrations (47 mg/kg for chromium and 230 mg/kg for vanadium [Baker, 2008b]) and ULM background concentrations (49.8 mg/kg for chromium and 259 mg/kg for vanadium and [Baker, 2008b]).

Based on the comparison of analytical data to sediment screening values and background screening values (i.e., maximum and ULM background concentrations), Upland Reference Area Nos. 1 and 2 are both considered appropriate sources of reference area surface soil for *Eisenia fetida* toxicity testing. Reference Area No. 3 is not considered an appropriate source of surface soil based on the chromium and vanadium detections in REF-SS09, which exceed soil screening values, maximum background concentrations, and ULM background concentrations. Reporting limits for two organochlorine pesticides at this upland reference area also exceed screening values.

4.1.1.3 Selection of Upland Reference Area for BERA Field Investigation

Based on the evaluation presented in Sections 4.1.1.1 through 4.1.1.2, Upland Reference Area Nos. 1 and 3 are not considered appropriate as sources of surface soil for earthworm toxicity testing. Upland Reference Area No. 1 was deemed inappropriate based on considerable differences in particle size distributions (lower silt/clay and higher sand content when compared to SWMU 1). Upland reference Area No. 3 was deemed inappropriate based on considerable differences in TOC content (lower TOC content when compared to SWMU 1). A surface soil sample collected at this reference area also contained chromium and vanadium at concentrations greater than soil screening values and background levels. Upland Reference Area No. 2 is considered most appropriate for the collection of surface soil for earthworm toxicity testing. Although Upland Reference Area No. 2 surface soils exhibited lower TOC and higher silt/clay content than SWMU 1 surface soils, differences were not as considerable as the observed differences between Upland Reference Area No. 1 and SWMU 1 particle size distributions Upland Reference Area No. 3 and SWMU 1 TOC content. In addition, the concentrations of PAHs, metals, and organochlorine pesticides in surface soil samples collected at Upland Reference Area No. 2 did not exceed soil screening values and/or background levels.

4.1.2 Open Water Reference Areas

Three open water reference areas (Open Water Reference Area No. 1, Open Water Reference Area No. 2, and Open Water Reference Area No. 3) were evaluated in Step 5 of the ERA process for SWMU 1 (Baker, 2008a). Open Water Reference Area No. 1 was established within Puerca Bay, Open Water Reference Area No. 2 was established within an Embayment of the Ensenada Honda, adjacent to the former Officer's Beach (approximately 1.0 mile from the open water portion of SWMU 1), while Open Water Reference Area No. 3 was established within Pelican Bay (see Figure 3-3). Activities associated with the evaluation included the collection of sediment at each open water reference area (see Figures 3-4 and 3-5). The open water reference areas were sampled on September 20 and September 21, 2006 during verification of the field sampling design for a BERA at SWMU 45. Each sediment sample was analyzed for the ecological COCs unique to SWMU 1 West Indian manatee dietary exposures (i.e., arsenic, cadmium, copper, mercury, selenium, and zinc), as well as TOC, and grain size. Analytical results for sediment collected at Open Water Reference Area Nos. 1, 2, and 3 are summarized in Tables 4-6, 4-7, and 4-8, respectively, while analytical results for associated equipment rinsate and field blanks are summarized in Table 4-9.

The proposed open water reference areas were evaluated based on biological, physical, and chemical properties. As outlined in Section 3.1, a given reference area was deemed acceptable for use as a source of turtle grass tissue for the BERA field investigation (Step 6) if the following conditions were met:

- The habitat offered by the reference area is similar to habitat found within the open water portion of SWMU 1 (climax turtle grass community).

- The range of TOC concentrations and grain size characteristics in open water reference area sediment are similar to the ranges found in sediment located within the open water portion of SWMU 1.

- The concentrations of arsenic, cadmium, copper, mercury, selenium, and zinc in reference sediment do not exceed the sediment screening values developed in Step 1 of the Navy ERA process (i.e., 7.24 mg/kg for arsenic, 0.68 mg/kg for cadmium, 18.7 mg/kg for copper, 0.13 mg/kg for mercury, 1.0 mg/kg for selenium, and 124 mg/kg for zinc) or the open water background sediment screening values established in the *Revised Final II Summary Report for Environmental Background Concentrations of Inorganic Compounds* (Baker, 2008b)

An evaluation of the open water reference areas against these criteria is presented within the sections that follow.

4.1.2.1 Habitat

As discussed in Section 2.3.2, seagrass meadows are prevalent throughout much of the Ensenada Honda, including the open water portion of SWMU 1. Seagrass meadows within the Ensenada Honda, including the area downgradient from SWMU1, are dominated by a nearly continuous cover of turtle grass with a high abundance of calcareous green algae (*Halimeda incrassate*, *Halimeda opuntia*, *Penicillis* spp. *Avranvilla* spp., *Ventricaria ventricosa*, *Caulerpa* spp., *Valonia* spp., and *Udotea* spp.) (Reid et al., 2001). The dominance by turtle grass and the absence of opportunistic seagrass species (i.e., shoal grass) indicates that the Ensenda Honda's seagrass meadows are in the climax stage and have not experienced any recent disturbances which were severe enough to alter the equilibrium species composition (Reid et al., 2001). Based on the modified Braun-Blanquet scale (Braun-Blanquet, 1972), turtle grass coverage and macroalgae coverage within the Ensenda Honda range from 50 percent to greater than 75 percent (Reid et al., 2001).

Turtle grass cover was not quantitatively measured at each open water reference area during verification of the field sampling design. However, observations indicate that turtle grass cover at Open Water Reference Area No. 1 ranges from approximately 50 percent to greater than 90 percent, while turtle grass cover at Open Water Reference Area No. 2 ranges from approximately 50 percent to greater than 65 percent. Identical to SWMU 1, the dominant seagrass species at both open water reference areas is turtle grass, indicating the presence of a climax community.

Marine algae (unknown species) also are prevalent at both open water reference locations. Identical to turtle grass, macroalgae coverage was not quantitatively measured during verification of the field sampling design. However, observations indicate similar macroalgae coverage at Open Water Reference Areas Nos. 1 and 2 as that measured within the Ensenada Honda by Reid et al. (2001). Turtle grass and macroalgae cover at Open Water Reference Area No. 3 was sparse (less than 10 percent). Based on the habitat criterion established within the Final Steps 3b and 4 Report (i.e., presence of a climax turtle grass community [Baker, 2007) and similar turtle grass and macroalgae coverage), Open Water Reference Area Nos. 1 and 2 are both deemed appropriate for the collection of turtle grass tissue, while Open Water Reference Area No. 3 is deemed inappropriate.

4.1.2.2 Physical Properties of Sediment

TOC concentrations measured in twelve SWMU 1 open water sediment samples collected during the 2003 and 2004 additional data collection field investigations (see Table 4-10) ranged from 14,000 mg/kg (01OWSD08) to 110,000 mg/kg (01OWSD10). Although the range of measured TOC concentrations is large, most values were reported at concentrations greater than or equal to 41,000 mg/kg and less than or equal to 70,000 mg/kg (i.e., seven values). TOC concentrations measured in Open Water Reference Area No. 1 sediment samples ranged from 27,000 mg/kg (REF1-SD02V) to 66,000 mg/kg (REF1-SD01V). Of the six samples collected, four had measured TOC concentrations ranging from 60,000 mg/kg to 66,000 mg/kg (see Table 4-6). TOC concentrations measured in Open Water Reference Area No. 2 sediments (9,300 mg/kg [REF2-SD04V] to 67,000 mg/kg [REF2-SD06V]) were generally lower than concentrations measured at SWMU 1 and Open Water Reference Area No. 1 (see Table 4-7). With the exception of REF2-SD06V, all reported values were less than or equal to 20,000 mg/kg. As discussed in Section 3.1, only two sediment samples were collected at Reference Area No. 3 due the high shell content of the sediment relative to SWMU 1 and the presence of low seagrass coverage (less than 10 percent). TOC concentrations in these two sediment samples were most similar to Open Water Reference Area No. 2 sediments (5,100 mg/kg in REF3-SD01V and 24,000 mg/kg in REF3-SD02V).

Grain size distributions in SWMU 1 sediments were most similar to grain size distributions in sediment samples collected at Open Water Reference Area No. 1. Both locations exhibited similar total sand and silt/clay content. Reference Area No. 2 sediment samples were comprised on somewhat coarser material (greater sand content and lower silt/clay content than SWMU 45 and Open Water Reference Area No. 1 sediments). Grain size distribution data for sediments collected at Open Water Reference Area No. 3 confirmed the visual observation made in the field. As evidenced by Table 4-8, sediments collected at this open water reference area exhibited high gravel content (34.7 percent in REF3-SD01V and 32.5 percent in REF3-SD02V) relative to SWMU 1 (0.0 percent to 6.1 percent). The high percentage of gravel measured in each Reference Area No. 3 sediment sample is likely attributable to the presence of crushed shell pieces.

The analytical data presented in Tables 4-6 through 4-10 indicate that Reference Area No. 1 sediments are most similar to SWMU 1 sediments with regard to TOC and grain size. Based on the analysis of physical and chemical properties, Open Water Reference Area No. 1 is deemed most appropriate as a source of turtle grass tissue for the evaluation of West Indian manatee dietary intakes.

4.1.2.3 Comparison of Analytical Data to Screening Values

As outlined in the Final Step 3b and 4 Report (Baker, 2007) and Sections 3.1 and 4.1.2 herein, a given reference area was considered acceptable as a source of turtle grass tissue in Step 6 of the

BERA if arsenic, cadmium, copper mercury, and selenium were not detected at concentrations greater than sediment screening values or the open water background sediment screening values established in the *Revised Final II Summary Report for Environmental Background Concentrations of Inorganic Compounds* (Baker, 2008b).

As Open Water Reference Area No. 3 was deemed unacceptable for use in Step 6 as a source of turtle grass tissue (based on the presence of sparse seagrass cover [see Section 4.1.2.1]), the arsenic, cadmium, copper, mercury, selenium, and zinc analytical data for this reference area were not evaluated. A comparison of the Open Water Reference Area Nos. 1 and 2 sediment analytical data to sediment screening values is provided below.

Reference Area No. 1

Arsenic, cadmium, copper, mercury, selenium, and zinc were detected in each sediment sample. As evidenced by the following table, maximum detected cadmium, mercury, selenium, and zinc concentrations are less than sediment screening values.

Chemical	Maximum Concentration (mg/kg)	Sediment Screening Value (mg/kg)	Description of Screening Value
Arsenic	9J	7.24	TEL (MacDonald, 1994)
Cadmium	0.093J	0.68	TEL (MacDonald, 1994)
Copper	59	18.7	TEL (MacDonald, 1994)
Mercury	0.047J	0.13	TEL (MacDonald, 1994)
Selenium	0.47J	1.0	AET (Buchman, 1999)
Zinc	38	124	TEL (MacDonald, 1994)

Arsenic was detected in two sediment samples (9J mg/kg in REF1-SD01V and 8.9 mg/kg in REF-SD01V) at concentrations greater than the sediment screening value (7.24 mg/kg; Threshold Effect Level [TEL] established by MacDonald, 1994), while copper was detected in each sediment sample (25J mg/kg in REF1-SD01V and REF1-SD06V, 33J mg/kg in REF1-SD05V, 35 mg/kg in REF1-SD02V and REF1-SD03V, and 59 mg/kg in REF1-SD04V) at concentrations greater than the sediment screening value (124 mg/kg; TEL established by MacDonald, 1994). Detected arsenic concentrations greater than the sediment screening value are less than the maximum concentration (11 mg/kg) and ULM concentration (10.5 mg/kg) for open water background sediments (Baker, 2008b), indicating that arsenic detections in Open Reference Area No. 1 sediment are representative of background levels. However, detected copper concentrations in REF1-SD05V (33J mg/kg), REF1-SD02V (35 mg/kg), REF1-SD03V (35 mg/kg), and REF1-SD04V (59 mg/kg) exceed background concentrations (maximum background concentration of 29 mg/kg and ULM background concentration of 29.1 mg/kg [Baker, 2008b]).

Reference Area No. 2

Arsenic and copper were detected in each sediment sample, selenium was detected in four of six sediment samples, while mercury and zinc were detected in a single sediment sample. Cadmium was not detected in any of the Open Water Reference Area No. 2 sediment samples. As evidenced by the following table, maximum detected concentrations and, in the case of cadmium, maximum reporting limits are less than sediment screening values.

Chemical	Maximum Concentration (mg/kg)	Sediment Screening Value (mg/kg)	Description of Screening Value
Arsenic	2.6J	7.24	TEL (1994)
Cadmium	0.22UJ	0.68	TEL (MacDonald, 1994)
Copper	7.4J	18.7	TEL (MacDonald, 1994)
Mercury	0.011J	0.13	TEL (MacDonald, 1994)
Selenium	0.3J	1.0	AET (Buchman, 1999)
Zinc	9.4J	124	TEL (MacDonald, 1994)

Based on the comparison of the analytical data to sediment screening values, Open Water Reference Area No. 2 is considered an appropriate source of turtle grass tissue for the evaluation of West Indian manatee dietary intakes.

4.1.2.4 Selection of Open Water Reference Area for the BERA Field Investigation

Based on the evaluation presented in Sections 4.1.2.1 through 4.1.2.3, Open Water Reference Area No. 2 is considered most appropriate for the collection of sea grass tissue. Although the physical and chemical characteristics of Open Water Reference Area No. 2 sediments did not match the characteristics measured in SWMU 1 sediments, this reference area exhibits similar habitat characteristics (e.g. climax turtle grass community). Sediment samples collected at this open water reference area also did not contain ecological COCs at concentrations greater than sediment screening values or background concentrations (i.e., maximum and ULM background concentrations). Open Water Reference Area No. 1 is not considered an appropriate source of turtle grass tissue based on the presence of copper in four sediment samples at concentrations greater than the sediment screening value, maximum background concentration, and ULM background concentration (see Section 4.2.2.3), while Open Water Reference Area No. 3 is not considered an appropriate source of turtle grass tissue based on low seagrass coverage at this location (i.e., less than 10 percent).

4.2 BERA Field Investigation

The sections that follow present and discuss the results of the surface soil, sediment, and seagrass tissue samples collected during the BERA field investigation (conducted April 28, 2007 to April 30, 2007). The *Eisenia fetida* toxicity test results and analytical data for tissue samples collected from earthworms maintained in surface during toxicity testing are also presented and discussed.

4.2.1 Quick-Turn Surface Soil Samples

Fifty-five surface soil samples (designated 1B-SS01 through 1B-SS55) were collected from the upland habitat at SWMU 1 during the BERA field investigation (see Figure 3-6) using the sampling methodology presented in Section 3.2.1. An additional six surface soil samples (designated 1B-REF-SS01 through 1B-REF-SS06), were collected from Upland Reference Area No. 2 (see Figure 3-7) for use as potential reference surface soil samples for *Eisenia fetida* toxicity testing. Each SWMU 1 and Upland Reference Area No. 2 surface soil sample was analyzed for 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, antimony, cadmium, copper, lead, mercury, tin, and zinc on a quick-turn basis in accordance with the analytical methodology presented in Table 3-6. The quick-turn analytical results for the SWMU 1 and upland reference area surface soil samples are summarized in Tables 4-11 and 4-12, respectively. Analytical results for associated equipment rinsate and field blanks are summarized in Table 4-13. As evidenced by Table 4-12, 4,4'-DDD, 4,4'-DDE, or 4,4'-DDT were not detected in surface soil collected at Upland Reference Area No. 2. Although antimony, cadmium, copper, lead, mercury, tin, and zinc were detected in each reference area surface soil sample, maximum concentrations (antimony: 0.034J mg/kg; cadmium: 0.18 mg/kg; copper: 78.3J mg/kg; lead: 6.2J mg/kg; mercury: 0.074 mg/kg; tin: 0.47J; zinc: 42.6J mg/kg) are less than soil screening values. These data support the selection of Upland Reference Area No. 2 as a source of surface soil for the BERA field investigation.

The quick-turn analytical results for the SWMU 1 surface soil samples presented in Table 4-11 were combined with the analytical results for surface soil collected during the 1996 RFI and 2004 additional data collection field investigations (see Table 2-3) into a unified data set. An analytical summary of the unified surface soil data set, including maximum concentrations, arithmetic mean concentrations, and 95 percent UCL of the mean concentrations (calculated using USEPA ProUCL Version 4.0.010 software [USEPA, 2007e and 2007f; see Appendix G) is presented in Table 4-14. The unified data set summarized in Table 4-14 was used to derive risk estimates (i.e., HQ values) for terrestrial invertebrate exposures to ecological COCs in surface soil. HQ values, derived using maximum, arithmetic mean, 95 percent UCL of the mean COC concentrations, and the surface soil screening values identified in Section 2.5.4, are included within Table 4-14. It is noted that the soil screening value presented in Section 2.5.4 for 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT (401 ug/kg) represents a default value based on an assumed organic carbon content of two percent. Prior to derivation of HQ values, the default screening value was adjusted to reflect the site-specific TOC content of SWMU 1 surface soil using the following formula (MHSPE, 2000):

$$\textit{Screening Value}_a = (\textit{Screening Value}_d)(\textit{TOC}/10)$$

where:

$\textit{Screening Value}_a$	=	Adjusted soil screening value (ug/kg)
$\textit{Screening Value}_d$	=	Default soil screening value (ug/kg)
TOC	=	Site-specific total organic carbon (percent)

The site-specific total organic carbon value used to adjust the default soil screening values for 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT (4.46 percent) represents an average percent organic carbon content for twenty surface soil samples collected during verification of the field sampling design (six surface soil samples; see Tables 3-1 and 4-1) and BERA field investigation (fourteen surface soil samples; see Tables 3-5 and 4-15). Use of an average organic carbon content of 4.46 percent results in a site-specific screening value of 894 ug/kg for 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT. A discussion of the SWMU 1 analytical data and risk estimates (i.e., HQ values) is presented below.

<u>4,4'-DDD</u>

4,4'-DDD was detected in fifty-two of eighty-eight (52/88) surface soil samples at concentrations ranging from 0.9J µg/kg to 13,000 µg/kg (see Table 4-14). Two detections (13,000 µg/kg in 1SS16 [collected during the 2004 additional data collection field investigation; see Table 2-3] and 1,900 µg/kg in 1B-SS19 [collected during the BERA field investigation; see Table 4-11]) exceed the soil screening value (894 µg/kg; MHSPE, 2000). HQ values based on the maximum concentration (13,000 µg/kg), 95 percent UCL of the mean concentration (1,134 µg/kg) and arithmetic mean concentration (203 µg/kg) are 14.54, 1.27, and 0.23, respectively. The magnitude of the maximum detected concentration above the surface soil screening value (HQ = 14.54) and an HQ value greater than 1.0 based on the 95 percent UCL of the mean concentration (HQ = 1.27) are lines of evidence supporting a conclusion of unacceptable risk to soil invertebrate communities from 4,4'-DDD in SWMU 1 surface soil.

4,4'-DDE

4,4'-DDE was detected in sixty-eight of eighty-nine (68/89) surface soil samples at concentrations ranging from 0.62J µg/kg to 28,000 µg/kg (see Table 4-14). Fifteen detections exceed the soil screening value (894 µg/kg; MHSPE, 2000). HQ values based on the maximum concentration (28,000 µg/kg), 95 percent UCL of the mean concentration (2,937 µg/kg), and arithmetic mean concentration (837 µg/kg) are 31.32, 3.29, and 0.94, respectively. The frequency of detected concentrations greater than the soil screening value, the magnitude of the maximum detected concentration above the soil screening value (HQ = 31.32), and an HQ value greater than 1.0 based on the 95 percent UCL of the mean concentration (HQ = 3.29) are lines of evidence supporting a conclusion of unacceptable risk to soil invertebrate communities from 4,4'-DDE in SWMU 1 surface soil.

4,4'-DDT

4,4'-DDT was detected in sixty-seven of eighty-nine (67/89) surface soil samples at concentrations ranging from 1.23J µg/kg to 43,000J µg/kg (see Table 4-14). Six detections exceed the soil screening value (894 µg/kg; MHSPE, 2000). HQ values based on the maximum concentration (43,000J µg/kg), 95 percent UCL of the mean concentration (3,981 µg/kg), and arithmetic mean concentration (799 µg/kg) are 48.10, 4.45, and 0.89, respectively. The magnitude of the maximum detected concentration above the soil screening value (HQ = 48.10) and an HQ value greater than 1.0 based on the 95 percent UCL of the mean concentration (HQ = 4.45) are lines of evidence supporting a conclusion of unacceptable risk to soil invertebrate communities from 4,4'-DDT in SWMU 1 surface soil.

Antimony

Antimony was detected in sixty-four of eighty-five (64/85) surface soil samples at concentrations ranging from 0.012J mg/kg to 220 mg/kg (see Table 4-14). Three detections (93 mg/kg in 1B-SS46, 130 mg/kg in 1B-SS50, and 220 mg/kg in 1B-SS48) exceed the soil screening value (78 mg/kg; USEPA, 2005a). These three detections also exceed the ULM background surface soil concentration (2.46 mg/kg; Baker, 2008b). HQ values based on the maximum concentration (220 mg/kg), 95 percent UCL of the mean concentration (28.7 mg/kg), and arithmetic mean concentration (14.1 mg/kg) are 2.82, 0.37, and 0.06, respectively. The frequency and magnitude of the detected concentrations above the soil screening value is low and HQ values based on 95 percent UCL of the mean and arithmetic mean concentrations are less than 1.0 (0.37 and 0.06, respectively). These factors are lines of evidence supporting a conclusion of minimal risk to soil invertebrate communities from antimony in SWMU 1 surface soil.

Cadmium

Cadmium was detected in eighty of eighty-five (80/85) surface soil samples at concentrations ranging from 0.02J mg/kg to 83.8 mg/kg (see Table 4-14). All detected concentrations are less than the soil screening value (140 mg/kg; USEPA, 2005c). HQ values based on the maximum concentration (83.8 mg/kg), 95 percent UCL of the mean concentration (10.4 mg/kg), and arithmetic mean concentration (3.58 mg/kg) are 0.59, 0.07, and 0.03, respectively. The absence of detected cadmium concentrations greater than the soil screening value is a line of evidence supporting a conclusion of minimal risk to soil invertebrate communities from cadmium in SWMU 1 surface soil.

Copper

Copper was detected in eighty-three of eighty-three (83/83) surface soil samples at concentrations ranging from 19.8 mg/kg to 2,340 mg/kg (see Table 4-14). Forty-one detections exceed the soil screening value (80 mg/kg; USEPA, 2007a). Twenty-nine of these detections also exceed the ULM background surface soil concentration (168 mg/kg; Baker, 2008b). HQ values based on the maximum concentration (2,340 mg/kg), 95 percent UCL of the mean concentration (383 mg/kg), and arithmetic mean concentration (221 mg/kg) are 29.25, 4.79, and 2.76, respectively. The frequency of detected concentrations greater than the soil screening value and ULM background concentration, the magnitude of the maximum detected concentration above the soil screening value (HQ = 29.25), and HQ values greater than 1.0 based on 95 percent UCL of the mean and arithmetic mean copper concentrations (HQs = 4.79, and 2.76, respectively) are lines of evidence supporting a conclusion of unacceptable risk to soil invertebrate communities from copper in SWMU 1 surface soil.

Lead

Lead was detected in eighty-two of eighty-two (82/82) surface soil samples at concentrations ranging from 0.7J mg/kg to 2,600J mg/kg (see Table 4-14). Two detections (2,300J mg/kg in 1B-SS48 and 2,600J mg/kg in 1B-SS46) exceed the soil screening value (1,700 mg/kg; USEPA, 2005d). These two detections also exceed the ULM background surface soil concentration (22 mg/kg; Baker, 2008b). HQ values based on the maximum concentration (2,600J mg/kg), 95 percent UCL of the mean concentration (633 mg/kg), and arithmetic mean concentration (287 mg/kg) are 1.53, 0.37, and 0.17, respectively. The frequency and magnitude of detected concentrations above the soil screening value is low and HQ values based on 95 percent UCL of the mean and arithmetic mean lead concentrations are less than 1.0 (0.37 and 0.17, respectively). These factors are lines of evidence supporting a conclusion of minimal risk to soil invertebrate communities from lead in SWMU 1 surface soil.

Mercury

Mercury was detected in eighty-two of eighty-five (82/85) surface soil samples at concentrations ranging from 0.023J mg/kg to 5.7J mg/kg (see Table 4-14). Forty-one detections exceed the soil screening value (0.1 mg/kg; Efroymson et al., 1997b) and ULM background surface soil concentration (0.109 mg/kg; Baker, 2008b). HQ values based on the maximum concentration (5.7J mg/kg), 95 percent UCL of the mean concentration (0.553 mg/kg), and arithmetic mean concentration (0.25 mg/kg) are 57.00, 5.53, and 2.50, respectively. The frequency of detected concentrations greater than the soil screening value and ULM background concentration, the magnitude of the maximum detected concentration above the soil screening value (HQ = 57.00), and HQ values greater than 1.0 based on 95 percent UCL of the mean and arithmetic mean concentrations (HQs = 5.53, and 2.50, respectively) are lines of evidence supporting a conclusion of unacceptable risk to soil invertebrate communities from mercury in SWMU 1 surface soil.

Tin

Tin was detected in forty-nine of sixty-nine (49/69) surface soil samples at concentrations ranging from 0.12J mg/kg to 1,500J mg/kg (see Table 4-14). Fourteen detections exceed the soil screening value (50 mg/kg; Efroymson et al., 1997a) and ULM background surface soil concentration (115 mg/kg; Baker, 2008b). HQ values based on the maximum concentration (1,500J mg/kg), 95 percent UCL of the mean concentration (199 mg/kg), and arithmetic mean concentration (57 mg/kg) are 30.00, 3.99, and 1.14, respectively. The frequency of detected concentrations greater than the soil screening value and ULM background concentration, the magnitude of the maximum detected concentration above the soil screening value (HQ = 30.00), and HQ values greater than 1.0 based on 95 percent UCL of the mean and arithmetic mean concentrations (HQs = 3.99 and 1.14, respectively) are lines of evidence supporting a conclusion of unacceptable risk to soil invertebrate communities from tin in SWMU 1 surface soil.

Zinc

Zinc was detected in eighty-five of eighty-five (85/85) surface soil samples at concentrations ranging from 13.9J mg/kg to 5,410 mg/kg (see Table 4-14). Forty-two detections exceed the soil screening value (120 mg/kg; USEPA, 2007c) and ULM background surface soil concentration (115 mg/kg; Baker, 2008b). HQ values based on the maximum concentration (5,410 mg/kg), 95 percent UCL of the mean concentration (1,296 mg/kg), and arithmetic mean concentration (585 mg/kg) are 45.05, 10.08, and 4.99, respectively. The frequency of detected concentrations greater than the soil screening value and ULM background concentration, the magnitude of the maximum detected concentration above the soil screening value (HQ = 45.05), and HQ values greater than 1.0 based on 95 percent UCL of the mean and arithmetic mean concentrations (HQs = 10.08 and 4.99, respectively) are lines of evidence supporting a conclusion of unacceptable risk to soil invertebrate communities from zinc in SWMU 1 surface soil.

In summary, the comparison of maximum, 95 percent UCL of the mean, and arithmetic mean concentrations to invertebrate-based soil screening values support a conclusion of minimal risks from antimony, cadmium, and lead to terrestrial invertebrate communities. The antimony and lead HQ values based on 95 percent UCL of the mean concentrations are less than 1.0 (HQ of 0.37 for both metals). In addition, the frequency and magnitude of antimony and lead detections above soil screening values are low (antimony was detected in only three of eighty-five [3/85] surface soil samples and lead was detected in only two of eight-two [2/82] surface soil samples at concentrations greater than soil screening values; HQ values based on maximum concentrations are 2.82 for antimony and 1.53 for lead). In the case of cadmium, this metal was not detected in any surface soil sample at a concentration greater than the invertebrate-based soil screening value. The evaluation performed on the 4,4’-DDD, 4,4’-DDE, 4,4’-DDT, copper, mercury, tin, and zinc surface soil data support a conclusion of unacceptable risks from these seven chemicals to terrestrial invertebrate communities. HQ values based on 95 percent UCL of the mean concentrations exceed 1.0 (HQ of 1.27 for 4,4’-DDD, 3.29 for 4,4’-DDE, 4.45 for 4,4’DDT, 4.79 for copper, 5.53 for mercury, 3.99 for tin, and 10.08 for zinc). Furthermore, in the case of 4,4’-DDE, copper, mercury, tin, and zinc, the frequency of detected concentrations above soil screening values is high, ranging from fourteen of sixty-nine [14/69] surface samples for tin to forty-two of eighty-five [42/85] surface soil samples for zinc.

It is noted that for metals, total concentrations in soil are poor predictors of toxicity due to a number of modifying factors, including pH, organic matter content, cation exchange capacity (CEC) and clay content (Ma, 1984, Beyer et al., 1987, Rhoads et al., 1989, Alva et al., 2000, Scott-Fordsmand et al., 2000, Maiz et al., 2000, Adriano, 2001, Lock and Janssen, 2001, Boyd and Williams, 2003, Broos et al., 2007). Studies have also shown that total 4,4’-DDD, 4,4’-DDE. And 4,4’-DDT concentrations are poor predictors of toxicity as their bioavailability decreases with aging in soil because of sequestration into inaccessible microsites within the soil matrix (Morrison et al., 2000). Specific soil parameters influencing the bioaccessibility/bioavailability of hydrophobic organic chemicals (HOCs), such as 4,4’-DDD, 4,4’-DDE, and 4,4’-DDT, include organic carbon (soil organic carbon and black carbon) and clay content (Alexander, 2000 and Jensen et al., 2006). For these reasons, the comparison of total soil concentrations to literature-based toxicological thresholds does not provide an accurate determination of bioavailability and toxicity.

4.2.2 Earthworm Toxicity Test Surface Soil Samples

As discussed in Sections 3.2.1 and 4.2.1, fifty-five SWMU 1 and six Upland Reference Area No. 2 surface soil samples were submitted to the analytical laboratory for quick-turn analyses. Each SWMU 1 and reference area surface soil sample was analyzed for the ecological COCs identified in Step 3b of the ERA process for terrestrial invertebrates (i.e., 4,4’-DDD, 4,4’-DDE, 4,4’-DDT, antimony, cadmium, copper, lead, mercury, tin, and zinc; see Table 4-11). Upon receipt of the unvalidated analytical results in the field, fourteen SWMU 1 surface soil samples (1B-SS09, 1B-SS13, 1B-SS15, 1B-SS18, 1B-SS19, 1B-SS29, 1B-SS33, 1B-SS37, 1B-SS39, 1B-SS46, 1B-SS48, 1B-SS49, 1B-SS50, and 1B-SS51) and three Upland Reference Area No. 2 surface soil samples (R1B-REF-SS03, 1B-REF-SS05, and 1B-REF-SS06) were submitted to the toxicity testing laboratory (Fort Environmental Laboratories) for 28-day *Eisenia fetida* survival, growth, and reproduction tests. A portion of each sample submitted for toxicity testing was analyzed for TOC and grain size using the methodology summarized in Table 3-6. Analyses were conducted by STL on a standard turn (i.e., 28 days).

The specific surface soil samples selected for earthworm toxicity testing exhibited a range of ecological COC concentrations, from non-detected values or values below soil screening values to maximum detected concentrations. To the extent possible, the co-location of ecological

COPCs was considered when surface soil samples were selected for toxicity testing. The Upland Reference Area No. 2 surface soil samples selected for toxicity testing (R1B-REF-SS03, 1B-REF-SS05, and 1B-REF-SS06) exhibited similar physical characteristics as those observed in the SWMU 1 surface soil samples tested for toxicity testing (i.e., TOC content and grain size characteristics [apparent, based on field observations and professional judgment]).

Because unvalidated, quick-turn analytical results were used to select the surface soil samples submitted for earthworm toxicity testing, several QA/QC issues associated with these data could not be taken into consideration during the selection process. For example, an analytical sequence (1B-SS13 through 1B-SS30) was re-analyzed for 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT due to calibration verification standards outside control limits. Because the analytical data from the re-analyses were not available for consideration when soil samples were selected for toxicity testing, the selection process only took into consideration analytical results from the initial analyses. In the case of tin, analytical results for soil samples 1B-SS33 through 1B-SS44 were rejected during data validation activities (see Section 3.4.2 [SDG SWMU26275-1]). At the time surface soil samples were selected for toxicity testing, the usability of the tin data was not known. The uncertainty associated with the selection of surface soil samples for earthworm toxicity testing using unvalidated, quick-turn analytical results is discussed in Section 7.0.

The specific concentration gradients tested for toxicity are summarized below. The results shown represent validated data.

- 4,4'-DDD: 0.38U µg/kg (1B-SS51), 20 µg/kg (1B-SS39), 22J µg/kg (1B-SS09), 42 µg/kg (1B-SS15), 51 µg/kg (1B-SS13), 59 µg/kg (1B-SS50), 79 µg/kg (1B-SS29), 100J µg/kg (1B-SS37), 110 µg/kg (1B-SS49), 120 µg/kg (1B-SS18), 150 µg/kg (1B-SS33), 170 µg/kg (1B-SS46), 210 µg/kg (1B-SS48), 210 µg/kg (1B-SS48), and 1,900 µg/kg (1B-SS19)

- 4,4'-DDE: 0.38U µg/kg (1B-SS51), 48 µg/kg (1B-SS09), 150 µg/kg (1B-SS39), 230 µg/kg (1B-SS29), 390 µg/kg (1B-SS13), 420 µg/kg (1B-SS15), 600 µg/kg (1B-SS37), 1,500 µg/kg (1B-SS49), 1,600 µg/kg (1B-SS50), 2,200 µg/kg (1B-SS18), 3,700 µg/kg (1B-SS46), 4,200 µg/kg (1B-SS48), 4,300 µg/kg (1B-SS33), and 9,100 µg/kg (1B-SS19)

- 4,4'-DDT: 0.34U µg/kg (1B-SS51), 22 µg/kg 91B-SS09), 25 µg/kg (1B-SS39), 58J µg/kg (1B-SS29), 230NJ µg/kg (1B-SS13), 240NJ µg/kg (1B-SS15), 350 µg/kg (1B-SS37), 360 µg/kg (1B-SS18), 370 µg/kg (1B-SS50), 1,100 µg/kg (1B-SS49), 1,200 µg/kg (1B-SS46), 1,400 µg/kg (1B-SS33), 1,500 µg/kg (1B-SS48), and 15,000 µg/kg (1B-SS19)

- Antimony: 0.24U mg/kg (1B-SS51), 1.1J mg/kg (1B-SS09), 5.2 mg/kg 91B-SS29), 8.2J mg/kg 91B-SS18), 10J mg/kg (1B-SS19), 15 mg/kg (1B-SS39), 27 mg/kg (1B-SS37), 32 mg/kg 91B-SS33), 35.5J mg/kg (1B-SS15), 47.7J mg/kg (1B-SS13), 65 mg/kg (1B-SS49), 93 mg/kg (1B-SS46), 130 mg/kg (1B-SS50), and 220 mg/kg (1B-SS48)

- Cadmium: 0.19 mg/kg (1B-SS51), 0.75 mg/kg (1B-SS09), 1.7 mg/kg (1B-SS39), 2J mg/kg (1B-SS29), 2.5 mg/kg (1B-SS37), 3.2J mg/kg (1B-SS18), 3.9J mg/kg (1B-SS19), 4.8 mg/kg (1B-SS33), 7 mg/kg (1B-SS49), 9.4J mg/kg (1B-SS13), 9.9J mg/kg (1B-SS15), 15 mg/kg (1B-SS50), 18 mg/kg (1B-SS46), and 25 mg/kg (1B-SS48).

- Copper: 33J mg/kg (1B-SS51), 77.7J mg/kg (1B-SS09), 99.9 mg/kg (1B-SS29), 140 mg/kg (1B-SS19), 210 mg/kg (1B-SS39), 212 mg/kg (1B-SS18), 230 mg/kg (1B-SS33), 360 mg/kg 91B-SS37), 490J mg/kg (1B-SS49), 580J mg/kg (1B-SS48), 779 mg/kg (1B-SS13), 940J mg/kg (1B-SS46), 1,000J mg/kg (1B-SS50), and 2,340 mg/kg (1B-SS15)

- <u>Lead</u>: 7.7J mg/kg (1B-SS51), 109J mg/kg (1B-SS09), 111 mg/kg (1B-SS29), 210 mg/kg (1B-SS18), 276 mg/kg (1B-SS19), 290 mg/kg (1B-SS33), 430 mg/kg (1B-SS37), 600 mg/kg (1B-SS39), 1060 mg/kg (1B-SS13), 1,100 mg/kg (1B-SS15), 1,300J mg/kg (1B-SS49), 1,500J mg/kg (1B-SS50), 2,300J mg/kg (1B-SS48), and 2,600J mg/kg (1B-SS46)

- <u>Mercury</u>: 0.11J mg/kg (1B-SS51), 0.13 mg/kg (1B-SS33), 0.16 mg/kg (1B-SS29), 0.19 mg/kg (1B-SS09 and 1B-SS18), 0.2 mg/kg (1B-SS19), 0.31 mg/kg (1B-SS37), 0.34 mg/kg (1B-SS39), 0.43 mg/kg (1B-SS46), 0.44 mg/kg (1B-SS48), 0.49 mg/kg (1B-SS15), 0.55J mg/kg (1B-SS50), 0.59 mg/kg (1B-SS13), and 5.7 mg/kg (1B-SS49)

- <u>Tin</u>: 6U mg/kg (1B-SS51), 7.1J mg/kg (1B-SS29), 7.3J mg/kg (1B-SS09), 12.8J mg/kg 91B-SS19), 30.2J mg/kg (1B-SS18), 104J mg/kg (1B-SS15), 190 J mg/kg (1B-SS46), 208J mg/kg (1B-SS13), 250J mg/kg (1B-SS48), 300J mg/kg (1B-SS49), and 1,500J mg/kg (1B-SS50)

- <u>Zinc</u>: 38 mg/kg (1B-SS51), 180J mg/kg (1B-SS09), 270 mg/kg (1B-SS29), 490 mg/kg (1B-SS19), 510 mg/kg (1B-SS33), 530 mg/kg (1B-SS39), 680 mg/kg (1B-SS37), 1,700 mg/kg (1B-SS49), 2,300 mg/kg (1B-SS48), 2,700 mg/kg (1B-SS46), 3,000 mg/kg (1B-SS50), 3090 mg/kg (1B-SS18), 4,460 mg/kg (1B-SS13), and 5,410 mg/kg (1B-SS15)

Toxicity tests were conducted in accordance with ASTM Standard E--1676-04: *Standard Guide for Conducting Soil Toxicity or Bioaccumulation Tests with the Lumbricid Earthworm Eisenia Fetida and the Enchytraeid Potworm Enchytraeus Albidus* (ASTM, 2006). Test endpoints for *Eisenia fetida* were survival, calculated as the mean percentage of test organisms at test initiation that survived in each replicate at test termination; growth, calculated as the mean weight loss per surviving earthworm in each replicate at test termination, and reproduction, expressed as the mean number of juveniles and cocoons per surviving earthworm in each replicate at test termination. The laboratory's toxicity report (included as Appendix E) summarizes the methodology used to conduct the *Eisenia Fetida* toxicity tests. No protocol deviations from ASTM Standard E-1676-04 were recorded during the performance of the tests. It is noted that each SWMU 1 and reference area surface soil sample was tested using eight replicates, with 10 earthworms per replicate. ASTM (2006) methodology recommends a minimum of three replicates per sample. Eight replicates were tested per sample in an attempt to increase the power of the toxicity tests by reducing the between-replicate (i.e., inter-replicate) variability of each endpoint.

Table 4-15 presents a summary of the toxicity test results and associated analytical data together. The sections that follow provide a discussion and analysis of the toxicity data.

4.2.2.1 <u>Comparison of Biological Responses in SWMU 1 Surface Soil to Biological Responses in Reference Area Surface Soil</u>

Eisenia fetida survival, growth, and reproduction data were statistically evaluated by the testing laboratory using SigmaStat® Version 2.03 statistical software (SPSS Inc., Chicago, IL). Statistical comparisons were made against the following test endpoints:

- Earthworm survival (percent) in each replicate at test termination

- Weight loss per surviving earthworm in each replicate at test termination

- Number of juveniles and cocoons per surviving earthworm in each replicate at test termination

The survival, growth (i.e., weight loss), and reproduction data were subjected to hypothesis testing to determine if measured biological responses in SWMU 1 and reference area surface soil samples are equal. Initially, normality and homogeneity of variance were tested at an alpha (α) of 0.05 using D'Agostino's test and Bartlett's test, respectively. D'Agostino's test was used instead of the Shapiro-Wilks test based on N > 50. Given that the assumption of normality or homogeneity failed for each test endpoint evaluated, Kruskal-Wallis one-way analysis of variance (ANOVA) tests were performed on the ranked data (tested at an α of 0.05). This non-parametric ANOVA tested the null hypothesis that all medians of each treatment, including the reference soils, are equal. When a statistically significant difference was detected for a given endpoint (i.e., differences in values among the treatments are greater than would be expected by chance), as was the case for each test endpoint evaluated, a multiple comparison procedure (Dunn's method) was run to isolate the specific treatments that differ. For a given endpoint, separate multiple comparison procedures were performed against each reference area surface soil sample. All statistical evaluations performed by the toxicity testing laboratory are included within Appendix E.

4.2.2.1.1 *Evaluation of Toxicity Test Negative Control and Reference Surface Soil Samples*

A negative control was run concurrently with the SWMU 1 and Reference Area No. 2 surface soil samples to ensure that the population of test organisms used in the toxicity tests was healthy. The negative control was tested using an organic top soil and peat moss mixture. As the initial moisture content of the control soil was less than 25 percent, soil was hydrated prior to use in the toxicity tests. Dechlorinated tap water was used to hydrate the control soil to a target percent moisture content of 25 percent to 45 percent (Stafford and Edwards, 1985 as cited in ASTM, 2006). Hydration water was prepared by passing tap water through a 5 micrometer (µm) pre-treatment filter to remove solids, a 3.6 cubic foot (cf) activated carbon filter to remove chlorine, ammonia, and higher molecular weight organics, and a 5 µm post-filter to remove any carbon particles from the carbon treatment phase. This same water also was used to hydrate, as necessary, the SWMU 1 and Reference Area No. 2 surface soil samples (see soil chemistry attachment in Appendix E). Minimum acceptable performance for the negative laboratory control is specified by ASTM (2006) as greater than 90 percent mean survival in each replicate test chamber at test termination. As evidenced by Table 4-15, control survival was 100 percent in each replicate test chamber. Based on these data, it is concluded that the earthworm population used as test organisms for toxicity testing were healthy and toxicity test results are valid.

Three surface soil samples were collected from Reference Area No. 2 and tested concurrently with the SWMU 1 surface soil samples (1B-REF-SS03, 1B-REF-SS05, and 1B-REF-SS06). These samples were collected to provide a site-specific basis for evaluating toxicity (survival, growth, and reproduction in SWMU 1 surface soil were statistically compared to survival, growth, and reproduction in each reference area surface soil sample). Good health of organisms used in each reference surface soil was demonstrated. Specifically, mean survival of test organisms exposed to surface soil samples 1B-REF-SS05 and 1B-REF-SS06 was 97.5 percent, while survival of test organisms exposed to surface soil sample 1B-REF-SS03 was 100 percent (see Table 4-16). As test organisms exposed to the reference soil met the minimum criteria for a healthy population and each reference soil sample did not contain detectable concentrations of ecological COCs or concentrations greater than soil screening values (see Table 4-12), it was concluded that statistical comparisons of survival, growth, and reproduction between SWMU 1 surface soil samples and reference area surface soil are reliable.

4.2.2.1.2 Survival

The Kruskal Wallis one-way ANOVA on ranks (performed on arcsine square root transformed data) detected a significant difference in earthworm survival among treatment groups ($p = <0.001$). The follow-on multiple comparison procedures (Dunn's method) identified a significant decrease in mean survival by earthworms exposed to SWMU 1 surface soil sample 1B-SS18 (76.25 percent) relative to mean survival by earthworms exposed to reference area surface soil samples 1B-REF-SS03 and 1B-REF-SS06 (100 percent and 97.5 percent, respectively; $p < 0.05$). As evidenced by Table 4-15, ecological COPC concentrations measured in 1B-SS18 are less than concentrations measured in SWMU 1 surface soil samples that did not show a significant reduction in survival relative to 1B-REF-SS03 and 1B-REF-SS06. For example, 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, antimony, cadmium, copper, lead, mercury, and tin concentrations detected in 1B-SS18 are less than concentrations detected in 1B-SS46 and 1B-SS48. Detected antimony, cadmium, copper, lead, mercury, tin, and zinc concentrations measured in 1B-SS18 also are less than detected concentrations in 1B-SS13 and 1B-SS15. The analytical data indicate that some physical and/or chemical parameter other than ecological COC concentrations may be responsible for or influencing the observed biological response (see Section 4.2.2.2).

4.2.2.1.3 Weight Loss

The Kruskal-Wallis one-way ANOVA on ranks detected a significant difference in earthworm weight loss among treatment groups ($p = <0.001$). The follow-on multiple comparison procedures (Dunn's method) identified a significant increase in weight loss by earthworms exposed to SWMU 1 surface soil samples 1B-SS09, 1B-SS18, 1B-SS29, and 1B-SS39 (0.1779 grams, 0.2381 grams, 0.1826 grams, and 0.2132 grams, respectively) relative to weight loss by earthworms exposed to reference area surface soil sample 1B-REF-SS03 (0.1325 grams). Identical to survival, a clear dose-response relationship between ecological COC concentrations and weight loss can not be established (see Table 4-15), indicating that some physical and/or chemical parameter other than ecological COC concentrations may be responsible for or influencing the observed biological response (see Section 4.2.2.2).

4.2.2.1.4 Reproduction

The Kruskal-Wallis one-way ANOVA on ranks detected a significant difference in earthworm reproduction (number of juveniles and cocoons) among the SWMU 1 and reference area treatment groups ($p < 0.001$). Follow-on multiple comparison procedures (Dunn's method) detected a significant difference in reproduction between SWMU 1 surface soil sample 1B-SS07 and reference area surface soil sample 1B-REF-SS06 ($p < 0.05$). However, the statistical difference detected by Dunn's method represents a significant increase in reproduction within the SWMU 1 surface soil sample relative to reproduction within reference area surface soil sample (the mean number of juveniles and cocoons per surviving earthworm in 1B-SS37 was 0.654, while the mean number of juveniles and cocoons per surviving earthworm in 1B-SS37 was 0.038). The absence of a significant reduction in earthworm reproduction in each SWMU 1 surface soil sample relative to each reference area surface soil sample is a line of evidence supporting minimal risk on this test endpoint. It is acknowledged that earthworm reproduction occurred in only three of fourteen SWMU 1 surface soil samples (1B-SS15, 1B-SS33, and 1B-SS37), while reproduction was observed in the negative control and each reference area surface soil sample. This observation could indicate an adverse effect of one or more of the ecological COCs on earthworm reproduction. The uncertainties associated with the interpretation of test results, including the statistical procedures conducted by the testing laboratory, are further discussed in Section 7.0.

4.2.2.2 Evidence of a Significant Correlation Between Laboratory Toxicity Test Results and the Chemical/Physical Characteristics of Surface Soil

When a toxicological response to a particular chemical occurs, there is typically a sigmoidal relationship between the response and the amount of chemical to which the receptor is exposed (i.e., the dose). In such a relationship, there is nearly always a dose below which no response occurs or can be measured. Furthermore, there is a dose above which no additional response will be observed. At doses intermediate to these two levels, the relationship between dose and response resembles a linear function. As discussed in Section 4.2.2.1.2, the statistical comparisons performed by the testing laboratory indicated that earthworm survival in SWMU 1 surface soil sample 1B-SS18 was significantly lower than earthworm survival in reference area surface soil samples 1B-REF-SS03 and 1B-REF-SS06. Statistical evaluations performed by the testing laboratory also indicated that earthworm weight loss in SWMU 1 surface soil samples 1B-SS09, 1B-SS18, 1B-SS29, and 1B-SS39 was significantly greater than earthworm weight loss in reference area surface soil sample 1B-REF-SS03 (see Section 4.2.2.1.3).

NCSS statistical and power analysis software [http://www.ncss.com] was used to run pair-wise linear regressions that examined the relationship between earthworm survival and weight loss and the chemical/physical characteristics of surface soil. The regression analysis included each surface soil sample submitted for toxicity testing (fourteen SWMU 1 and three Reference Area No. 2 surface soil samples). The following surface soil variables were included in the analysis: 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, antimony, cadmium, copper, lead, mercury, tin, and zinc (ecological COCs for terrestrial invertebrate exposures; non-detected results were evaluated as detected at the reporting limit), TOC (results reported by the analytical laboratory), test soil pH (day 0 and day 28 measurements performed by the toxicity testing laboratory), and grain size (percent gravel, sand, and fines [silt and clay]). Prior to running the pair-wise linear regressions, survival data were transformed using arcsine square root transformation

NCSS output pages for each regression are included within Appendix H. Results of the linear regressions are summarized in Table 4-16. For a given variable, the results presented in Table 4-16 are expressed as the correlation coefficient (r) and coefficient of determination (r^2). The correlation coefficient is an index that ranges from one to negative one. When a value is near zero, there is no linear relationship. As the correlation gets closer to plus or minus one, the relationship is stronger. A value of one (or negative one) indicates a perfect linear relationship between variables. The coefficient of determination is an index that ranges from zero to one. A value near zero indicates no linear relationship, while a value near one indicates a perfect linear fit. As evidenced by Appendix H and Table 4-16, the linear regression analysis indicated that none of the ecological COCs had a significant influence on earthworm survival and weight loss per surviving earthworm. The following sediment variables also had no influence on earthworm survival and weight loss: percent gravel, percent sand, and percent fines. However, pH at test initiation, pH at test termination, and TOC has a significant influence on earthworm survival, while pH at test termination and TOC had a significant influence of earthworm weight loss. The regression reports for these variables show the following relationships;

- Earthworm survival decreased as soil pH increased (pH at test initiation and test termination)
- Earthworm survival increased as soil TOC concentrations increased
- Earthworm weight loss increased as soil pH increased
- Earthworm weight loss decreased as soil TOC increased

The significant influence of pH on soil toxicity (i.e., decreased survival and increased weight loss) is not consistent with the literature cited at the end of Section 4.2.1, which report lower bioavailability and toxicity of metals at higher pH values. As metal concentrations in earthworm tissue can be attributed primarily to dermal exposure (Saxe et al., 2001), the response may be related to an increase in dissolved organic carbon, potentially caused by dissolution of organic matter at alkaline pH values, which can contribute to enhanced metals content in soil solution (Temminghoff et al., 1997 as cited in Daoust et al., 2006). The significant influence of TOC on soil toxicity (increased survival and decreased weight loss) is consistent with the literature cited in Section 4.2.1, which report lower bioavailability and toxicity of metals and HOCs at higher organic carbon concentrations.

To further evaluate the relationship between TOC, pH, and ecological COC concentrations in surface soil and earthworm responses in the toxicity tests (survival and weight loss), a multiple regression analysis was performed using NCSS software. Initially, the All Possible Regressions variable selection routine was run on the survival and growth data using the following independent variables: 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, antimony, cadmium, copper, lead, mercury, zinc, TOC, and soil pH at test termination. The variable selection routine was run to (1) identify every independent variable that is even remotely related to the dependent variable (survival or growth) and (2) eliminate those independent variables that are irrelevant since their inclusion would decrease the precision of the multiple regression analysis. It is noted that tin was excluded from the selection routine since three data points were rejected during data validation activities. Inclusion of tin in the selection routine would have resulted in the omittance of all independent variable data for affected samples. Percent gravel, percent sand, and percent fines also were omitted from the evaluation since these two independent variables did not significantly influence earthworm survival and growth (as determined by the pair-wise linear regressions). Finally, soil pH at test initiation was omitted from the evaluation of earthworm growth based on the pair-wise linear regressions (see Table 4-16).

NCSS printouts showing the results of the variable selection routine are included as Appendix H. A total of 4,096 separate models were run for the evaluation of earthworm survival (eleven independent variables), while 2,048 separate models were run for the evaluation of earthworm growth (eleven independent variables). For a given dependent variable (earthworm survival and growth), plots showing the number of independent variables in each model versus r^2 values were examined to determine the point at which the increase in the r^2 value with the addition of an independent variable levels off (i.e., a plateau in the curve is achieved). The r^2 versus variable count plot for survival indicates that beyond the inclusion of 5 variables in the model, r^2 values do not increase substantially. The model with five independent variables with the highest r^2 value (0.8754) includes 4,4'-DDE, lead, mercury, zinc, and TOC. It is noted that there is little difference among r^2 values for many of the five independent variable models. TOC is the only variable included in all ten of the most explanatory models (models with the highest r^2 values). The r^2 versus variable count plot for growth indicates that beyond the inclusion of 4 independent variables in the model, the r^2 values do not increase substantially. The model with four independent variables with the highest r^2 value (0.6744) includes copper, mercury, zinc, and TOC. Identical to survival, there is little difference among r^2 values for many of the four variable models. However, TOC and mercury are included in all ten of the most explanatory models (i.e., models with the highest r^2 values).

Based on the independent variables identified by examination of the variable selection routine, multiple regressions were run to determine if the models selected for analysis had a significant influence on earthworm survival and growth. NCSS printouts showing the results of the multiple regressions, included within Appendix H, show that the five independent variable model for survival was significant ($p = 0.0001$). Within the model, all five independent variables had a significant influence on earthworm survival ($p = 0.002$ for DDE and lead, 0.0235 for mercury, and 0.0001 for TOC and zinc). The four independent variable model for growth also was significant ($p = 0.006$). Within the model, TOC, mercury, and zinc had a significant influence of earthworm weight loss ($p = 0.0007$, 0.0112, and 0.0367, respectively).

In conclusion, the lack of a dose-response relationship in the data paired with the significant pair-wise and multiple regression results suggest that the bioavailability and toxicity of the ecological COCs are being influenced by TOC. However, this modifying factor, as well as other factors such as additive, synergistic, or antagonistic effects of co-located ecological COCs, prevent the establishment of a clear relationship between individual ecological COC concentrations in surface soil and earthworm responses in the toxicity tests. Therefore, the toxicity test results could not be used to establish site-specific NOAELs for terrestrial invertebrate exposures to ecological COCs in SWM 1 surface soil.

4.2.3 Earthworm Tissue

Tissue data from earthworms maintained in surface soil during toxicity testing were used to evaluate potential risks to terrestrial avian omnivores that may forage within the upland habitat at SWMU 1. As discussed in Section 3.2.2, one composite tissue sample was prepared for each surface soil sample tested for toxicity (fourteen SWMU 1 surface soil samples and three Upland Reference Area No. 2 surface soil samples [see Table 3-5]) by combining all surviving earthworms from each replicate at test termination. Surviving earthworms were depurated by transferring them to vessels containing damp filter paper for a period of 24 hours. After depuration, earthworms were transferred to sample containers, frozen, and shipped to the analytical laboratory (STL-Savannah). Each earthworm tissue sample was analyzed for antimony, cadmium, copper, lead, mercury, tin, zinc, 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, and percent lipids using the analytical methodology summarized in Table 3-6. The SWMU 1 and Upland Reference Area No. 2 earthworm tissue analytical data are presented in Tables 4-17 and 4-18, respectively. Analytical results for each sample are reported as wet-weight and dry-weight concentrations. The analytical laboratory did not report the percent solids content of the earthworm tissue samples. Therefore, the dry-weight concentrations presented in Tables 4-17 and 4-18 were estimated by dividing wet-weight concentrations by the approximate solids content of earthworms (16 percent [0.16]; USEPA, 1993).

4.2.3.1 Comparison of American Robin Dietary Intakes at SWMU 1 to NOAEL-based Screening Values

American robin dietary intakes at SWMU 1 were estimated using the following formula modified from USEPA (1993):

$$DI_x = \frac{[[\sum_i [(FIR)(FC_{xi})(PDF_i)]] + [(FIR)(SC_x)(PDS)]][AUF]}{BW}$$

where:

DI_x	=	Dietary intake for chemical x (mg chemical/kg-BW/day)
FIR	=	Mean food ingestion rate (kg/day, dry-weight)
FC_{xi}	=	95 percent UCL of the mean concentration of chemical x in food item i (mg/kg, dry weight)
PDF_i	=	Proportion of diet composed of food item i (unitless; dry weight basis)
SC_x	=	95 percent UCL of the mean concentration of chemical x in surface soil (mg/kg, dry weight)
PDS	=	Proportion of diet composed of surface soil (unitless; dry weight basis)
BW	=	Mean body weight (kg, wet weight)
AUF	=	Area Use Factor (unitless)

The American robin was used as a representative species for terrestrial avian omnivores at SWMU 1. As outlined in Section 2.6.4, exposure parameters used for the American robin included a mean food ingestion rate of 0.00383 kg/day-dry weight (Levey and Karasov, 1989) and a mean body weight of 0.0773 kg (USEPA, 1993). Although the American robin is omnivorous, the exposure diet was assumed to be 90.9 percent earthworms and 9.1 percent surface soil (no plant material). It also was assumed that the American robin spends 100 percent of its time within the upland portions of SWMU 1.

With the exception of 4,4'-DDD, tissue concentrations used in the dietary intake equation were 95 percent UCL of the mean concentrations calculated using USEPA ProUCL Version 4.0.010 software (USEPA, 2007e and 2007f; see Appendix I). Based on the low frequency of detection in earthworm tissue, a 95 percent UCL of the mean concentration could not be calculated for 4,4'-DDD (4,4'-DDD was detected in one of fourteen earthworm tissue samples). For this organochlorine pesticide, the single detected concentration (12,500 μg/kg) was used to estimate American robin dietary intakes. For a given ecological COC, when more than one 95 percent UCL of the mean concentration was calculated and recommended by USEPA ProUCL Version 4.0.010 software, the maximum value was conservatively selected for the estimation of dietary intakes. Surface soil concentrations used in the dietary intake equation also were 95 percent UCL of the mean concentrations derived for the data set summarized in Table 4-11 (data set for surface soil samples collected during the 1996 RFI, 2004 additional data collection investigation, and BERA field investigation; see Appendix G). Chemical-specific 95 percent UCL of the mean surface soil and earthworm tissue concentrations for 4,4'-DDE, 4,4'-DDT, antimony, cadmium, copper, lead, mercury, tin, zinc are summarized below. As discussed above, the maximum earthworm tissue concentration was used for 4,4'-DDD since a 95 percent UCL of the mean concentration could not be calculated for this organochlorine pesticide.

<u>95 percent UCL of the mean SWMU 1 surface soil concentrations</u>

- 1,134 μg/kg for 4,4'-DDD, 2,937 μg/kg for 4,4'-DDE, 3,981 μg/kg for 4,4'-DDT, 28.67 mg/kg for antimony, 10.24 mg/kg for cadmium, 383.1 mg/kg for copper, 632.6 mg/kg for lead, 0.553 mg/kg for mercury, 199.4 mg/kg for tin, and 1,296 mg/kg for zinc

<u>95 percent UCL of the mean SWMU 1 earthworm tissue concentrations</u>

- 12,500 μg/kg for 4,4'-DDD (maximum concentration), 12,997 μg/kg for 4,4'-DDE, 15,477 μg/kg for 4,4'-DDT, 5.491 mg/kg for antimony, 7.049 mg/kg for cadmium, 68.1 mg/kg for copper, 52.99 mg/kg for lead, 0.452 mg/kg for mercury, 403.7 mg/kg for tin, and 222.2 mg/kg for zinc

Ingestion-based risk estimates (i.e., HQ values) for the American robin were calculated by dividing dietary intakes by the literature-based NOAEL values summarized in Table 2-8. Sample et al. (1996) consider a scaling factor of 1.0 most appropriate for interspecies extrapolation between birds. Therefore, the NOAEL values summarized in Table 2-8 were not adjusted to reflect differences in body weights between avian test species and avian receptor species. As discussed in Section 2.6.4, it was conservatively assumed that all mercury at SWMU 1 is present as methyl mercury. Therefore, the 95 percent UCL of the mean HQ value was derived using the NOAEL value from the study using methyl mercury chloride as the test material (see Table 2-9).

Risk estimates for American robin dietary exposures to 4,4’-DDD, 4,4’-DDE, 4,4’-DDT, antimony, cadmium, copper, lead, mercury, tin, zinc in SWMU 1 surface soil are summarized in Table 4-19. As evidenced by the table, 4,4’-DDD, 4,4’-DDE, 4,4’-DDT, copper, lead, and tin NOAEL-based HQ values using 95 percent UCL of the mean surface soil and earthworm tissue concentrations are greater than 1.0. The HQ values indicate that these six ecological COCs are bioaccumulating in earthworm tissue at concentrations that could impact terrestrial avian omnivore populations that feed exclusively on terrestrial invertebrates within the upland areas at SWMU 1. NOAEL-based risk estimates for American robin dietary exposures to antimony, cadmium, mercury and zinc in SWMU 1 surface soil are less than 1.0 (<0.01, 0.25, 0.88, and 0.24, respectively). The HQ values indicate that these four metals are not bioaccumulating in earthworm tissue at concentrations that could impact terrestrial avian omnivore populations feeding exclusively on terrestrial invertebrates at SWMU 1.

4.2.3.2 <u>Comparison of SWMU 1 and Reference Area Risk Estimates</u>

To determine if potential risks presented by 4,4’-DDD, 4,4’-DDE, 4,4’-DDT, copper, lead, and tin to terrestrial avian omnivore populations at SWMU 1 are site-related, risk estimates also were derived for American robin dietary exposures to these three metals in Upland Reference Area No. 2 surface soil. Based on the low number of surface soil samples collected at the upland reference area during the BERA field investigation (six surface soil samples) and the low number of upland reference area earthworm tissue samples submitted for analytical testing (three earthworm tissue samples), 95 percent UCL of mean surface soil and earthworm tissue concentrations could not be calculated. Therefore, upland reference area risk estimates were derived using maximum detected surface soil and earthworm tissue concentrations contained within Tables 4-12 and 4-18, respectively. In the case of non-detected chemicals (i.e., 4,4’-DDD, 4,4’-DDD, and 4,4’-DDT), risk estimates were derived using maximum reporting limits. To allow for a direct comparison of SWMU 1 HQ values to Upland Reference Area No. 2 HQ values, maximum surface soil and earthworm tissue concentrations contained within Tables 4-14 and 4-17, respectively, also were used to derive risk estimates for American robin dietary exposures at SWMU 1. Maximum SWMU 1 and reference area surface soil and earthworm tissue concentrations for copper, lead, tin, 4,4’-DDD, 4,4’-DDE, and 4,4’-DDT are summarized below.

<u>Maximum SWMU 1 and Upland Reference Area No. 2 surface soil concentrations</u>

- SWMU 1: 2,340 mg/kg for copper, 2,600J mg/kg for lead, 1,500J mg/kg for tin, 13 mg/kg for 4,4’-DDD, 28 mg/kg for 4,4’-DDE, and 43 mg/kg for 4,4’-DDT

- Upland Reference Area No. 2: 78.3J mg/kg for copper, 6.2J mg/kg for lead, 0.47J mg/kg for tin, 0.013U mg/kg for 4,4’-DDD, 0.013U mg/kg for 4,4’-DDE, and 0.013U mg/kg for 4,4’-DDT

<u>Maximum SWMU 1 and Upland Reference Area No. 2 earthworm tissue concentrations</u>

- SWMU 1: 169 mg/kg for copper, 106 mg/kg for lead, 450J mg/kg for tin, 12.5 mg/kg for 4,4’-DDD, 48.75J mg/kg for 4,4’-DDE, and 27.5J mg/kg for 4,4’-DDT

- Upland Reference Area No. 2: 17 mg/kg for copper, 6.3 mg/kg for lead, 425J mg/kg for tin, 0.041U mg/kg for 4,4’-DDD, 0.069U mg/kg for 4,4’-DDE, and 0.106 mg/kg for 4,4’-DDT

Maximum HQ values for American robin dietary exposures at SWMU 1 and Reference Area No. 2 are summarized in Table 4-20. As evidenced by the table, maximum NOAEL-based HQ values for American robin dietary exposures to copper, lead, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT in Upland Reference Area No. 2 surface soil are less than 1.0, while maximum NOAEL-based HQ values for American robin dietary exposures to these five chemicals in SWMU 1 surface soil exceed 1.0. The HQ values summarized in Table 4-20 clearly indicate that potential risks presented by copper, lead, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT in SWMU 1 surface soil are site-related. NOAEL-based HQ values for American robin dietary exposures to tin in SWMU 1 and Upland Reference Area No. 2 surface soil exceed 1.0 (NOAEL-based HQ for SWMU 1: 3.98; NOAEL-based HQ for Upland Reference Area No. 2: 2.98). The HQ values show that potential risks from dietary exposures to tin in SWMU 1 surface soil exceed potential risks at the reference area. The difference represents that component of risk that is site-related.

4.2.4 Turtle Grass Tissue and Co-located Sediment Samples

Whole-plant and above ground turtle grass tissue samples were collected from the open water portion of SWMU 1 in order to evaluate potential risks to West Indian manatees that may forage within the Ensenada Honda. Three whole-plant and three above ground composite samples were collected from the open water portion of SWMU 1 (see Table 3-5). As discussed in Section 3.2.4, specific locations were not targeted for sampling based on analytical chemistry (analytical data for sediment samples collected during the 2003 additional data collection field investigation indicate that ecological COCs exhibit a fairly uniform concentration distribution throughout the open water portion of SWMU 1). Instead, sample locations, depicted on Figure 3-8, were selected based on the presence of turtle grass. Three whole-plant and three above ground turtle grass tissue samples also were collected from Reference Area No. 2 (see Table 3-7 and Figure 3-9). The SWMU 1 and Reference Area No. 2 turtle grass tissue samples were analyzed for arsenic, cadmium, copper, mercury, selenium, zinc, and percent moisture using the methodology summarized in Table 3-6. Arsenic, cadmium, copper, mercury, selenium, and zinc represent the ecological COCs identified in Step 2 of the ERA process for West Indian manatee food web exposures.

In addition to the turtle grass tissue samples, a single sediment sample was collected at each SWMU 1 and reference area turtle grass tissue sampling location (see Table 3-5). The co-located sediment samples were analyzed for arsenic, cadmium, copper, mercury, selenium, zinc, TOC, and grain size using the methodology summarized in Table 3-6. Sediment samples collected at the open water reference area also were analyzed for pH. As outlined in the Final Steps 3b and 4 Report (Baker, 2007) and Section 3.2.3, analytical data for the SWMU 1 open water sediment samples were evaluated to determine if the turtle grass tissue samples were collected from areas representative of the range of sediment concentrations observed within the Ensenada Honda during the 2003 additional data collection field investigation (open water sediment data used in the SERA and Step 3a of the BERA [Baker, 2006a]). If ecological COC concentrations in co-located sediment samples are representative of previously reported concentrations, it can be concluded that concentrations in turtle grass tissue samples collected during the BERA field investigation are representative of ecological COC concentrations in turtle grass tissue throughout the open water portion of SWMU 1. Such a conclusion assumes that the only factor affecting arsenic, cadmium, copper, mercury, selenium, and zinc bioaccumulation in turtle grass tissue is their concentration in sediment.

4.2.4.1 Turtle Grass Tissue and Co-Located Sediment Sample Analytical Results

The SWMU 1 and Open Water Reference Area No. 2 whole-plant and above ground turtle grass tissue analytical results are presented in Tables 4-21 (SWMU 1) and 4-22 (Reference Area No. 2). Although analytical data were reported on a wet-weight basis by the laboratory, the tables include both wet-weight and dry-weight concentrations. For a given sample and analyte, the dry-weight concentration was derived by dividing the wet-weight concentration by the solids content of that sample (i.e., fraction of sample that is solids). Dry-weight concentrations were calculated since the estimation of West Indian manatee dietary intakes (presented in Section 4.2.4.2) uses exposure parameters expressed on a dry-weight basis.

As evidenced by the dry-weight analytical data presented in Table 4-21, selenium was not detected in any of the SWMU 1 turtle grass tissue samples (whole-plant or above ground samples). Cadmium was detected in a one whole plant tissue sample (0.15J mg/kg in 1B-SG02-WP) and one above ground tissue sample (00.19J mg/kg in 1B-SG03-AG). Mercury was detected in two whole plant tissue samples (0.0507J mg/kg in 1B-SG01-WP and 0.0508J mg/kg in 1B-SG02-WP) and one above ground tissue sample (0.0833J mg/kg in 1B-SG02-AG). Arsenic, copper, and zinc were detected in each SWMU 1 tissue sample. Arsenic concentrations in whole-plant tissue samples ranged from 3.4J mg/kg (1B-SG03-WP) to 3.8 mg/kg (1B-SG02-WP), while concentrations in above ground tissue samples ranged from 2.2J mg/kg (1B-SG01-AG) to 3.3J mg/kg (1B-SG03-AG). Copper concentrations in whole-plant tissue samples ranged from 4.5 mg/kg (1B-SG03-WP) to 7.4 mg/kg (1B-SG02-WP), while concentrations in above ground tissue samples ranged from 4.9 mg/kg (1B-SG01-AG) to 6.5 mg/kg (1B-SG03-AG). Finally, zinc concentrations in whole-plant tissue samples ranged from 22.1J mg/kg (1B-SG01-WP) to 33.6J mg/kg (1B-SG03-WP), while concentrations in above ground tissue samples ranged from 36.7 mg/kg (1B-SG02-AG) to 50.0 mg/kg (1B-SG01-AG). The arsenic, cadmium, copper, mercury, selenium, and zinc analytical data do not indicate that these six metals are preferentially accumulating in above ground (i.e., leaf blades) or below ground (i.e., roots and rhizomes) portions of turtle grass tissue.

Identical to the SWMU 1 tissue samples, selenium was not detected in any of the Open Water Reference Area No. 2 whole-plant or above ground tissue samples (see Table 4-22). Mercury also was not detected in any of the above ground or whole-plant tissue samples collected from the open water reference area. Arsenic was detected in each above ground and whole-plant tissue sample. Concentrations in above-ground tissue samples ranged from 1.3J mg/kg (REF2-VEG-AB02) to 2.1J mg/kg (REF-2-VEG-AB03), while whole-plant tissue concentrations ranged from 2.2J mg/kg (REF2-VEG-WB03) to 3.5J mg/kg (REF2-VEG-WB02). Cadmium and copper were detected in each above ground tissue sample and two of three whole-plant tissue samples. Cadmium concentrations in above ground tissue ranged from 0.17J mg/kg (REF2-VEG-AB02) to 0.27J mg/kg (REF2-VEG-AB01), while copper concentrations in above-ground tissue ranged from 3.8 mg/kg (REF2-VEG-AB02) to 4.6 mg/kg (REF2-VEG-AB01). Detected cadmium and copper concentrations in whole-plant tissue concentrations showed little variability (cadmium was detected in REF2-VEG-WB01 at 0.22J mg/kg and REF2-VEG-WB03 at 0.19J mg/kg, while copper was detected in REF2-VEG-WB01 at 3.8 mg/kg and REF2-VEG-WB03 at 3.0 mg/kg. Zinc was detected in two above ground tissue concentrations (30.0 mg/kg in REF2-VEG-AB01 and 26.9 mg/kg in REF2-VEG-AB03). This metal was not detected in any of whole-plant tissue samples. The reference area turtle grass tissue analytical data do not indicate that arsenic, cadmium, copper, mercury, selenium, or zinc are preferentially accumulating in above ground or below ground portions. These results are consistent with the above ground and whole-plant tissue analytical data for SWMU 1.

Analytical results for the co-located SWMU 1 and open water reference area sediment samples are presented in Tables 4-23 and 4-24, respectively. As discussed in Section 4.2.4, the co-located SWMU 1 sediment samples were collected to determine if turtle grass tissue was collected from areas representative of the range of sediment concentrations observed within the embayment during the 2003 additional data collection field investigation). The range of arsenic, cadmium, copper, mercury, selenium, and zinc concentrations detected in sediment samples collected during the BERA field investigation and in sediment samples collected during previous field investigations are summarized within the table that follows.

Chemical	Detected Concentration Range: BERA Field Investigation (mg/kg)	Detected Concentration Range: 2003 Additional Data Collection Field Investigation (mg/kg)
Arsenic	4.7J - 7.9J	5.3 - 8.7
Cadmium	0.085J - 0.13J	0.1J - 0.15J
Copper	12J - 30J	12 - 26
Mercury	0.02J - 0.037	0.023J - 0.066
Selenium	0.59J - 1.1J	0.53J - 1.2J
Zinc	9.8J - 40J	13 - 32

As evidenced by the table, arsenic, cadmium, copper, mercury, selenium, and zinc concentrations in sediment samples collected during the 2003 additional data collection field investigation are comparable to concentrations detected in sediment samples collected during the BERA field investigation. Therefore, it can be concluded that concentrations in the turtle grass tissue samples are representative of turtle grass tissue concentrations throughout the open water portion of SWMU 1.

4.2.4.2 Comparison of West Indian Manatee Dietary Intakes at SWMU 1 to NOAEL-Based Screening Values

West Indian manatee dietary intakes at SWMU 1 were estimated using the following formula modified from USEPA (1993):

$$DI_x = \frac{[[\sum_i[(FIR)(FC_{xi})(PDF_i)]] + [(FIR)(SC_x)(PDS)]][AUF]}{BW}$$

where:

DI_x	=	Dietary intake for chemical x (mg chemical/kg-BW/day)
FIR	=	Maximum food ingestion rate (kilograms per day [kg/day], dry-weight)
FC_{xi}	=	Maximum concentration of chemical x in food item i (mg/kg, dry weight basis)
PDF_i	=	Proportion of diet composed of food item i (unitless; dry weight basis)
SC_x	=	Maximum concentration of chemical x in sediment (mg/kg, dry weight)
PDS	=	Proportion of diet composed of sediment (unitless; dry weight basis)
BW	=	Minimum body weight (kg, wet weight)
AUF	=	Area Use Factor (unitless)

As outlined in Section 2.5.4, exposure parameters used for the West Indian manatee included a maximum food ingestion rate of 21.9 kg/day-dry weight (Ethridge et al., 1985) and a minimum body weight of 800 kg (USGS, 2000). These values were developed in the SERA (Baker, 2006a) and presented in the Final Steps 3b and 4 Report (Baker, 2007). The exposure diet was assumed to be 99 percent plant material (USFWS, 1986a and Odell, 1992) and 1 percent sediment (from incidental ingestion; USGS, 2000). Ingestion of surface water is not a potential complete exposure pathway and was not considered in risk calculations for dietary exposures (see Section 2.6.4). Finally, it was assumed that the West Indian manatee spends 100 percent of its time within the open water portion of SWMU 1 (i.e., AUF of 1.0).

The analytical data for the whole-plant and above ground tissue samples (see Tables 4-21) indicate that turtle grass at SWMU 1 does not preferentially accumulate arsenic, cadmium, copper, mercury, selenium, or zinc in above ground portions (i.e., leaf blades) or below ground portions (i.e., roots and rhizomes). As a measure of conservatism, dietary intakes were derived using the maximum detected concentration or, in the case of selenium (not detected in turtle grass tissue samples), the maximum reporting limit for the above ground and whole-plant tissue samples. Maximum detected concentrations for co-located sediment collected during the BERA field investigation also were used in the dietary intake equation to account for incidental ingestion of sediment. The maximum turtle grass and sediment concentrations used to estimate dietary intakes are summarized below.

- Maximum Turtle Grass Tissue Concentrations: 3.8 mg/kg for arsenic, 0.19J mg/kg for cadmium, 7.4 mg/kg for copper, 0.0833J for mercury, 0.86U mg/kg for selenium, and 50.0 mg/kg for zinc (see Table 4-21)

- Maximum Sediment Concentrations: 7.9J mg/kg for arsenic, 0.13J mg/kg for cadmium, 30J mg/kg for copper, 0.037J mg/kg for mercury, 1.1J mg/kg for selenium, and 40J mg/kg for zinc (see Table 4-23)

Ingestion-based HQs for the West Indian manatee were calculated by dividing maximum dietary intakes by literature-based NOAEL values adjusted to reflect differences in body weights between mammalian test species and the West Indian manatee. Test species NOAEL values, as well as adjusted values used in the derivation of maximum arsenic, cadmium, copper, mercury, selenium, and zinc HQ values are summarized in Table 2-9. As discussed in Section 2.5.4, it was conservatively assumed that all mercury at SWMU 1 is present as methyl mercury. Therefore, mercury HQ values were derived using the NOAEL value from the study using methyl mercury chloride as the test material (see Table 2-9). Based on the endangered species status of the West Indian manatee, NOAEL values are most appropriate for this receptor.

Maximum NOAEL-based HQ values for West Indian manatee dietary exposures at SWMU 1 are summarized in Table 4-25. As evidenced by the table, arsenic, cadmium, copper, mercury, selenium, and zinc HQ values using maximum SWMU 1 turtle grass and sediment concentrations are less than 1.0 (HQ = 0.30 for arsenic, 0.21 for cadmium, 0.06 for copper, 0.81 for mercury, 0.43 for selenium, and 0.25 for zinc). The HQ values indicate that these six metals are not bioaccumulating in turtle grass at concentrations that would impact West Indian manatees that feed exclusively on turtle grass within the open water portion of SWMU 1. Because the evaluation did not detect any unacceptable risks to West Indian manatees feeding exclusively at SWMU 1, risk estimates for West Indian manatees feeding exclusively at the open water reference area were not derived.

5.0 RISK CHARACTERIZATION

The potential for risk to terrestrial invertebrates from direct contact exposures to 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, antimony, cadmium, copper, lead, mercury, tin, and zinc in surface soil, American robin dietary exposures to 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT, antimony, cadmium, copper, lead, mercury, tin, zinc in surface soil, and West Indian manatee dietary exposures to arsenic, cadmium, copper, mercury, selenium, and zinc in Ensenada Honda sediment is characterized in the sections that follow.

The general risk questions focusing the BERA for SWMU 1 are listed below.

1. Are 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, antimony, cadmium, copper, lead, mercury, tin, and zinc concentrations in SWMU 1 surface soil high enough to impair the survival, growth, or reproduction of terrestrial invertebrate communities to the extent that the prey base supporting terrestrial predators is adversely affected?

2. Are 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, cadmium, lead, mercury, and zinc concentrations in SWMU 1 surface soil high enough to adversely effect the survival, growth, or reproduction of terrestrial avian omnivore populations?

3. Are arsenic, cadmium, copper, mercury, selenium, and zinc concentrations in Ensenada Honda sediment high enough to adversely effect the survival, growth, or reproduction of West Indian manatees?

The lines of evidence considered in the evaluation of these questions are:

1. Comparison of 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, antimony, cadmium, copper, lead, mercury, tin, and zinc concentrations in surface soil to invertebrate-based toxicological thresholds (terrestrial invertebrates).

2. Comparison of SWMU 1 and reference area toxicity test results from 28-day *Eisenia fetida* survival, growth, and reproduction tests (terrestrial invertebrates).

3. Evidence of a significant correlation between laboratory toxicity test results and the chemical/physical characteristics of surface soil for those test endpoints in which an overall significant result was measured (terrestrial invertebrates).

4. Comparison of estimated dietary intakes using tissue data from earthworms maintained in SWMU 1 and reference area surface soil during toxicity testing to NOAEL-, MATC-, and LOAEL-based screening values (American robin)

5. Comparison of estimated dietary intakes using SWMU 1 and reference area turtle grass tissue data to NOAEL-based ingestion screening values (West Indian manatee)

Applicable lines of evidence are discussed in the sections that follow for each receptor group/species selected to represent the assessment endpoints.

5.1 Terrestrial Invertebrates

The lines of evidence considered in the evaluation of terrestrial invertebrates were (1) comparison of 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, antimony, cadmium, copper, lead, mercury, tin, and zinc concentrations in SWMU 1 surface soil to invertebrate-based toxicological thresholds, (2) comparison of *Eisenia fetida* survival, growth, and reproduction data in SWMU 1 surface soil to *Eisenia fetida* survival growth, and reproduction in reference area surface soil, and (3) evidence of a correlation between *Eisenia fetida* toxicity test results and the chemical/physical characteristics of SWMU 1 surface soil for those endpoints in which an overall significant result was measured.

5.1.1 Comparison of Ecological COC Concentrations in Surface Soil to Invertebrate-Based Toxicological Thresholds

The comparison of 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, antimony, cadmium, copper, lead, mercury, tin, and zinc concentrations in SWMU 1 surface soil to invertebrate-based toxicological thresholds used a data set consisting of analytical results for surface soil samples collected during the 1996 RFI, 2003 additional data collection investigation, and BERA field investigation. For each ecological COC, risk estimates (i.e., HQ values) were derived by dividing maximum, 95 percent UCL of the mean, and arithmetic mean concentrations by the invertebrate-based toxicological thresholds listed in Table 4-14.

The comparison of maximum, 95 percent UCL of the mean, and arithmetic mean concentrations to invertebrate-based screening values support a conclusion of minimal risks to terrestrial invertebrate from exposures to antimony, cadmium, and lead in SWMU 1 surface soil. Cadmium was not detected in any surface soil sample at a concentration greater than the soil screening value (HQ value based on the maximum concentration is 0.59). In the case of antimony and lead, HQ values based on 95 percent UCL of the mean concentrations are less than 1.0 (0.37 for both metals). In addition, the frequency and magnitude of antimony and lead detections above soil screening values is low. Antimony was detected in only three of eighty-five (3/85) surface soil samples and lead was detected in only two of eighty-two (2/82) surface soil samples at concentrations greater than soil screening values. HQ values based on maximum concentrations are 2.82 for antimony and 1.53 for lead. The absence of cadmium detections above the soil screening value, 95 percent UCL of the mean antimony and lead concentrations less than soil screening values, and the low frequency and magnitude of antimony and lead detections above soil screening values are lines of evidence supporting a conclusion of minimal risks to terrestrial invertebrate communities from exposures to these three metals in SWMU 1 surface soil.

The evaluation performed on the 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, copper, mercury, tin and zinc analytical data support a conclusion of unacceptable risks to terrestrial invertebrate communities. HQ values for each chemical, derived using 95 percent UCL of the mean concentrations, exceed 1.0 (HQ of 1.27 for 4,4'-DDD, 3.29 for 4,4'-DDE, 4.45 for 4,4'-DDT, 4.79 for copper, 5.53 for mercury, 3.99 for tin, and 10.80 for zinc). In addition, the frequency of 4,4'-DDE, copper, mercury, tin and zinc detections above soil screening values is high, ranging from fourteen of sixty-nine (14/69) surface soil samples for tin to forty-two of eighty-five (42/85) surface soil samples for zinc.

5.1.2 Comparison of SWMU 1 and Reference Area Surface Soil Toxicity Test Results

Direct toxicity to terrestrial invertebrates was evaluated using 28-day *Eisenia fetida* survival, growth, and reproduction tests. The statistical evaluations performed by the testing laboratory (discussed in Section 4.2.2.1) indicated that survival in SWMU 1 surface soil sample 1B-SS18 was significantly lower relative to survival in Reference Area No. 2 surface soil samples 1B-REF-SS03 and 1B-REF-SS06, while weight loss in 1B-SS09, 1B-SS18, 1B-SS29, and 1B-SS39 was significantly greater than weight loss in Reference Area No. 2 surface soil sample 1B-REF-SS03. Statistical evaluations performed on the reproduction data (number of juveniles and cocoons per surviving earthworm in each replicate at test termination) indicated that reproduction in SWMU 1 surface soil was not significantly lower relative to reproduction in the reference area surface soil samples. However, it is acknowledged that earthworm reproduction occurred in only three of fourteen SWMU 1 surface soil samples (1B-SS15, 1B-SS33, and 1B-SS37), while reproduction was observed in the negative control and each reference area surface soil sample. This observation could indicate an adverse effect of one or more of the ecological COCs on earthworm reproduction.

As evidenced by the analytical and toxicity test data presented in Table 4-15, a clear dose-response relationship between ecological COC concentrations and earthworm survival and weight loss was not established by the toxicity tests. For example, survival in SWMU 1 surface soil sample 1B-SS18 (76.25 percent) was significantly lower than survival in Reference Area No. 2 surface soil samples 1B-REF-SS03 and 1B-REF-SS06 (100 percent and 97.5 percent, respectively). Earthworm weight loss in 1B-SS18 also was significantly higher relative to earthworm weight loss in 1B-REF-SS03. Four ecological COCs were detected in the 1B-SS18 surface soil sample at concentrations greater than soil screening values (4,4'-DDE: 2,200 µg/kg; copper: 212 mg/kg; mercury: 0.19 mg/kg; zinc: 3,090 mg/kg). However, survival was not significantly lower and weight loss was not significantly higher in SWMU 1 surface soil samples 1B-SS13, 1B-SS15, 1B-SS19, 1B-SS46, 1B-SS48, 1B-SS49, and 1B-SS50 relative to the reference area surface soil samples even though these samples contained higher ecological COC concentrations. Because a clear dose-response relationship could not be established for any of the ecological COCs, it was concluded that physical and/or chemical parameters other than ecological COC concentrations were responsible for or influencing the observed biological responses.

5.1.3 Evidence of a Significant Correlation between Laboratory Toxicity Test Results and the Chemical/Physical Characteristics of Surface Soil

Pair-wise linear regressions were run to statistically examine the relationship between earthworm survival and earthworm weight loss and the chemical/physical characteristics of surface soil submitted for toxicity testing (fourteen SWMU 1 and three reference area surface soil samples). The following sediment variables were included in the analysis: 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, antimony, cadmium, copper, lead, mercury, tin, zinc, TOC (results reported by the analytical laboratory), test soil pH (measurements performed by the toxicity testing laboratory at test initiation and test termination), and grain size (percent gravel, sand, and fines [silt and clay]). As outlined in Section 4.2.2.2, the pair-wise linear regressions indicated that none of the ecological COC had a significant influence on earthworm survival and growth.

As evidenced by Appendix H and Table 4-16, the linear regression analysis indicated that none of the ecological COCs had a significant influence on earthworm survival and weight loss per surviving earthworm. The following sediment variables also had no influence on earthworm survival and weight loss: percent gravel, percent sand, and percent fines. However, pH at test initiation, pH at test termination, and TOC had a significant influence on earthworm survival, while pH at test termination and TOC had a significant influence of earthworm weight loss. The regression reports for these variables showed the following relationships;

- Earthworm survival decreased as soil pH increased (pH at test initiation and test termination)

- Earthworm survival increased as soil TOC concentrations increased

- Earthworm weight loss increased as soil pH increased

- Earthworm weight loss decreased as soil TOC increased

To further evaluate the relationship between TOC, pH, and ecological COC concentrations in surface soil and earthworm responses in the toxicity tests (survival and weight loss), a multiple regression analysis was performed using NCSS software. Prior to the analysis, the All Possible Regression variable selection routine was run to identify appropriate models to include within the multiple regression analyses. A five variable model was selected for the survival endpoint (TOC, 4,4'-DDE, lead, mercury, and zinc), while a four variable model was selected for the growth endpoint (TOC, copper, mercury, and zinc). Multiple regression analysis indicated that both models are significant. Independent variables within each model also were found to have a significant influence on survival (TOC, 4,4'-DDE, lead, and zinc) and weight loss (TOC, mercury, and zinc). The lack of a dose response in the toxicity test data paired with the significant pair-wise and multiple regression results suggest that the bioavailability and toxicity of the ecological COCs are being influenced by TOC. However, this modifying factor, as well as other factors such as additive, synergistic, or antagonistic effects of co-located ecological COCs, prevent the establishment of a clear relationship between individual ecological COC concentrations in surface soil and earthworm responses in the toxicity tests.

5.2 Terrestrial Avian Omnivores

A single line of evidence was used to evaluate potential risks to terrestrial avian omnivores from dietary exposures to 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, antimony, cadmium, copper, lead, mercury, and zinc in SWMU 1 surface soil. The American robin was used as a representative species for terrestrial avian omnivores at SWMU 1. Dietary intakes were estimated using 95 percent UCL of the mean surface soil and earthworm tissue concentrations. As discussed in Section 4.2.3, a 95 percent UCL of the mean earthworm tissue concentration could not be calculated for 4,4'-DDD (insufficient number of detections); therefore, the maximum tissue concentration was used to estimate the dietary intake for this organochlorine pesticide). The evaluation showed that dietary intakes for 4'4-DDD, 4,4'-DDE, 4,4'-DDD, copper, lead, and tin exceed NOAEL-based screening values (HQ = 11.37 for 4,4'-DDD, 11.98 for 4,4'-DDE, 14.32 for 4,4'-DDT, 1.19 for copper, 3.22 for lead, and 2.81 for tin), while dietary intakes for antimony, cadmium, mercury, and zinc are less than NOAEL-based screening values (HQ = <0.01 for antimony, 0.25 for cadmium, 0.88 for mercury, and 0.24 for zinc). HQ values based on 95 percent UCL of the mean concentrations indicate that 4'4-DDD, 4,4'-DDE, 4,4'-DDD, copper, lead, and tin are bioaccumulating in earthworm tissue at concentrations that could impact terrestrial avian omnivore populations feeding exclusively on terrestrial invertebrates at SWMU 1.

To determine if potential risks presented by 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, copper, lead, and tin are site-related, risk estimates for these three metals were derived for American robin dietary exposures at Upland Reference Area No. 2 and compared to risk estimates for American robin dietary exposures at SWMU 1. Risk estimates for each location (reference area and SWMU 1) were derived using maximum surface soil and earthworm tissue concentrations. Maximum surface soil and earthworm tissue concentrations were used since 95 percent UCL of the mean concentrations could not be calculated for the reference area (insufficient number of samples; see Section 4.2.3.2). The HQ values derived for each area show that potential risks presented by 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, copper, and lead in SWMU 1 surface soil also are site-related. Although HQ values for American robin dietary exposures to tin in surface soil exceed 1.0 at both areas, the site-related risk (NOAEL-based HQ of 3.98) exceeds the background risk (NOAEL-based HQ of 2.98).

5.3 West Indian Manatee

Identical to the evaluation of terrestrial avian omnivores, a single line of evidence was used to evaluate potential risks to West Indian manatees that may forage within the open water portion of SWMU 1: comparison of estimated arsenic, cadmium, copper, mercury, selenium, and zinc dietary intakes using turtle grass tissue analytical data to NOAEL-based screening values. The evaluation, which used maximum arsenic, cadmium, mercury, and selenium concentrations in SWMU 1 turtle grass tissue and sediment, showed that dietary intakes for each ecological COPC are less than NOAEL-based screening values (i.e., HQ = 0.30 for arsenic, 0.21 for cadmium, 0.06 for copper, 0.8 for mercury, 0.43 for selenium, and 0.25 for zinc. The HQ values indicate that these six metals are not bioaccumulating in turtle grass at concentrations that would impact West Indian manatees that feed exclusively within the open water portion of SWMU 1.

6.0 CONCLUSIONS AND RECOMMENDATIONS

Conclusions from the evaluation of the analytical and toxicity test data, as well as recommendations for the SWMU are presented below. The decision rules and criteria that were used to outline potential recommendations and actions associated with the lines of evidence discussed in Section 5.0 are presented in Table 2-10.

6.1 Conclusions

The comparison of 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, antimony, cadmium, copper, lead, mercury, tin, and zinc concentrations in SWMU 1 surface soil to soil screening values indicated that antimony, cadmium, and lead present minimal risks to terrestrial invertebrate communities. HQ values based on 95 percent UCL of the mean concentrations are less than 1.0 (0.07 for cadmium and 0.37 for antimony and lead). However, HQ values for 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, copper, mercury, tin and zinc indicate that these seven chemicals may be impacting terrestrial invertebrate communities at SWMU 1 (HQ values based on 95 percent UCL of the mean concentrations are 1.27, 3.29, 4.45, 4.79, 5.53, 3.99, and 10.08, respectively).

Surface soil toxicity tests were run using *Eisenia fetida* to further refine potential risks suggested by the comparison of ecological COC concentrations to soil screening values. Toxicity tests can account for effects of multiple chemicals (i.e., additive, synergistic, and antagonistic effects). As well as site-specific factors that may influence the bioavailability of metals and pesticides (e.g., pH, TOC, and clay content). The statistical evaluations performed by the testing laboratory indicated that earthworm reproduction (juvenile and cocoon production per surviving earthworm) in SWMU 1 surface soil was not significantly lower than reproduction in each reference area surface soil. However, it is acknowledged that earthworm reproduction occurred in only three of fourteen SWMU 1 surface soil samples (1B-SS15, 1B-SS33, and 1B-SS37), while reproduction was observed in the negative control and each reference area surface soil sample. This observation could indicate an adverse effect of one or more of the ecological COCs on earthworm reproduction. A significant response was detected by the statistical tests evaluating earthworm survival and growth. Survival in SWMU 1 surface soil sample 1B-SS18 was significantly lower than survival in Reference Area No. 2 surface soil samples 1B-REF-SS03 and 1B-REF-SS06, while earthworm weight loss in 1B-SS09, 1B-SS18, 1B-SS29, and 1B-SS39 was significantly greater than weight loss in Reference Area No. 2 surface soil sample 1B-REF-SS03.
Because a clear dose-response relationship could not be established for any of the ecological COCs, it was concluded that physical and/or chemical parameters other than ecological COC concentrations may be responsible for or influencing the observed biological responses.

Pair-wise linear regressions and multiple regressions were run to further examine the relationship between earthworm survival and weight loss and the chemical/physical characteristics of SWMU 1 surface soil. The pair-wise linear regressions indicated that none of the ecological COCs had a significant influence on earthworm survival and weight loss. However, pH at test initiation, pH at test termination, and TOC had a significant influence on earthworm survival, while pH at test termination and TOC had a significant influence of earthworm weight loss. Multiple regressions also indicate that TOC is influencing the bioavailability and toxicity of the ecological COCs. The lack of a dose response in the toxicity test data paired with the significant pair-wise and multiple regression results suggest that the bioavailability and toxicity of the ecological COCs are being influenced by TOC. However, this modifying factor, as well as other factors such as additive, synergistic, or antagonistic effects of co-located ecological COCs, prevent the establishment of a clear relationship between individual ecological COC concentrations in surface soil and earthworm responses in the toxicity tests.

American robin dietary intakes for antimony, cadmium, and mercury, and zinc, derived using 95 percent UCL of the mean earthworm tissue and surface soil concentrations, are less than NOAEL-based screening values (HQ = <0.01 for antimony, 0.25 for cadmium, 0.88 for mercury, and 0.24 for zinc). However, dietary intakes for 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, copper, lead, and tin exceed NOAEL-based screening values (HQ = 11.37 for 4,4'-DDD, 11.98 for 4,4'-DDE, 14.32 for 4,4'-DDT, 1.19 for copper, 3.22 for lead, and 2.81 for tin), indicating that these six chemicals are bioaccumulating in earthworm tissue at concentrations that could impact terrestrial avian omnivore populations feeding exclusively on terrestrial invertebrates at SWMU 1. To determine if potential risks presented by 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, copper, lead, and tin are site-related, risk estimates for these six chemicals were derived for American robin dietary exposures at Upland Reference Area No. 2 and compared to risk estimates for American robin dietary exposures at SWMU 1. The HQ values derived for each area show that potential risks presented by 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, copper, and lead in SWMU 1 surface soil are site-related. Although HQ values for American robin dietary exposures to tin in surface soil exceed 1.0 at both areas, the site-related risk (NOAEL-based HQ of 3.98) exceeds the background risk (NOAEL-based HQ of 2.98).

West Indian manatee dietary intakes for arsenic, cadmium, copper, mercury, selenium, and zinc at SWMU 1, derived using maximum measured turtle grass tissue and sediment concentrations, are less than NOAEL-based screening values (HQ = 0.30 for arsenic, 0.21 for cadmium, 0.06 for copper, 0.81 for mercury, 0.43 for selenium, and 0.25 for zinc). The HQ values indicate that these six metals are not bioaccumulating in turtle grass at concentrations that would impact West Indian manatees feeding exclusively within the open water portion of SWMU 1.

6.2 Recommendations

The lines of evidence for terrestrial invertebrates and terrestrial avian omnivores, when evaluated using a weight-of-evidence approach and taking into consideration the uncertainty associated with them (see Section 7.0), support additional evaluation. Initially, it is recommended that an Interim Corrective Measure (ICM) be performed (i.e., soil removal) to eliminate potential risks to terrestrial invertebrates and terrestrial avian omnivores from exposures to 4'4,-DDD, 4,4'-DDE, 4,4'-DDT, antimony, copper, lead, and/or tin in surface soil. The ICM will focus on these seven chemicals based on their co-location with one another and/or their limited spatial extent above soil screening values. Specifics of the soil removal action, including locations and volumes, will be detailed within the ICM's Basis of Design Report. Following the ICM, it is recommended that SWMU 1 proceed to a CMS to further address the low-level, wide-spread spatial coverage of mercury and zinc concentrations above soil screening values. As part of the CMS, CAOs for these two metals will be developed. Although cadmium was identified as an ecological COC in Step 3b of the ERA process at SWMU 1, additional evaluation of cadmium is not recommended since this metal has never been detected above the invertebrate-based screening value established in Section 2.5.4. Based on the evaluation of West Indian manatee dietary exposures using measured ecological COC concentrations in turtle grass tissue and sediment, a recommendation of corrective action complete without controls is made for sediments within the Ensenada Honda.

7.0 UNCERTAINTIES

Uncertainties are present in all risk assessments because of the limitations of the available data and the need to make certain assumptions and extrapolations based on incomplete information. The BERA was designed to reduce the uncertainties identified from previous investigations, to address suspected confounding influences, and to provide a more realistic evaluation of potential risks in the aquatic habitat at SWMU 1. Uncertainties that have been identified for the BERA are presented and discussed below to aid in risk management decisions about the site.

<u>Analytical Data</u>

- Analytical data for several chemicals were qualified as estimated, "J" because the results fall between the MDL and method reporting limit (MRL). Although concentrations that fall between the MDL and MRL are considered usable, they are estimated values with greater uncertainty. Analytical data for several chemicals also were qualified as estimated, "J", estimated, "UJ", and estimated, "NJ" due to a number of issues identified during data validation activities (see Section 3.4). Identical to the "J" flagged analytical data, these data are usable with the understanding that the associated values are estimated.

- Surface soil samples submitted for toxicity testing were analyzed for particle size (i.e., grain size) by the analytical laboratory using a modified version of ASTM Method D-422 (sieve only). Because sedimentation using a hydrometer was not performed as part of the test method, particles with diameters less than 75 µm were classified as "fines" (percent silt and percent clay were not measured). Clay is a soil characteristic that has been shown to influence the bioavailability of metals to microorganisms, plants, and invertebrates (bioavailability decreases with increasing clay content). Because the modified analytical method cannot classify particles with diameters less than 75 µm, pair-wise linear regressions examining the relationship between earthworm survival and weight loss and the clay content of soil could not be performed.

- A third uncertainty related to the analytical data applies to the quick-turn analytical results used to select surface soil samples for toxicity testing. The SWMU 1 surface soil samples submitted for toxicity testing were selected from a pool of fifty-five samples submitted to the analytical laboratory for quick-turn analytical testing results. Because the selection of surface soil samples for toxicity testing used unvalidated analytical results, QA/QC issues associated with the analytical data were not taken into consideration. As discussed in Section 4.2.2, tin analytical results for quick-turn surface soil samples 1B-SS33 through 1B-SS44 were rejected during data validation activities. Three of these surface soil samples were selected for toxicity testing (1B-SS33, 1B-SS37, and 1B-SS39). Because 1B-SS33, 1B-SS37, and 1B-SS39 were selected for toxicity testing based on quick-turn analytical results for other metals that were not rejected during data validation activities (antimony, copper, lead, and zinc) and an adequate tin concentration gradient was established by other surface soil samples, the rejection of the tin analytical results had no impact on the design of the investigation.

  A second QA/QC issue associated with the quick-turn analytical results involves 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT. An analytical sequence (1B-SS13 through 1B-SS30) was re-analyzed for these three pesticides because calibration verification standards were outside control limits. Five surface soil samples within this analytical sequence were selected for toxicity testing, in part, on the basis of the quick-turn results for 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT. A review of the unvalidated and validated analytical results indicates that reported concentrations changed significantly. For example, the initial 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT analytical results reported by the analytical laboratory for surface sample 1B-SS18 were 3,500 μg/kg, 300 μg/kg, and 330 μg/kg, respectively. However, following re-analyses and validation, reported 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT concentrations were 120 μg/kg, 2,200 μg/kg, and 330 μg/kg, respectively. Although the quick-turn analytical results for the affected analytical sequence were not accurate, adequate 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT concentration gradients were established by the samples selected for testing (i.e., concentrations ranging from less than soil screening values to maximum concentrations were tested).

Lines of Evidence

- The comparison of SWMU 1 ecological COC concentrations to literature-based toxicological thresholds was selected as a line of evidence for terrestrial invertebrates. Invertebrate-based toxicological thresholds were preferentially selected as toxicological thresholds. However, invertebrate-based toxicological thresholds are not available from the literature for tin, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT. A plant-based toxicological threshold reported by Efroymson et al. (1997a) was selected as the toxicological threshold for tin, while soil standards developed by MHSPE (2000) were selected as toxicological thresholds for 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT. The MHSPE (2000) soil standards represent an integration of human and ecotoxicological effects and, therefore, may not correspond to invertebrate-based values. The use of a plant-based toxicological threshold for tin may have resulted in an overstatement or understatement of potential risks if plants and invertebrates exhibit different sensitivities to this metal. The use of MHSPE (2000) soil standards for 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT also may have resulted in an overstatement or understatement of potential risks if the soil standards are not invertebrate-based values.

- Maximum 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, and cadmium concentrations were detected in surface soil samples collected during previous investigations. Maximum 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT concentrations (1,900 μg/kg, 9,100 μg/kg, 15,000 μg/kg) were detected in a surface soil sample collected during the 2004 additional data collection field investigation (1SS16), while the maximum cadmium concentration (83.8 mg/kg) was detected in a surface soil sample collected during the 1996 RFI (1SS07). Both sample locations were re-sampled during the BERA field investigation (see Section 3.2.1); however, these maximum concentrations were not duplicated or exceeded (maximum 4,4'-DDD, 4,4'-DDE, 4,4'DDT and cadmium concentrations detected and tested for toxicity were 1,900 μg/kg, 9,100 μg/kg, 15,000 μg/kg, and 25 mg/kg, respectively). Because maximum concentrations were not duplicated or exceeded during the BERA field investigation, earthworms were not exposed to maximum 4,4'-DDD, 4,4'-DDE, 4,4'DDT and cadmium concentrations during toxicity testing. Furthermore, earthworm tissue concentrations used in the estimation of avian omnivore dietary exposures (95 percent UCL of the mean concentrations) do not reflect bioaccumulation under conditions of maximum exposures.

  Although the BERA field investigation did not assess maximum 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT concentrations, the evaluation presented in Section 4.2.3.1 showed that exposure to lower surface soil concentrations still resulted in bioaccumulation within earthworm tissue at concentrations that could impact terrestrial avian omnivores that feed exclusively on terrestrial invertebrates at SWMU 1. Based on this result, maximum 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT concentrations detected during the 2004 additional data collection investigation will be addressed by CAOs developed for these three organochlorine pesticides in the CMS. In the case of cadmium, the maximum concentration detected during the 1996 RFI, is less than the invertebrate-based screening value. Therefore, it is unlikely that this maximum concentration would have had any influence on the earthworm toxicity test results. However, because earthworms were not exposed to the maximum cadmium concentration during the toxicity tests, the tissue concentration used to estimate dietary exposures may have resulted in an understatement of potential risks to terrestrial avian omnivores. It is noted that BERA surface soil samples collected at and within the 20-foot by 20-foot sampling grid established around RFI sample location 1SS07 (1B-SS36 through 1B-SS40) contained elevated concentrations of copper and lead. The evaluation presented in Section 4.2.3.1 showed that that these three metals are bioaccumulating in earthworm tissue at concentrations that could impact terrestrial avian omnivores. One or more the CAOs developed in the CMS for these three metals will likely require application of corrective measures at 1SS07, indirectly addressing any potential cadmium impacts to terrestrial avian omnivore populations.

- A third uncertainty related to the lines of evidence employed in this BERA applies to the earthworm toxicity tests. As stated elsewhere in this document, a clear relationship between individual ecological COC concentrations in surface soil and earthworm responses in the toxicity tests could not be established. The lack of a dose response in the toxicity test data paired with the significant pair-wise and multiple regression results suggest that the bioavailability and toxicity of the ecological COCs are being influenced by TOC. The inability to establish site-specific NOAEL values using toxicity tests and the apparent influence TOC has on the bioavailability and toxicity of ecological COCs requires that a greater reliance be put on the comparison of ecological COC concentrations to soil screening values when making recommendations for the SWMU.

- Forth uncertainty related to the lines of evidence employed in this BERA also applies to the earthworm toxicity tests. The statistical evaluations performed by the testing laboratory indicated that earthworm reproduction (juvenile and cocoon production per surviving earthworm) in SWMU 1 surface soil was not significantly lower than reproduction in each reference area surface soil. However, earthworm reproduction occurred in only three of fourteen SWMU 1 surface soil samples (1B-SS15, 1B-SS33, and 1B-SS37), while reproduction was observed in the negative control and each reference area surface soil sample. This observation could indicate an adverse effect of one or more of the ecological COCs on earthworm reproduction. However, mean reproduction by earthworms in each reference area surface soil sample was extremely low, ranging from 0.038 to 0.065 juveniles/cocoons per surviving earthworm. Furthermore, for a given reference area surface soil sample, the number of replicates with evidence of reproduction also was low (ranging from 20 percent to 40 percent). Given these facts, it is not surprising that the statistical evaluations performed by the toxicity testing laboratory did not detect a significant decrease in reproduction in SWMU 1 surface soil relative to reproduction in reference area surface soil.

Ecological Receptors

- The American robin was used as a surrogate receptor for the yellow-shouldered blackbird. The American robin was modeled as a ground-feeding receptor. However, as discussed in Section 2.5.4, the yellow-shouldered black bird is an arboreal feeder that forages within the canopy and sub-canopy of trees (USFWS, 1996a). It is assmed that the American robin can be protectively used as a surrogate receptor for the yellow-shouldered blackbird. However, the diet of the yellow-shouldered blackbird likely includes carnivorous arthropods (i.e., spiders) that may bioaccumulate ecological COCs at higher concentrations than the prey item modeled for the American robin (earthworms). If bioaccumulation in prey items consumed by the yellow-shouldered blackbird exceeds bioaccumulation in the pry item consumed by the American robin (i.e., earthworms), risk estimates derived for the American robin will understate potential risks to the yellow-shouldered blackbird.

Limited data is available regarding the diet preferences of the yellow-shouldered blackbird; however, available information from the literature indicates that spiders represent a minor contribution to the total diet. Wetmore (1916) analyzed the stomach contents of 55 yellow-shouldered blackbirds at eleven undisclosed locations within Puerto Rico. The stomach content data from this investigation (available at http://fwie.fw.vt.edu/WWW/esis/lists/e104009.htm) show that representatives of the order Arachnida contributed only 7.83 percent by weight to the total diet. This compares to a 35.21 percent by weight contribution by Coleoptera (beetles), a 28.32 percent by weight contribution by Lepidoptera (moths and butterflies), a 9.06 percent by weight contribution by Homoptera (e.g., cicadas and aphids), and a 9.90 percent by weight contribution by plant material. Furthermore, given that yellow-shouldered blackbirds are arboreal, it can be concluded that spiders consumed by yellow-shouldered blackbirds also are arboreal and are not likely to bioaccumulate ecological COCs to the extent that forest litter spiders do. Finally, it is noted that the USEPA (2005f) did not consider ecological soil screening level development appropriate for arboreal insectivores (mammals and birds) because they do not forage from terrestrial environments. The stomach content data reported by Wetmore (1916), as well as the exclusion of arboreal avian insectivores from ecological soil screening level development by the USEPA (2005f), supports the assertion that the American robin (modeled as a ground insectivore) can be can be protectively used as a surrogate receptor for the yellow-shouldered blackbird.

8.0 REFERENCES

Adriano, D.C. 2001. *Trace Elements in Terrestrial Environments: Biogeochemistry, Bioavailability and Risks of Metals*. Second Edition. Springer-Verlag, New York. 867 pp.

Agency for Toxic Substances and Disease Registry. (ATSDR). 2005a. *Toxicological Profile for Arsenic*. PB/2000/108021. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. September, 2005.

ATSDR. 2005b. *Draft Toxicological Profile for Lead*. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. September 2005.

ATSDR. 2005c. *Toxicological Profile for Tin and Tin Compounds*. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. August 2005.

ATSDR. 2005d. *Toxicological Profile for Zinc*. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. August 2005

ATSDR. 2004. *Toxicological Profile for Copper*. PB2004-10733. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. September 2004.

ATSDR. 2003. *Toxicological Profile for Selenium*. PB2004-100005. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. September 2003.

ATSDR. 2002. *Toxicological Profile for DDT, DDE, and DDD*. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. September 2002.

ATSDR. 1999a. *Toxicological Profile for Cadmium*. PB/99/166621. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. July 1999.

ATSDR. 1999b. *Toxicological Profile for Mercury*. PB/99/142416. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. March 1999.

ATSDR. 1992 *Toxicological Profile for Antimony and Compounds*. PB/93/110641/AS. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. September 1992.

Alexander, M. 2000. Aging, Bioavailability and Overestimation of Risk from Environmental Pollutants. *Environ. Sci. Technol*. 34:4259-4265.

Allcroft, R., K.N. Burns, and G. Lewis. 1961. The Effects of High levels of Copper in Rations for Pigs. *Vet. Rec*. 73:714.

Alva, A.K., B. Huang, and S. Paramasivam. 2000. Soil pH Affects Copper Fractionation and Phytotoxicity. *Soil Sci. Soc. Am. J*. 64:955-962.

American Society for Testing and Materials (ASTM). 2006. Standard Guide for Conducting Laboratory Soil Toxicity or Bioaccumulation Tests with the Lumbricid Earthworm *Eisenia Fetida* and the Enchytraeid Potworm *Enchytraeus albidu*s. In, *Annual Book of ASTM Standards, Volume 11.06*. E1676-04.

Andreae, M.O. and P.N. Froehlich, Jr. 1984. Arsenic, Antimony, Germanium Biogeochemistry in the Baltic Sea. *Tellus Ser. B*. 36B:101-117.

Andreae, M.O., J.T. Byrd, and P.N. Froehlich, Jr. 1983. Arsenic, Antimony, Germanium, and Tin in the Tejo Estuary, Portugal: Modeling a Polluted Estuary. *Environ. Sci. Technol.* 17:731-737.

Ankari, A., H. Najib, and A. Hozab. 1998. Yolk and Serum Cholesterol and Production Traits, as Affected by Incorporating a Supraoptimal Amount of Copper in the Diet of the Leghorn Hen. *Br. Poult. Sci*. 39(3):393-397.

Ankley, G.T., D.M. Di Toro, D.J. Hansen, and W.J. Berry. 1996. Technical Basis and Proposal for Deriving Sediment Quality Criteria for Metals. *Environ. Toxicol. Chem*. 15:2056-2066.

A.T. Kearney, Inc. 1988. *Phase II RCRA Facility Assessment of the U.S. Naval Station Roosevelt Roads Facility, Roosevelt Roads, Puerto Rico*.

Aulerich, R.J., R.K. Ringer, and S. Iwamotot. 1974. Effects of Dietary Mercury on Mink. *Arch. Environ. Comtam. Toxicol*. 2:43-51.

Austin, L.S. and G.E. Millwood. 1988. Simulated Effects of Tropospheric Emissions on the Global Antimony Cycle. *Atmos. Environ*. 22:1395-1403.

Baker Environmental, Inc. (Baker). 2008a. *Final Steps 6 and 7 of the Baseline Ecological Risk Assessment, SWMU 45, Naval Activity Puerto Rico, Ceiba, Puerto Rico*. July 11, 2008.

Baker. 2008b. *Revised Final II Summary Report for Environmental Background Concentrations of Inorganic Compounds, Naval Activity Puerto Rico, Ceiba, Puerto Rico*. Coraopolis, Pennsylvania. February 29, 2008.

Baker. 2007. *Final Steps 3b and 4 of the Baseline Ecological Risk Assessment for SWMUs 1 and 2, Naval Activity Puerto Rico, Ceiba, Puerto Rico*. Coraopolis, Pennsylvania. January 10, 2007.

Baker. 2006a. *Final Additional Data Collection Report and Screening-Level Ecological Risk Assessment and Step 3a of the Baseline Ecological Risk Assessment at SWMUs 1 and 2, Naval Activity Puerto Rico, Ceiba, Puerto Rico.* Coraopolis, Pennsylvania. May 18, 2006.

Baker. 2006b. Draft *Steps 3b and 4 of the Baseline Ecological Risk Assessment for SWMUs 1 and 2, Naval Activity Puerto Rico, Ceiba, Puerto Rico*. Coraopolis, Pennsylvania. January 10, 2007.

Baker. 2006c. *Final Steps 3b and 4 of the Baseline Ecological Risk Assessment at SWMU 45, Naval Activity Puerto Rico, Ceiba, Puerto Rico*. Coraopolis, Pennsylvania. July 26, 2006.

Baker. 1999. *Revised Draft RCRA Facility Investigation Report for Operable Unit 3/5, Naval Station, Roosevelt Roads, Puerto Rico.* Coraopolis, Pennsylvania. April 1, 1999.

Baker. 1995. *Final RCRA Facility Investigation, Naval Station Roosevelt Roads, Ceiba, Puerto Rico*. Coraopolis, Pennsylvania. September 14, 1995.

Barnthouse, L.W. and G.W. Suter II. 1996. *Guide for Developing Data Quality Objectives for Ecological Risk Assessment at DOE Oak Ridge Operations Facilities.* Environmental Restoration Division, ORNL Environmental Restoration Program. ES/ER/TM-185/R1.

Berry, W.J., D.J. Hansen, J.D. Mahony, D.L. Robson, D.M. Di Toro, B.P. Shipley, B. Rogers, J.M. Corbin, and W.S. Boothman. 1996. Predicting the Toxicity of Metal-Spiked Laboratory Sediments Using Acid-Volatile Sulfide and Interstitial Water Normalizations. *Environ. Toxicol. Chem*. 15:2067-2079.

Beyer, W.N., G. Hensler, and J. Moore. 1987. Relation of pH and Other Soil Variables to Concentrations of Pb, Cu, Zn, Cd, and Se in Earthworms. *Pedobiologia*. 30:167-172.

Blakemore, R.J. 2005. *Tables of Hawaiian and Puerto Rican Earthworms*. 7 pp. May 2005.

Bloom, N.S. 1990. On the Chemical Form of Mercury in Edible Fish and Marine Invertebrate Tissue. *Can. J. Fish. Aquat. Sci*. 49:1010-1017.

Boyd, W. and P.L. Williams. 2003. Availability of Metals to the Nematode *Caenorhabditis elegans*: Toxicity Based on Total Concentrations in Soil and Extracted Fractions. *Environ. Toxicol. Chem*. 22:1100-1106.

Braun-Blanquet, J. 1965. *Plant Sociology: The Study of Plant Communities*. Hafner Publications, London. 439p.

Broos, K., M.S.J. Warne, D.A. Heemsbergen, D. Stevens, M.B. Barnes, R.L. Correl, and M.J. McLaughlin. 2007. Soil Factors Controlling the Toxicity of Copper and Zinc to Microbial Processes in Australian Soils. *Environ. Toxicol. Chem*. 26:583-590.

Buchman, M.F. 1999. *NOAA Screening Quick Reference Tables*. NOAA HAZMAT Report 99-1. Coastal Protection and Restoration Division, National Oceanic and Atmospheric Administration, Seattle, WA. 12 pp.

Capiomont, A., L. Piazzi., and G. Pergent. 2000. Seasonal Variations of Total Mercury in Foliar Tissues of *Posidonia oceanica. J. Mar. Bio. Ass. U.K.* 80: 1119-1123.

Cecil, H.C., S.J. Harris, and J. Bitman. 1978. Liver Mixed Function Oxidases in Chickens: Induction by Polychlorinated Biphenyls and Lack of Induction by DDT. *Arch. Environ. Contam. Toxicol*. 7(3):283-290.

Chatterjee., A. B. Bhattacharya, and R. Das. 2001. Temporal and Organ-Specific Variability of Selenium in Marine Organisms From the Eastern Coast of India. *Adv. Environ. Res.* 5:167-174.

Chief of Naval Operations (CNO). 1999. *Navy Policy for Conducting Ecological Risk Assessments*. Memorandum from Chief of Naval Operations to Commander, Naval Facilities Engineering Command. Ser. N453E/9U595355. April 5, 1999.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. *Classification of Wetlands and Deepwater Habitats of the United States.* FWS/OBS-79-31. Office of Biological Services, Fish and Wildlife Service, U.S. Department of the Interior, Washington, DC.

Daoust, C.M., C. Bastien, and L. Deschenes. 2006. Influence of Soil Properties and Aging on the Toxicity of Copper on Compost Worm and Barley. *J. Environ. Qual*. 35:558-567.

Department of the Navy (DoN). 2007. *Environmental Assessment for the Disposal of Naval Activity Puerto Rico (Formally Naval Station Roosevelt Roads)*. April 2007.

Di Toro, D.M., C.S. Zarba, D.J. Hanses, W.J. Berry, R.C. Swartz, C.E. Cowan, S.P. Pavlou, H.E. Allen, N.A. Thomas, and P.R. Paquin. 1991. Technical Basis for Establishing Sediment Quality Criteria for Nonionic Organic Chemicals Using Equilibrium Partitioning. *Environ. Toxicol. Chem.* 10:1541-1583.

Edens, F.W. and J.D. Garlich. 1983. Lead-Induced Egg Production Decrease in Leghorn and Japanese Quail Hens. *Poult. Sci*. 62(9):1757-1763.

Efroymson, R.A., Will, M.E., Suter II, G.W., and Wooten, A.C. 1997a. *Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision*. Oak Ridge National Laboratory. Oak Ridge, TN. (ES/ER/TM-85/R3).

Efroymson, R.A., Will, M.E., and Suter II, G.W. 1997b. *Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process: 1997 Revision*. Oak Ridge National Laboratory, Oak Ridge, TN. (ES/ER/TM-126/R2).

Eisler, R. 1998a. *Copper Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review*. U.S. Fish and Wildlife Service Biological Report 10 (1.12), Contaminant Hazard Reviews Report No. 33. 98 pp.

Eisler, R. 1998b. *Lead Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review*. U.S. Fish and Wildlife Service Biological Report 15 (1.14), Contaminant Hazard Reviews Report No. 14. 134 pp.

Eisler, R. 1988. *Arsenic Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review.* U.S. Fish and Wildlife Service Biological Report 85(1.12), Contaminant Hazard Reviews Report No. 12. 92 pp.

Eisler, R. 1985. *Cadmium Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review*. U.S. Fish and Wildlife Service Biological Report 85(1.2), Contaminant Hazard Reviews. Report No. 2. 46 pp.

Etheridge, K., G.B. Rathbun, J.A. Powell, and H.I. Kochman. 1985. Consumption of Aquatic Plants by the West Indian Manatee. *J. of Aquat. Plant Manage*. 23: 21-25.

Ewel, J.J., and J.L. Whitmore. 1973. *The Ecological Life Zones of Puerto Rico and the U.S. Virgin Islands.* Institute of Tropical Forestry, Rio Piedras, PR. (U.S. Forest Service Research Paper ITF-18).

Ferrat. L., A. Bingert., M. Romeo., M. Gnassia-Barelli, and C. Pergent-Martini. 2002. Mercury Uptake and Enzymatic Response of *Posidonia oceanica* After an Experimental Exposure to Organic and Inorganic Forms. *Environ. Toxicol. Chem.* 21:2365-2371.

Friday, G.P. 1998. *Ecological Screening Values for Surface Water, Sediment, and Soil*. Westinghouse Savannah River Company, Savannah River Site, Aiken, South Carolina. WSRC-TR-98-00110.

Geo-Marine, Inc. 2005. *Draft Environmental Assessment for the Disposal of Naval Activity Puerto Rico (Formerly Naval Station Roosevelt Roads).* Geo-Marin, Inc., Plano, TX. December 2005.

Geo-Marine, Inc. 2000. *Habitat Characterization of Solid Waste Management Units (SWMU) 1, SWMU 2, and SWMU 45, Naval Station Roosevelt Roads, Puerto Rico.* Geo-Marine, Inc., Plano, TX. October 11, 2000.

Geo-Marine, Inc. 1998. *Integrated Natural Resource Management Plan for U.S. Naval Station Roosevelt Roads: Plan Years 1998-2007*. Geo-Marine, Inc., Plano, TX.

Gilmour, C.C., E.A. Henry, and R. Mitchell. 1992. Sulfate Stimulation of Mercury Methylation in Freshwater Sediments. *Environ. Toxicol. Chem*. 26:2281-2287.

Gilmour, C.C. and E.A. Henry. 1991. Mercury Methylation in Aqueous Systems Affected by Acid Rain. *Environ. Pollut.* 71:131-169.

Grieb, T., C. Driscoll, S. Gloss, C. Schofield, G. Bowie, and D. Porcella. 1990. Factors Affecting Mercury Accumulation in Fish in the Upper Michigan Peninsula. *Environ. Toxicol. Chem*. 9:919-930.

Hallas, L.E., J.C. Means, and J.J. Cooney. 1982. Methylation of Tin by Estuarine Microorganisms. *Science*. 215:1505-1507.

Hill, W.R., A. J. Stewart, and G.E. Napolitano. 1996. Mercury Speciation and Bioaccumulation in Lotic Primary Produces and Primary Consumers. *Can. J. Fish. Aquat. Sci.* 53: 812-819.

Hill, G.M., E.R. Miller, and H.D. Stowe. 1983. Effect of Dietary Zinc Levels on Health and Productivity of Gilts and Sows Through Two Parities. *J. Anim. Sci*. 57(1):130-138. Ref No. 35659.

Huckabee, J.W., J.W. Elwood, and S.G. Hildebrand. 1979. Accumulation of Mercury in Freshwater Biota. *In*: Nriagu, J. O., ed. *The Biogeochemistry of Mercury in the Environment*. Amsterdam, Elsevier North Holland. pp. 277-302.

Humphreys, D.J. 1988. *Veterinary Toxicology, 3rd Edition.* B. Tindall, London, England. (ISBN 0702012491). 356 pp.

Irwin, R.J., M. van Mouwerik, L. Stevens, M.D. Seese, and W. Basham. 1998. *Environmental Contaminants Encyclopedia.* National Park Service, Water Resources Division, Fort Collins, Colorado. http://www.nature.nps.gov/hazardssafety/toxic//.

Jaagumagi, R. 1990. *Development of the Ontario Provincial Sediment Quality Guidelines for Arsenic, Cadmium, Chromium, Copper, Iron, Lead, Manganese, Mercury, Nickel, and Zinc*. Water Resources Branch, Environment Ontario. Toronto, Ontario. 10 pp.

John, D.A. and J.S. Leventhal. 1995. Bioavailability of Metals. *In*: du Bray, E.A., ed. *Preliminary Compilation of Descriptive Geoenvironmental Mineral Deposit Models*. U.S. Department of the Interior, U.S. Geological Survey, Denver, Colorado. Open-File Report 95-831. 272 pp.

Kelly, C.A., J.W. Rudd, and M.H. Holoka. 2003. Effect of pH on Mercury Uptake by an Aquatic Bacterium: Implications for Hg Cycling. *Environ. Toxicol. Chem*. 37(13):2941-2946.

Levy, D.J. and W.H. Karasov. 1989. Digestive Responses of Temperate Birds Switched to Fruit or Insect Diets. *Auk*. 106:675-686.

Lewis, R.R., III. 1986. *Status of Mangrove Forests, Roosevelt Roads Naval Station, Puerto Rico*. Buffalo, New York: Ecology and Environment.

Little, E.L. and F.H. Wadsworth. 1964. *Common Trees of Puerto Rico and the Virgin Islands*. Agricultural U.S Department of Agriculture, Forest Department, Washington, D.C. Agricultural Handbook No. 249.

Loibner, A., J. Jensen, T. Ter Laak, R. Celis, and T. Hartnik. 2006. Sorption and Ageing of Soil Contamination. Pages 19 to 29 *in* Jensen, J. and Mesman, M. (eds.). *Ecological Risk Assessment of Contaminated Land: Decision Support for Site-Specific Investigations*. Dutch National Institute for Public Health and the Environment. Bilthoven, The Netherlands.

Lock, K. and C.R. Janssen. 2001. Test Designs to Assess the Influence of Soil Characteristics on the Toxicity of Copper and Lead to the Oligochaete *Enchyytraeus albidus*. *Ecotoxicol*. 10:137-144.

Ma, W.C. 1994. Sublethal Toxic Effects of Copper on Growth, Reproduction and Litter Breakdown Activity in the Earthworm *Lumbriculus rubellus*, With Observations on the Influence of Temperature and Soil pH. *Environ. Pollut*. 33:207-219.

Mac, M.J., P.A. Opler, C.E. Puckett Haecker, and P.D. Doran. 1998. *Status and Trends of the Nation's Biological Resources*. 2 Vols. U.S. Department of the Interior, U.S. Geological Survey, Reston, Va. http://www.nwrc.usgs.gov/sandt/index.html

MacDonald, D.D. 1994. *Approach to the Assessment of Sediment Quality in Florida Coastal Waters*. Florida Department of Environmental Protection. Office of Water Quality. 199 pp.

Mahan, D.C. and A.L. Moxon. 1984. Effect of Inorganic Selenium Supplementation on Selenosis in Postweaning Swine. *J. Anim. Sci*. 58(5):1216-1221.

Maher, W., S. Baldwin., M. Deaker, and M. Irving. 2004. Characteristics of Selenium in Australian Marine Biota. *Appl. Organomet. Chem.* 6:103-112.

Maiz, I., I. Arambarri, R. Garcia, and E. Millan. 2000. Evaluation of Heavy Metal Availability in Polluted Soils by Two Sequential Extraction Procedures Using Factor Analysis. *Environ. Pollut*. 110:3-9.

May, K., M. Stoeppler, and K. Reisinger. 1987. Studies in the Ratio Total Mercury/Methylmercury in the Aquatic Food Chain. *Environ. Toxicol. Chem.* 13:153-159.

Mignucci-Giannoni, A.A. and C.A. Beck. 1998. The Diet of the Manatee (*Trichechus manatus*) in Puerto Rico. *Mar. Mam. Sci.* 14:394-397.

Ministry of Housing, Spatial Planning and Environment (MHSPE). 2000. *Circular on Target Values and Intervention Values for Soil Remediation*. Directorate-General for Environmental Protection, Department of Soil Protection, The Hague, Netherlands. February 4, 2000.

Morrison, D.E., B.K. Robertson, and M. Alexander. 2000. Bioavailability of Aged DDT, DDE, DDD, and Dieldrin in Soil. *Environ. Sci. Technol*. 34(4):709-713.

Naval Energy and Environmental Support Activity (NEESA). 1984. *Initial Assessment Study of Naval Station Roosevelt Roads, Puerto Rico.* NEESA 13-051.

Naval Facilities Engineering Command (NAVFAC). 2006. *Biological Assessment for the Disposal of Naval Station Roosevelt Roads/Naval Activity Puerto Rico (Final Report)*. Naval Facilities Engineering Command Atlantic, Norfolk, VA.

Naval Facilities Engineering Service Center (NFESC). 2000. *Guide for Incorporating Bioavailability Adjustments into Human Health and Ecological Risk Assessments at U.S. Navy and Marine Corps Facilities. Part 1: Overview of Metals Bioavailability*. Naval Facilities Engineering Command, Washington, D.C. NFESC User's Guide UG-2041-ENV.

NFESC. 1996. *Survey of Potential Habitat for Yellow-Shouldered Blackbird on U.S. Naval Station Roosevelt Road, Puerto Rico*. Naval Facilities Engineering Command, Atlantic Division, Norfolk, VA.

Neiger, R.D. and G.D. Osweiler. 1989. Effect of Subchronic Low Level Dietary Sodium Arsenite on Dogs. *Fund. Appl. Toxicol*. 13:439-451.

Odell, D.K. 1992. West Indian Manatee. Pages 828 to 837 *in* Chapman, J.A. and Feldhamer, G.A. (eds.). *Wild Mammals of North America: Biology, Management and Economics*. The Johns Hopkins University Press, Baltimore, MD.

Pannhorst, T.S. and J.H. Weber. 1999. Speciation of Mercury in Eelgrass (*Zostera maina* L.): A Seasonal Study in the Great Bay Estuary, New Hampshire. *Appl. Organomet. Chem*. 13: 461-467.

Parker, N., G. McDermott, and D. Neptune. 2003. *U.S. Navy Ecological Screening and COPC Refinement for Sediment, Soil, and Surface Water*. 18 pp.

Parks, J.W., A. Lutz, and J.A. Sutton. 1989. Water Column Methylmercury in the Wabigoon/English River-Lake System: Factors Controlling Concentrations, Speciation, and Net Production. *Can. J. Fish. Aquat. Sci*. 46:2184-2202.

Pereira, A.A., B. van Hattum, A. Brouwer, P.M. van Bodegom, C.E. Rezende, and W. Salomons. 2008. Effects of Iron-Ore Mining and Processing on Metal Bioavailability in a Tropical Coastal Lagoon. *J. Soils Sediments*. 8(4):239-252.

Puerto Rico Department of Natural Resources (PRDNR). 2002. Memorandum from Eduardo A. Ventosa-Febles to Jose L. Chabert, Director of Wildlife Division. August 12, 2002.

Purkerson, D.G., M.A. Doblin, S.M. Bollens, S.N.Luoma, and G.A. Cutter. 2003. Selenium in San Francisco Bay Zooplankton: Potential Effects of Hydrodynamics and Food Web Interactions. *Estuaries*. 26:956-969.

Raffaele, H.A. 1989. *A Guide to the Birds of Puerto Rico and the Virgin Islands.* Princeton University Press, Princeton, N.J. 254 pp.

Reid, J.P., D. Easton, W.J. Kenworthy. 2001. *Manatee and Seagrass Habitat Characterization in Puerto Rico.* Department of the Navy and US Geological Survey Interagency Report, Agreement No. 320723L87. September 2001. 34 pp.

Reid, J.P. and C.R. Kruer. 1998. *Mapping and Characterization of Nearshore Benthic Habitats Around Vieques Island, Puerto Rico, Report to Navy*. U.S. Geological Survey Biological Resource Discipline, Sirenia Project, Gainsville, Florida.

Rhoads, F.M., S.M. Olson, and A. Manning. 1989. Copper Toxicity in Tomato Plants. *J. Environ. Qual*. 18:195-197.

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. *Toxicological Benchmarks for Wildlife: 1996 Revision.* Risk Assessment Program, Health Sciences Research Division. Oak Ridge, Tennessee.

Saxe, J.K., C.A. Impellitteri, Willie J.G.M. Peijnenburg, and H.E. Allen. Novel Model Describing trace Metal Concentrations in the Earthworm, *Eisenia Andrei*. *Environ. Sci. Technol*. 35(22):4522-4529.

Scott-Fordsmand, J.J., J.M. Weeks, and S.P. Hopkin. 2000. Importance of Contamination History for Understanding Toxicity of Copper, to Earthwom *Eisenia fetida* (Oligochaeta: annelid), Using Neutral-Red Retention Assay. *Environ. Toxicol. Chem*. 19:1174-1780.

Sellers, P., C.A. Kelly, J.W.M. Rudd, and A.R. MacHutchon. 1996. Photodegradation of Methylmercury in Lakes. *Nature*. 380:694-697.

Sibley, P.K., G.T. Ankley, A.M. Cotter, and E.N. Leonard. 1996. Predicting Chronic Toxicity of Sediments Spiked with Zinc: An Evaluation of the Acid-Volatile Sulfide Model using a Life-Cycle Test with the Midge *Chironomus tetans*. *Environ. Toxicol. Chem*. 15(12):2102-2112.

Stafford, E.A. and C.A. Edwards. 1985. *Comparison of Heavy Metal Uptake by Eisenia fetida with that of Other Common Earthworms*. Final Technical Report. Contract No. DAJA 45-84-C-0027. Pothamsted Experiemental Station, Harpenden Herts, United Kingdom.

Temminghoff, E.J.M., S.E.A.T.M. Van der Zee, and F.A.M. De Haan. 1997. Copper Mobility in a Copper-Contaminated Sandy Soil as Affected by pH and Solid and Dissolved Organic Matter. *Environ. Sci. Technol*. 31:1109-1115.

Tolson, P.J. 2004. *Surveys for the Puerto Rican Boa, Epicrates inornatus, and the Virgin Islands Boa, Epicrates monenis granti, at the U.S. Naval Base, Roosevelt Roads, Puerto Rico*. Prepared for Geo-Marine, Inc., Plano, Texas.

United Nations Environmental Program (UNEP). 1995. *Regional Management Plan for the West Indian Manatee, Trichechus manata*. Caribbean Environment Programme Technical Report No. 35. Kingston, Jamaica. http://www.cep.unep.org/pubs/Techreports/tr35en/index.html.

U.S. Army Corps of Engineers (USACE). 1987. *Corps of Engineers Wetlands Delineation Manual.* Technical Report Y-87-1. U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS.

U.S. Environmental Protection Agency. 2007a. *Ecological Soil Screening Levels for Copper (Interim Final)*. Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-68. February 2007.

USEPA. 2007b. *Ecological Soil Screening Levels for Selenium (Interim Final)*. Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-72.

USEPA. 2007c. *Ecological Soil Screening Levels for Zinc (Interim Final)*. Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-73. June 2007.

USEPA 2007d. *Ecological Soil Screening Levels for DDT and Metabolites*. Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-57. April 2007.

USEPA. 2007e. ProUCLVersion 4.00.02. April 2007. http://www.epa.gov/esd/tsc/software.htm

USEPA. 2007f. ProUCLVersion 4.00.02 User Guide. EPA/600/R-07/038. April 2007. http://www.epa.gov/esd/tsc/images/proucl-4-0-02-user.pdf.

USEPA. 2007g. *Ecological Soil Screening Levels for Polycyclic Aromatic Hydrocarbons (PAHs) (Interim Final)*. Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-78.

USEPA. 2006. Ecological Risk Assessment Frequently Asked Questions: Ecological Receptors. http://www.epa.gov/reg3hwmd/risk/eco/faqs/ecorecept.html.

USEPA. 2005a. *Ecological Soil Screening Levels for Antimony (Interim Final)*. Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-61. February 2005.

USEPA. 2005b. *Ecological Soil Screening Levels for Arsenic (Interim Final)*. Office of Solid Waste and Emergency response, Washington, D.C. OSWER Directive 9285.7-62.

USEPA. 2005c. *Ecological Soil Screening Levels for Cadmium (Interim Final)*. Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-65. March 2005.

USEPA. 2005d. *Ecological Soil Screening Levels for Lead (Interim Final)*. Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-70. March 2005.

USEPA. 2005e. *Evaluation of Metals Data for the Contract Laboratory Program (CLP)*. SOP HW-2, Revision 13. September 2005.

USEPA. 2005f. *Guidance for Developing Ecological Soil Screening Levels*. Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-55.

USEPA. 2003. *Guidance for Developing Ecological Soil Screening Levels*. Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-55.

USEPA. 2001. *Validating Semivolatile Organic Compounds by SW-846 Method 8270*. SOP HW-22, Revision 2. June 2001.

USEPA. 2000a. *Bioaccumulation Testing and Interpretation for the Purpose of Sediment Quality Assessment. Status and Needs*. Office of Water and Office of Solid Waste. EPA 823-R-00-001.

USEPA. 2000b. *Draft Ecological Soil Screening Level Guidance*. Office of Emergency and Remedial Response, Washington, D.C. July 2000.

USEPA. 2000c. *Data Quality Objectives Process for Hazardous Waste Site Investigations*. EPA QA/G-4HW. EPA/600/R-00/007.

USEPA. 2000d. *Guidance for the Data Quality Objectives Process*. EPA QA/G-4. EPA/600/R-96/055.

USEPA. 1999. *Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities*. Office of Solid Waste and Emergency Response. 530-D-99-001A. August 1999.

USEPA. 1998. *Guidelines for Ecological Risk Assessment.* Risk Assessment Forum, Washington, DC. EPA/630/R-95/002B.

USEPA. 1997a. *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments (Interim Final).* Office of Solid Waste and Emergency Response. EPA/540/R-97-006.

USEPA. 1997b. *Mercury Study Report to Congress. Volume VI: An Ecological Assessment for Anthropogenic Mercury Emissions in the United States*. Office of Air Quality Planning and Standards and Office of Research and Development, Washington, D.C. EPA-452/R-97-008.

USEPA. 1995. *Validating Pesticide/PCB Compounds by SW-846 Method 8080A.* SOP HW-23, Revision 0. May 1995.

USEPA. 1993. *Wildlife Exposure Factors Handbook*. Office of Research and Development, Washington, D.C. EPA/600/R-93/187a.

USEPA. 1981. *The Carcinogen Assessment Group's Final Risk Assessment on Arsenic*. Office of Health and Environmental Assessment, Washington, D.C. PB 81-206013.

U.S. Fish and Wildlife Service. (USFWS). 2008. Threatened and Endangered Animals and Plants. Species Information. http://www.fws.gov/endangered/wildlife.html. Accessed: September 15, 2008.

USFWS. 1996a. *Recovery Plan for the Yellow-Shouldered Blackbird (Agelaius xanthomus).* USFWS, Southeast Region, Atlanta, GA.

USFWS. 1996b. *Revised Recovery Plan for the Atlantic Coast Population of the Piping Plover (Charadrius melodus)*. USFWS, Region 5, Hadley, MA.

USFWS. 1996c. *Species Account for the West Indian Manatee (Trichechus manatus)*. USFWS.

USFWS. 1987. Endangered and Threatened Wildlife and Plants: Determination of Threatened Status for the Puerto Rican Crested Toad. *Federal Register*. 52 (149): 28828-28831.

USFWS. 1986a. *Recovery Plan for the Puerto Rico Population of the West Indian (Antillean) Manatee (Trichechus manatus manatus L.)*. USFWS, Southeast Region, Atlanta, GA.

USFWS. 1986b. *Puerto Rico Boa Recovery Plan*. USFWS, Southeast Region, Atlanta, GA.

USFWS. 1984. *Recovery Plan for the Golden Coqui (Eleutherodactylus jasperi)*. USFWS, Southeast Region, Atlanta, GA.

USFWS. 1983. *Yellow-Shouldered Blackbird Recovery Plan*. USFWS, Southeast Region, Atlanta, GA.

United States Geological Survey (USGS). 2000. Personal Correspondence with Cathy Beck, USGS. Biological Resources Division. Florida Caribbean Science Center, Sirenia Project, Gainesville, FL.

Warren, L.A., P.M. Outridge, and A.P. Zimmerman. 1994. Geochemical Partitioning and Bioavailability of Copper to Aquatic Plants in an Artificial Oxide-Organic Sediment. *Hydrobiologia*. 304(3):197-207.

Watras, C.J. and N.S. Bloom. 1992. Mercury and Methylmercury in Individual Zooplankton: Implications for Bioaccumulation. *Limnol. Oceanagr.* 37(6):1313-1318.

Wetmore, A. 1916. Birds of Puerto Rico. *U.S. Department of Agriculture Bull*. 326:1-140.

Winfrey, M.R. and J.W.M. Rudd. 1990. Environmental Factors Affecting the Formation of Methylmercury in Low pH Lakes. *Environ. Toxicol. Chem.* 9:853-869.

Wobeser, G., O. Nielson, and B. Schiefer. 1976. Mercury and Mink II. Experimental Methyl Mercury Intoxication. *Can. J. Comp. Med*. 34-35.

Wood, T.S. and M.L. Shelley. 1999. A Dynamic Model of Bioavailability in Constructed Wetland Sediments. *Ecol. Eng*. 12:231-252.

Woods, C.A., G.B. Rathbun, T. Carr, and N. Carr. 1984. *Distribution and Abundance of Manatees and Sea Turtles at Roosevelt Roads Naval Station, Puerto Rico, Progress Report*. U.S. Navy Facilities Planning and Real Estate Division, Norfolk, Virginia.

Wright, D.R. and R.D. Hamilton. 1992. Release of Methyl Mercury from Sediments: Effects of Mercury Concentration, Low Temperature, and Nutrient Addition. *Can. J. Fish. Aquat. Sci.* 39:1459-1466.

Xun, L., N. Cambell, and J.W. Rudd. 1987. Measurements of Specific Rates of Net Methyl Mercury Production in the Water Column and Surface Sediments of Acidified and Circumneutral Lakes. Can. J. *Fish. Aquat. Sci.* 44:750-757.

Yuhas, E.M., R.C. Schnell, and T.S. Miya. 1979. Dose-Related Alterations in Growth and Mineral Disposition by Chronic Oral Cadmium Administration in the Male Rat. *Toxicol*. 12(1):19-29.

Zillioux, E.J., D.B. Porcella, J.M. Benoit. 1993. Mercury Cycling and Effects in Freshwater Wetland Ecosystems. *Environ. Toxicol. Chem.* 12:2245-2264.

TABLES

TABLE 2-1
LIST OF BIRDS REPORTED FROM OR HAVING THE POTENTIAL TO OCCUR AT NAVAL ACTIVITY PUERTO RICO
SWMU 1 – ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Common Name [1]		
Pied-billed grebe	Red-billed tropicbird	Brown pelican [2]
Brown booby	Magnificent frigatebird	Great blue heron
Louisiana heron	Snowy egret	Great egret
Striated heron	Little blue heron	Cattle egret
Least bittern	Yellow-crowned night heron	Black-crowned night heron
White-cheeked pintail	Blue-winged teal	American widgeon
Red-tailed hawk	Osprey	Merlin
Clapper rail	American coot	Caribbean coot
Common gallinule	Piping plover [3][4]	Semipalmated plover
Black-bellied plover	Wilson's plover	Killdeer
Ruddy turnstone	Black-necked stilt	Whimbrel
Spotted sandpiper	Semipalmated sandpiper	Short-billed dowitcher
Greater yellowlegs	Lesser yellowlegs	Willet
Stilt sandpiper	Pectoral sandpiper	Laughing gull
Royal tern	Sandwich tern	Bridled tern
Least tern	Brown noddy	White-winged dove
Zenaida dove	White-crowned pigeon	Mourning dove
Red-necked pigeon	Common ground dove	Bridled quail dove
Ruddy quail dove	Caribbean parakeet	Smooth-billed ani
Yellow-billed cuckoo	Mangrove cockoo	Short-eared owl
Chuck-will's-widow	Common nighthawk	Antillean crested hummingbird
Green-throated carib	Antillean mango	Belted kingfisher

TABLE 2-1
LIST OF BIRDS REPORTED FROM OR HAVING THE POTENTIAL TO OCCUR AT NAVAL ACTIVITY PUERTO RICO
SWMU 1 – ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Common Name [1]		
Gray kingbird	Loggerhead kingbird	Stolid flycatcher
Caribbean elaenia	Purple martin	Cave swallow
Barn swallow	Northern mockingbird	Pearly-eyed thrasher
Red-legged thrush	Black-whiskered vireo	American redstart
Parula warbler	Prairie warbler	Yellow warbler
Magnolia warbler	Cape May warbler	Black-throated blue warbler
Adelaide's warbler	Palm warbler	Black and white warbler
Ovenbird	Northern water thrush	Bananaquit
Striped-headed tanager	Shiny cowbird	Black-cowled oriole
Greater Antillean grackle	Yellow-shouldered blackbird [2]	Hooded mannikin
Yellow-faced grassquit	Black-faced grassquit	Least sandpiper
Western sandpiper	Puerto Rican woodpecker	Rock dove
Puerto Rican emerald	Puerto Rican flycatcher	Pin-tailed whydah
Spice finch	Ruddy duck	Peregrine falcon
Marbled godwit	Puerto Rican lizard cuckoo	Prothonotary warbler
Green-winged teal	Orange-cheeked waxbill	Roseate tern [3][4]
Least grebe	West Indian whistling duck	Puerto Rican screech owl
Puerto Rican tody	Green heron	

Notes:

(1) List of birds taken from Geo-Marine, Inc. (1998).
(2) Federally-designated endangered species.
(3) Federally-designated threatened species.
(4) Species has the potential to occur at Naval Activity Puerto Rico.

TABLE 2-2a
SCREENING-LEVEL ASSESSMENT ENDPOINTS, RISK QUESTIONS, AND MEASUREMENT ENDPOINTS
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Assessment Endpoints	Risk Questions	Measurement Endpoints
Terrestrial Habitat:		
Survival, growth, and reproduction of terrestrial soil invertebrate communities.	Are site-related chemical concentrations in surface and subsurface soil sufficient to adversely affect terrestrial soil invertebrate communities?	Comparison of maximum chemical concentrations in surface and subsurface soil with soil screening values.
Survival, growth, and reproduction of terrestrial plant communities.	Are site-related surface and subsurface soil concentrations sufficient to adversely affect terrestrial plant communities?	Comparison of maximum chemical concentrations in surface and subsurface soil with soil screening values.
Survival, growth, and reproduction of terrestrial avian herbivores.	Are site-related chemical concentrations in surface and subsurface soil sufficient to cause adverse effects (on growth, survival, or reproduction) to avian species that may consume terrestrial plants from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on maximum chemical concentrations in surface and subsurface soil.
Survival, growth, and reproduction of terrestrial avian omnivores.	Are site-related chemical concentrations in surface and subsurface soil sufficient to cause adverse effects (on growth, survival, or reproduction) to avian species that may consume terrestrial plants and soil invertebrates from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on maximum chemical concentrations in surface and subsurface soil.
Survival, growth, and reproduction of terrestrial avian carnivores.	Are site-related chemical concentrations in surface and subsurface soil sufficient to cause adverse effects (on growth, survival, or reproduction) to avian species that may consume small mammals from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on maximum chemical concentrations in surface and subsurface soil.
Survival, growth, and reproduction of terrestrial amphibian and reptile communities.	Are site-related chemical concentrations in surface soil sufficient to cause adverse effects (on growth, survival, or reproduction) to terrestrial reptiles?	Qualitative examination of exposures and risks to ecological receptors occupying similar trophic levels.
Estuarine Wetland:		
Survival, growth, and reproduction of benthic invertebrate communities.	Are site-related chemical concentrations in surface water and sediment sufficient to adversely affect benthic invertebrate communities?	Comparison of maximum chemical concentrations in surface watre and sediment with surface water and sediment screening values.

TABLE 2-2a
SCREENING-LEVEL ASSESSMENT ENDPOINTS, RISK QUESTIONS, AND MEASUREMENT ENDPOINTS
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Assessment Endpoints	Risk Questions	Measurement Endpoints
Estuarine Wetland:		
Survival, growth, and reproduction of aquatic plant communities.	Are site-related chemical concentrations in surface water and sediment sufficient to adversely affect aquatic plant communities?	Comparison of maximum chemical concentrations in surface water and sediment with surface water and sediment screening values.
Survival, growth, and reproduction of fish communities	Are site-related chemical concentrations in surface water and sediment sufficient to adversely affect fish communities?	Comparison of maximum chemical concentrations in surface water and sediment with surface water and sediment screening values.
Survival, growth, and reproduction of avian invertebrate consumers.	Are site-related chemical concentrations in estuarine wetland sediment sufficient to cause adverse effects (on growth, survival, or reproduction) to avian species that may consume aquatic invertebrates from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on maximum chemical concentrations in sediment.
Survival, growth, and reproduction of avian piscivores.	Are site-related chemical concentrations in estuarine wetland surface water and sediment sufficient to cause adverse effects (on growth, survival, or reproduction) to avian species that may consume fish from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on maximum chemical concentrations in surface water and sediment.
Ensenada Honda: Survival, growth, and reproduction of benthic invertebrate communities.	Are site-related chemical concentrations in surface water and sediment sufficient to adversely affect benthic invertebrate communities?	Comparison of maximum chemical concentrations in surface watre and sediment with surface water and sediment screening values.
Survival, growth, and reproduction of aquatic plant communities.	Are site-related chemical concentrations in surface water and sediment sufficient to adversely affect aquatic plant communities?	Comparison of maximum chemical concentrations in surface water and sediment with surface water and sediment screening values.
Survival, growth, and reproduction of fish communities	Are site-related chemical concentrations in surface water and sediment sufficient to adversely affect fish communities?	Comparison of maximum chemical concentrations in surface water and sediment with surface water and sediment screening values.

TABLE 2-2a
SCREENING-LEVEL ASSESSMENT ENDPOINTS, RISK QUESTIONS, AND MEASUREMENT ENDPOINTS
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Assessment Endpoints	Risk Questions	Measurement Endpoints
Ensenada Honda: Survival, growth, and reproduction of avian piscivores.	Are site-related chemical concentrations in estuarine wetland surface water and sediment sufficient to cause adverse effects (on growth, survival, or reproduction) to avian species that may consume fish from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on maximum chemical concentrations in surface water and sediment.
Survival, growth, and reproduction of mammalian herbivores.	Are site-related chemical concentrations in Ensenada Honda sediment sufficient to cause adverse effects (on growth, survival, or reproduction) to mammals that may consume aquatic vegetation from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on maximum chemical concentrations in sediment.
Survival, growth, and reproduction of reptile communities.	Are site-related chemical concentrations in surface soil sufficient to cause adverse effects (on growth, survival, or reproduction) to terrestrial reptiles?	Qualitative examination of exposures and risks to ecological receptors occupying similar trophic levels.

Revised: December 1, 2009

TABLE 2-2b
SUMMARY OF MEDIA AND SAMPLES EVALUATED BY THE SCREENING-LEVEL ECOLOGICAL RISK ASSESSMENT AND STEP 3A OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Investigation	Sample Media	Sample Identification Number
1992 Supplemental Investigation	Subsurface Soil (0.5 to 1.5-feet bgs)	05SS126
		05SS128
		05SS130
		05SS132
		05SS135
		05SS138
1996 RCRA Facility Investigation	Surface Soil (0.0 to 1.0-foot bgs)	1MW01-00
		1MW02-00
		1MW03-00
		1MW04-00
		1SB01-00
		1SB02-00
		1SB03-00
		1SS01
		1SS02
		1SS03
		1SS04
		1SS05
		1SS06
		1SS07
		1SS08
		1SD01 [(1)]
		1SD02 [(1)]
		1SD03 [(1)]
2003 Additional Data Collection Investigation	Estuarine Wetland Surface Water	01EWSW01
		01EWSW02
		01EWSW03
		01EWSW04
		01EWSW05
		01EWSW06
		01EWSW07
		01EWSW08
		01EWSW09
	Ensenada Honda Surface Water	01OWSW01
		01OWSW02
		01OWSW03
		01OWSW04
		01OWSW05
		01OWSW06
		01OWSW07
		01OWSW08
		01OWSW09

Revised: December 1, 2009

TABLE 2-2b
SUMMARY OF MEDIA AND SAMPLES EVALUATED BY THE SCREENING-LEVEL ECOLOGICAL RISK ASSESSMENT AND STEP 3A OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Investigation	Sample Media	Sample Identification Number
2003 Additional Data Collection Investigation (continued)	Estuarine Wetland Sediment	01EWSD01
		01EWSD02
		01EWSD03
		01EWSD04
		01EWSD05
		01EWSD06
		01EWSD07
		01EWSD08
		01EWSD09
	Ensenada Honda Sediment	01OWSD01
		01OWSD02
		01OWSD03
		01OWSD04
		01OWSD05
		01OWSD06
		01OWSD07
		01OWSD08
		01OWSD09
2004 Additional Data Collection Investigation	Estuarine Wetland Sediment	1EWSD10
		1EWSD11
		1EWSD12
		1EWSD13
		1EWSD14
		1EWSD15
		1EWSD16
		1EWSD17
		1EWSD18
		1EWSD19
		1EWSD20
	Ensenada Honda Sediment	1OWSD10
		1OWSD11
		1OWSD12
	Subsurface Soil (1.0 to 2.0-foot bgs)	1SB15-01
		1SB16-01
		1SB17-01
	Surface Soil (0.0 to 1.0-foot bgs)	1SS09
		1SS10
		1SS11
		1SS12
		1SS13
		1SS14

TABLE 2-2b
SUMMARY OF MEDIA AND SAMPLES EVALUATED BY THE SCREENING-LEVEL ECOLOGICAL RISK ASSESSMENT AND STEP 3A OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Investigation	Sample Media	Sample Identification Number
2004 Additional Data Collection Investigation (continued)	Surface Soil (0 to 1-foot bgs) (continued)	1SS15
		1SS16
		1SS17
		1SS18
		1SS19

Notes:

bgs = below ground surface
RCRA = Resource Conservation and Recovery Act

(1) The sample was re-designated as surface soil based on observations during the 2003 additional data collection field investigation (the sample identification number assigned to this sample during the 1996 RCRA facility investigations was not changed).

TABLE 2-2c
ECOLOGICAL CHEMICALS OF CONCERN IDENTIFIED IN STEP 3A OF THE ECOLOGICAL RISK ASSESSMENT
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Habitat	Receptor/Receptor Group	Exposure Media	Ecological COCs
Terrestrial	Terrestrial invertebrate communites	Surface Soil	Antimony, cadmium, copper, lead, mercury, tin, zinc, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT
		Subsurface Soil	4,4'-DDE and 4,4'-DDT
	Terrestrial plant communities	Surface Soil	Antimony, cadmium, copper, lead, mercury, tin, zinc, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT
		Subsurface Soil	4,4'-DDE and 4,4'-DDT
	Mourning dove (herbivovre)	Surface soil and prey items	Lead
		Subsurface Soil and prey items	None
	American robin (omnivore)	Surface soil and prey items	Cadmium, lead, mercury, zinc, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT
		Subsurface Soil and prey items	None
	Red-tailed hawk (carnivore)	Surface soil and prey items	None
		Subsurface Soil and prey items	None
Estuarine Wetland	Benthic invertebrate communities	Sediment	None
		Surface water	None
	Aquatic plant communities	Sediement	None
		Surface water	None
	Fish communities	Sediment	None
		Surface water	None
	Spotted sandpiper (invertebrate consumer)	Sediment and prey items	None
	Belted kingfisher (piscivore)	Sediment and prey items	None
	Great blue heron (piscivore)	Sediment and prey items	None
Open Water (Ensenada Honda)	Benthic invertebrate communities	Surface water	None
		Sediment	None
	Aquatic plant communities	Surface water	None
		Sediment	None
	Fish communities	Surface water	None
		Sediment	None
	Double-crested cormorant (piscivore)	Sediment, and prey items	None
	West Indian manatee (herbivore)	Sediment and prey items	Arsenic, cadmium, copper, mercury, selenium, and zinc

TABLE 2-3
SURFACE SOIL ANALYTICAL DATA FOR ECOLOGICAL CHEMICALS OF CONCERN FROM THE 1996 RCRA FACILITY INVESTIGATION AND 2004 ADDITIONAL DATA COLLECTION INVESTIGATION
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	1MW01	1MW02	1MW03	1MW04	1SB01	1SB02	1SB03	1SS01
Sample ID	1MW01-00	1MW02-00	1MW03-00	1MW04-00	1SB01-00	1SB02-00	1SB03-00	1SS01
Sampling Date	10/29/96	10/11/96	10/11/96	10/13/96	10/13/96	10/13/96	10/11/96	10/13/96
Sample Depth (feet bgs)	0.00-1.00	0.00-1.00	0.00-1.00	0.00-1.00	0.00-1.00	0.00-1.00	0.00-1.00	0.00-1.00
Pesticides (ug/kg)								
4,4'-DDD	9 U	9.6 U	9.8 U	9.4 U	10 U	9.7 U	20 U	9.1 U
4,4'-DDE	9 U	9.6 U	4.1	7.4	1.2 J	9.7 U	610	9.1 U
4,4'-DDT	9 U	9.6 U	4.5	14	2.5	1.2 J	340	9.1 U
Metals (mg/kg)								
Antimony	2.4 J	2.8 J	1.9 UJ	2.1 J	2.9 J	1.5 J	1.9 J	1.3 UJ
Cadmium	0.77	0.27	0.34	0.41	0.23 U	0.38	0.7	0.2
Copper	169	19.8	45.9	71.2	41.5	75	57.1	35.2
Lead	3.6 R	4.4	13	8.3	5.4	7.5	25.7	3.4
Mercury	0.02 U	0.05	0.06	0.03	0.07	0.06	0.06	0.08
Tin	0.94 U	1 U	1.1	0.92 U	0.96 U	0.79 U	1.5	0.69 U
Zinc	140 J	13.9 J	38.3 J	40.9	28.3	35.8	61.6 J	19.1

TABLE 2-3
SURFACE SOIL ANALYTICAL DATA FOR ECOLOGICAL CHEMICALS OF CONCERN FROM THE 1996 RCRA FACILITY INVESTIGATION AND 2003 ADDITIONAL DATA COLLECTION INVESTIGATION
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	1SS02	1SS03	1SS04	1SS05	1SS06	1SS07	1SS08	1SD01
Sample ID	1SS02	1SS03	1SS04	1SS05	1SS06	1SS07	1SS08	1SD01
Sampling Date	10/11/96	10/10/96	10/10/96	10/11/96	10/11/96	10/13/96	10/21/96	10/22/96
Sample Depth (feet bgs)	0.00-1.00	0.00-1.00	0.00-1.00	0.00-1.00	0.00-1.00	0.00-1.00	0.00-1.00	0.00-0.00
Pesticides (ug/kg)								
4,4'-DDD	9.6 U	9.1 U	10 U	9.6 U	49 U	8.8 U	9 U	42
4,4'-DDE	3.2	9.1 U	1.7 J	1.6 J	1,300	280	9 U	930
4,4'-DDT	1.6 J	9.1 U	1.2 J	3.6	270	140	9 U	130
Metals (mg/kg)								
Antimony	2 J	1.8 UJ	3.3 J	2.1 J	4 J	9.4 J	1.4 UJ	23.6 J
Cadmium	0.56	0.23 U	0.41	0.23 U	0.25 U	83.8	0.19 U	4.7
Copper	45.9	37.9	78.2	66.6	359	166	29.8	1020
Lead	5.9	2	9.3	9.1	79.4	101	6.9 J	659 J
Mercury	0.06	0.02 U	0.06	0.05	0.09	0.09	0.11	0.85
Tin	1.2	0.95 U	0.8 U	0.94 U	6.7	15.9	0.78 U	181
Zinc	26.9 J	23.1 J	29 J	36.9 J	136 J	223	24.8	1780

TABLE 2-3
SURFACE SOIL ANALYTICAL DATA FOR ECOLOGICAL CHEMICALS OF CONCERN FROM THE 1996 RCRA FACILITY INVESTIGATION AND 2003 ADDITIONAL DATA COLLECTION INVESTIGATION
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	1SD02	1SD03	1SS09	1SS10	1SS11	1SS12	1SS13	1SS14
Sample ID	1SD02	1SD03	1SS09	1SS10	1SS11	1SS12	1SS13	1SS14
Sampling Date	10/22/96	11/10/96	10/02/04	10/02/04	10/02/04	10/02/04	10/02/04	10/02/04
Sample Depth (feet bgs)	0.00-0.00	0.00-0.00	0.00 - 1.00	0.00 - 1.00	0.00 - 1.00	0.00 - 1.00	0.00 - 1.00	0.00 - 1.00
Pesticides (ug/kg)								
4,4'-DDD	97	9.9 U	9.6 J	220	15 J	NA	69 J	4.1 U
4,4'-DDE	370	9.9 U	110	810	89	NA	1,700	4.1 U
4,4'-DDT	63	9.9 U	95	110 J	61 J	NA	520 J	4.1 U
Metals (mg/kg)								
Antimony	14.5 J	1.4 UJ	0.98 J	23 J	2.3 J	0.089 J	20 J	0.079 J
Cadmium	2.4	0.34	0.33 J	5.1	9.4	0.12 J	12	0.082 J
Copper	608	50.8	98 J	540 J	220 J	41 J	740 J	40 J
Lead	966 J	1.3 J	34 J	680 J	94 J	4.2 J	660 J	8.7 J
Mercury	0.2	0.03 U	0.064	0.44	0.15	0.075	0.59	0.034
Tin	33.9	0.74 U	5.2 J	100	38	3 J	88	3.1 J
Zinc	1100	15.6	110 J	1,600 J	190 J	43 J	2,000 J	39 J

TABLE 2-3
SURFACE SOIL ANALYTICAL DATA FOR ECOLOGICAL CHEMICALS OF CONCERN FROM THE 1996 RCRA FACILITY INVESTIGATION AND 2003 ADDITIONAL DATA COLLECTION INVESTIGATION
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	1SS15	1SS16	1SS17	1SS18	1SS19
Sample ID	1SS15	1SS16	1SS17	1SS18	1SS19
Sampling Date	10/03/04	10/03/04	10/03/04	10/03/04	10/02/04
Depth Range (feet bgs)	0.00 - 1.00	0.00 - 1.00	0.00 - 1.00	0.00 - 1.00	0.00 - 1.00
Pesticides (ug/kg)					
4,4'-DDD	3.9 J	13,000	1.8 J	0.9 J	1.7 J
4,4'-DDE	64	28,000	6.3	5.9	15
4,4'-DDT	21 J	43,000 J	1.4 J	9.9	23
Metals (mg/kg)					
Antimony	NA	NA	NA	NA	NA
Cadmium	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA
Mercury	NA	NA	NA	NA	NA
Tin	NA	NA	NA	NA	NA
Zinc	NA	NA	NA	NA	NA

Notes:

J = The analyte was positiviely identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit.
R = The sample result is rejected. The presence or absence of the analyte cannot be verified.
U = The analyte was analyzed for, but not detected at the reported sample quantitation limit
UJ = The analyte was analyzed for, but not detected above the reported sample quantitation limit; The reported sample quantitation limit is qualified as estimated

NA = Not analyzed
ug/kg = microgram per kilogram
mg/kg - milligram per kilogram
bgs = below ground surface
RCRA = Resource Conservation and Recovery Act

TABLE 2-4
SUBSURFACE SOIL ANALYTICAL DATA FOR ECOLOGICAL CHEMICALS OF CONCERN FROM THE 1992 SUPPLEMENTAL INVESTIGATION AND 2004 ADDITIONAL DATA COLLECTION INVESTIGATION
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	05SS101	05SS102	05SS103	05SS104	05SS105	05SS106	1SS15	1SS16	1SS17
Sample ID	05SS126	05SS128	05SS130	05SS132	05SS135	05SS138	1SB15-01	1SB16-01	1SB17-01
Sampling Date	11/15/92	11/15/92	11/15/92	11/16/92	11/16/92	11/17/92	10/02/04	10/02/04	10/02/04
Depth Range (feet bgs)	0.5-1.5	0.5-1.5	0.5-1.5	0.5-1.5	0.5-1.5	0.5-1.5	1.00 - 2.00	1.00 - 2.00	1.00 - 2.00
Pesticides (ug/kg)									
4,4'-DDE	5.5	2.2 J	480 J	0.63 J	4 U	3.7 U	4.2 U	520	11
4,4'-DDT	2.1 J	2.9 J	3,500 CD	0.49 J	4 U	0.11 NJ	4.2 U	960 J	10

Notes:

J = The analyte was positiviely identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit
U = The analyte was analyzed for, but not detected at the reported sample quantitation limit
NJ = Presumptive evidence for the presence of the analyte at an estimated concentration
CD = Analytical result confirmed by Gas Chromatography/Mass Spectrometry (GC/MS); Analyte identified in an analysis at a secondary dilution factor

bgs = below ground surface
ug/kg = microgram per kilogram

TABLE 2-5
STEP 2 AND STEP 3A SCREENING-LEVEL RISK ESTIMATES FOR TERRESTRIAL INVERTEBRATE AND PLANT EXPOSURES TO ECOLOGICAL CHEMICALS OF CONCERN IN SWMU 1 SURFACE SOIL
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Analyte	Contaminant Frequency/Range				Value used in Step 2 Screen	Value used in Step 3a Screen	Soil Screening Value	Reference	Maximum HQ [1]	Mean HQ [2]
	No. of Positive Detects/No. of Samples	Range of Positive Detections	Range of Non-Detects	Arithmetic Mean (Half Non-Detects)						
Pesticides (ug/kg)										
4,4'-DDD	11/28	0.9J - 13,000	4.1U - 49U	484.42	13,000	484.42	400	MHSPE 1994	32.50	1.21
4,4'-DDE	20/28	1.2J - 28,000	4.1U - 9.9U	1226.58	28,000	1226.58	400	MHSPE 1994	70.00	3.07
4,4'-DDT	21/28	1.2J - 43,000J	4.1U - 9.9U	1601.53	43,000	1601.53	400	MHSPE 1994	107.50	4.00
Metals (mg/kg)										
Antimony	19/24	0.079J - 23.6J	1.3UJ - 1.9UJ	5.12	23.6	5.12	5.00	Efroymson et al. 1997a	4.72	1.02
Cadmium	19/24	0.082J - 83.8	0.19U - 0.25U	5.12	83.8	5.12	4.00	Efroymson et al. 1997a	20.95	1.28
Copper	24/24	19.8 - 1,020	NA	194.00	1020	194.00	50.0	Efroymson et al. 1997b	20.40	3.88
Lead	23/23	1.3J - 966J	NA	147.33	966	147.33	50.0	Efroymson et al. 1997a	19.32	2.95
Mercury	21/24	0.03 - 0.85	0.02U - 0.03U	0.14	0.85	0.14	0.10	Efroymson et al. 1997b	8.50	1.40
Tin	13/24	1.1 - 181	0.69U - 1U	20.14	181	20.14	50.0	Efroymson et al. 1997a	3.62	0.40
Zinc	24/24	13.9J - 2,000J	NA	323.13	2,000	323.13	50.0	Efroymson et al. 1997a	40.00	6.46

Notes:

Shaded cells indicate a Hazard Quotient (HQ) greater than 1.0.

J = The analyte was positiviely identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection L
U = The analyte was analyzed for, but not detected at the reported sample quantitation limit

NA = Not Applicable
MHSPE = Ministry of Housing, Spatial Planning and Environment
HQ = Hazard Quotient
ug/kg = microgram per kilogram
mg/kg - milligram per kilogram

(1) The maximum HQ was derived in Step 2 of the ecological risk assessment process by dividing the maximum detected concentration by the soil screening value.
(2) The mean HQ was derived in Step 3a of the ecological risk assessment process by dividing the mean concentration (one-half non-detected results) by the soil screening value.

Table References:

Efroymson, R.A., Will, M.E., Suter II, G.W., and Wooten, A.C. 1997a. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision. Oak Ridge National Laboratory. Oak Ridge, TN. (ES/ER/TM-85/R3).

Efroymson, R.A., Will, M.E., and Suter II, G.W. 1997b. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process: 1997 Revision. Oak Ridge National Laboratory, Oak Ridge, TN. (ES/ER/TM-126/R2).

Ministry of Housing, Spatial Planning and Environment (MHSPE). 1994. Intervention values. Directorate-General for Environmental Protection, Department of Soil Protection, The Hague, Netherlands. May 9, 1994. DBO/0749

TABLE 2-6
STEP 2 AND STEP 3A SCREENING-LEVEL RISK ESTIMATES FOR TERRESTRIAL INVERTEBRATE AND PLANT EXPOSURES
TO ECOLOGICAL CHEMICALS OF CONCERN IN SWMU 1 SUBSURFACE SOIL
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

	Contaminant Frequency/Range									
Analyte	No. of Positive Detects/No. of Samples	Range of Positive Detections	Range of Non-Detects	Arithmetic Mean (Half Non-Detects)	Value used in Step 2 Screen	Value used in Step 3a Screen	Soil Screening Value	Reference	Maximum HQ [(1)]	Mean HQ [(2)]
Pesticides (ug/kg)										
4,4'-DDE	6/9	0.63J - 520	3.7U - 4.2U	113.92	520	113.92	400	MHSPE 1994	1.30	0.28
4,4'-DDT	7/9	0.11NJ - 3,500CD	4U - 4.2U	497.74	3,500	497.74	400	MHSPE 1995	8.75	1.24

Notes:

Shaded cells indicate a hazard quotient (HQ) greater than 1.0.

U = The analyte was analyzed for, but not detected at the reported sample quantitation limit
CD = Results were confirmed by GS/MS, Parameter identified in an analysis at a secondary dilution factor.
NJ = Presumptive evidence for the presence of the analyte at an estimated concentration

MHSPE = Ministry of Housing, Spatial Planning and Environment
HQ = Hazard Quotient
ug/kg = microgram per kilogram

(1) The maximum HQ was derived IN Step 2 of the ecological risk assessment process by dividing the maximum detected concentration by the soil screening value.
(2) The mean HQ was derived in Step 3a of the ecological risk assessment process by dividing the mean concentration (one-half non-detected results) by the soil screening value.

Table References:

Ministry of Housing, Spatial Planning and Environment (MHSPE). 1994. Intervention values. Directorate-General for Environmental Protection, Department of Soil Protection, The Hague, Netherlands. May 9, 1994. DBO/07494013.

TABLE 2-7
ENSENADA HONDA SEDIMENT ANALYTICAL DATA FOR ECOLOGICAL CHEMICALS OF CONCERN FROM THE 2003 ADDITIONAL DATA COLLECTION INVESTIGATION
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	1OW01	1OW02	1OW03	1OW04	1OW05	1OW06	1OW07	1OW08	1OW09
Sample ID	01OWSD01	01OWSD02	01OWSD03	01OWSD04	01OWSD05	01OWSD06	01OWSD07	01OWSD08	01OWSD09
Sampling Date	07/24/03	07/24/03	07/25/03	07/25/03	07/25/03	07/24/03	07/24/03	07/25/03	07/25/03
Depth Range (feet bgs)	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5
Metals (mg/kg)									
Arsenic	8.3	6.7	8.7	6.5	5.3	6.2	5.8	8.5	5.3
Cadmium	1.3 U	1.2 U	0.15 J	2.1 U	0.1 J	1.2 U	1.4 U	0.91 U	1.8 U
Copper	14	12	26	21	23	13	19	21	26
Mercury	0.034 J	0.029 J	0.062 J	0.085 U	0.066	0.032 J	0.024 J	0.023 J	0.031 J
Selenium	0.61 J	0.77 J	1.1 J	1.2 J	0.74 J	0.53 J	0.6 J	0.75 J	1 J
Zinc	18	16	32	25	32	17	27	13	30

Notes:

J = The analyte was positiviely identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit.
U = The analyte was analyzed for, but not detected at the reported sample quantitation limit

bgs = below ground surface
mg/kg = milligram per kilogram

Revised: December 1, 2009

TABLE 2-8
INGESTION-BASED SCREENING VALUES FOR TERRESTRIAL AVIAN OMNIVORES
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Chemical	Test Organism	Body Weight (kg)	Duration	Exposure Route	Effect/Endpoint	Test Material	NOAEL (mg/kg-bw/d)	MATC [(1)] (mg/kg-bw/d)	LOAEL (mg/kg-bw/d)	Data Reference [(2)]
Pesticides:										
4,4'-DDD	Leghorn chicken	2.04	30 days	Oral in diet	Growth (body weight)	4,4'-DDT	0.227 [(3)]	0.718	2.27	USEPA, 2007a [(6)]
4,4'-DDE	Leghorn chicken	2.04	30 days	Oral in diet	Growth (body weight)	4,4'-DDT	0.227 [(3)]	0.718	2.27	USEPA, 2007a [(6)]
4,4'-DDT	Leghorn chicken	2.04	30 days	Oral in diet	Growth (body weight)	4,4'-DDT	0.227 [(3)]	0.718	2.27	USEPA, 2007a [(6)]
Metals:										
Antimony	Northern bobwhite	0.19	6 weeks	Oral	Unknown	Unknown	4,740	14,989	47,400	Opresko et al. 1993 [(6)]
Cadmium	Multiple species	Various	Various	Oral in diet/water	Reproduction and growth	Cadmium, cadmium sulfate and cadmium chloride	1.47 [(4)]	3.06	6.36 [(5)]	USEPA 2005a
Copper	Chicken	1.52	84 days	Oral in diet	Reproduction (eggs per nest)	Copper	4.05 [(3)]	7.00	12.1	USEPA 2007b [(6)]
Lead	Leghorn chicken	1.81	4 weeks	Oral in diet	Reproduction (progeny counts)	Lead Acetate	1.63 [(3)]	2.31	3.26	USEPA 2005b [(6)]
Mercury	Mallard duck	1.00	3 generations	Oral in diet	Reproduction (egg and duckling counts)	Methylmercury Dicyandiamide	0.026	0.045	0.078	USEPA, 1997 [(6)]
	Japanese quail	0.15	6 months	Oral in diet	Reproduction (egg fertitlity and hatchability)	Mercuric Chloride	0.9	0.64	0.45	Sample et al., 1996 [(6)]
Tin	Japanese quail	0.15	6 weeks	Oral in diet	Reproduction (egg weight and hatchability	bis(Tributyltin)-oxide	6.8	10.7	16.9	Sample et al., 1996 [(6)]
Zinc	Multiple species	Various	Various	Oral in diet	Reproduction and growth	Zinc carbonate, zinc oxide, and zinc sulfate	66.1 [(4)]	106	171 [(5)]	USEPA, 2007c

Notes:

NOAEL = No Observed Adverse Effect Level
LOAEL = Lowest Observed Adverse Effect Level
MATC = Maximum Acceptable Toxicant Concentration
USEPA = United States Environmental Protection Agency
mg/kg-bw/day = milligram per kilogram-body weight per day
kg = kilogram

(1) MATC values were derived by calculating the geometric mean of the NOAEL and LOAEL values
(2) Data references for NOAEL and LOAEL values represent primary data sources (as reported by original authors) unless otherwise noted.
(3) The value shown, selected by the USEPA as the toxicity reference value for avian ecological soil screening value development, represents the highest bounded NOAEL below the lowest bounded LOAEL for reproduction, growth, or survival.
(4) The NOAEL value represents the geometric mean of all reproduction and growth-based NOAEL values listed within the cited ecological soil screening level document (cadmium: USEPA, 2005a; zinc: USEPA, 2007c). The value was calculated and used by the USEPA to derive the avain ecological soil screening level.
(5) The LOAEL represents a geometric mean of all reproduction- and growth-based LOAEL values listed within the cited ecological soil screeing level document (cadmium: USEPA, 2005a; zinc: USEPA, 2007c). The value was calculated by Baker Environmental, Inc.
(6) Data references for NOAEL and LOAEL values represent secondary data sources (see text in Section 2.4.1 for primary data source [i.e., original authors]).

Table References:

Opresko, D.M., B.E. Sample, and G.W. Suter II. 1993. Toxicological Benchmarks for Wildlife. Environmental Restoration Division, ORNL Environmental Restoration Program. ES/ER/TM-86.

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. Toxicological Benchmarks for Wildlife: 1996 Revision. Risk Assessment Program, Health Sciences Research Division. Oak Ridge, Tennessee.

U.S. Environmental Protection Agency. 2007a. Ecological Soil Screening Levels for DDT and Metabolites (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-57.

TABLE 2-8
INGESTION-BASED SCREENING VALUES FOR TERRESTRIAL AVIAN OMNIVORES
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Table References (continued):

USEPA. 2007b. Ecological Soil Screening Level for Copper (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.D. OSWER Directive 9285.7-77.

USEPA. 2007c. Ecological Soil Screening Levels for Zinc (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-73.

USEPA. 2005a. Ecological Soil Screening Levels for Cadmium (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-65.

USEPA. 2005b. Ecological Soil Screening Levels for Lead (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-70.

USEPA. 2003. Guidance for Developing Ecological Soil Screening Levels. Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 92857-55.

USEPA. 1997. Mercury Study Report to Congress. Volume VI: An Ecological Assessment for Anthropogenic Mercury Emissions in the United States. Office of Air Quality Planning and Standards and Office of Research and Development, Washington, D.C. EPA-452/R-97-008.

TABLE 2-9
INGESTION-BASED SCREENING VALUES FOR THE WEST INDIAN MANATEE
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Chemical	Test Organism	Body Weight (kg)	Duration	Exposure Route	Effect/Endpoint	Test Material	Test Species NOAEL (mg/kg-bw/d)	Test Species MATC [1] (mg/kg-bw/d)	Test Species LOAEL (mg/kg-bw/d)	Data Reference [2]	Ecological Receptor	Receptor Species [3] NOAEL (mg/kg-bw/d)	Receptor Species [3] MATC [1] (mg/kg-bw/d)	Receptor Species [3] LOAEL (mg/kg-bw/d)
Metals:														
Arsenic	Dog	10.1	8 weeks	Oral in diet	Growth (body weight)	Sodium Arsenite	1.04 [4]	1.31	1.66	USEPA, 2005a	West Indian manatee	0.3486	0.4405	0.5564
Cadmium	Rat	0.43	2 weeks	Oral in water	Growth (body weight)	Cadmium Acetate	0.77 [4]	2.44	7.70	USEPA, 2005b	West Indian manatee	0.1172	0.3708	1.1724
Copper	Pig	100	4 weeks	Oral in diet	Growth (body weight)	Copper Sulfate Pentahydrate	5.6 [4]	7.23	9.34	USEPA, 2007a	West Indian manatee	3.3298	4.3002	5.5536
Mercury	Mink	1.00	93 days	Oral in diet	Mortality (weight loss)	Methyl Mercury Chloride	0.015	0.019	0.025	Sample et al., 1996	West Indian manatee	0.0028	0.0036	0.0047
	Mink	1.00	6 months	Oral in diet	Reproduction (fertility and kit weight)	Mercuric Chloride	1.0	3.2	10.0	Sample et al., 1996	West Indian manatee	0.1880	0.5946	1.8803
Selenium	Pig	17.8	37 days	Oral in diet	Growth (body weight)	Sodium selenite	0.143 [4]	0.173	0.215	USEPA, 2007b	West Indian manatee	0.0552	0.0668	0.0830
Zinc	Pig	167	1 year	Oral in diet	Reproduction (offspring development)	Zinc Oxide	8.23 [5]	26.0	82.3	USEPA, 2007c	West Indian manatee	5.5630	17.5920	55.6297

Notes:

kg = kilogram
mg/kg-bw/day = milligram per kilogram-body weight per day
NOAEL = No Observed Effect Level
LOAEL = Lowest Observed Effect Level
MATC = Maximum Acceptable Toxicant Concentration

(1) MATC values were derived by calculating the geometric mean of the NOAEL and LOAEL values
(2) Data references for NOAEL and LOAEL values represent secondary data sources (see text in Section 2.4.1 for primary data source [i.e., original authors]).
(3) NOAEL, LOAEL, and MATC values were adjusted to reflect differences in body weights between the mammalian test species and the West Indian manatee (see Section 2.5.4).
(4) The value shown, selected by by the USEPA as the toxicity reference value for mammalian ecological soil screening value development, represents the highest bounded NOAEL below the lowest bounded LOAEL for reproduction, growth, or survival.
(5) See text in Section 2.4.1.9 for a description of the NOAEL value.

Table References:

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. Toxicological Benchmarks for Wildlife: 1996 Revision. Oak Ridge National Laboratory, Health Sciences Research Division, Oak Ridge, TN. ES/ER/TM-86/R3.

U.S. Environmental Protection Agency (USEPA). 2007a. Ecological Soil Screening Levels for Copper (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-68.

USEPA. 2007b. Ecological Soil Screening Levels for Selenium (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-72.

USEPA. 2007c. Ecological Soil Screening Levels for Zinc (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-73.

USEPA. 2005a. Ecological Soil Screening Levels for Arsenic (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-62

USEPA. 2005b. Ecological Soil Screening Levels for Cadmium (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-65.

Revised: April 5, 2010

TABLE 2-10
DECISION RULES FOR THE BASELINE ECOLOGICAL RISK ASSESSMENT
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Line of Evidence	Decision Based on	Uncertainties/ Limitations/ Factors to Consider	Decision Criteria	Decision Recommendations/Actions
Comparison of the spatial and statistical distributions (95% UCL of the mean concentrations) in SWMU 1 surface soil to literature-based toxicological thresholds	Do the 95% UCL of the mean surface soil concentrations exceed acceptable toxicological thresholds? What is the spatial pattern of exceedance of these criteria?	Literature-based toxicological thresholds are not site-specific (do not take into consideration site-specific factors that can influence bioavailability)	HQ > 1.0	Indication of unacceptable risk
			HQ ≤ 1.0	Indication of acceptable/minimal risk
Comparisons of toxic response in SWMU 1 surface soil to the toxic response in reference area surface soil	Is there a significant reduction ($\alpha = 0.05$) in the survival, growth, and/or reproduction of *Eisenia fetida* exposed to SWMU 1 surface soil?	Low control or reference survival, growth, and/or reproduction - potential inability to make decision; power of toxicity and statistical tests	$p < 0.05$, No significant difference	Unacceptable risk identified
			$p \geq 0.05$, Significant difference	Indication of acceptable/minimal risk; no further action recommended
Demonstration of a dose-response relationship between chemical concentrations and toxicity test endpoint response variables	Does a response relationship exists (indicated by simple regression with a $p < 0.05$) between ecological chemicals of concern and the most sensitive of the measured response variables (survival, growth, or reproduction for *Eisenia fetida*)?	Confounding influences may include the use of inappropriate reference samples, inability of field effort to capture known concentration gradient of ecological COCs, response variables outside of concentration ranges, and physical/chemical parameters (i.e., grainsize, TOC, and pH) impacting the response variable.	Significant difference ($p < 0.05$), low variability in response	Unacceptable risk identified
			Significant difference ($p < 0.05$), high variability in response	Large variability in response variable caused by confounding variables; investigation into variable impact and weight to arrive at decision point
			No significant difference ($p > 0.05$)	Indication of acceptable/minimal risk only after investigation of the limits and uncertainties associated with the potential for confounding influences; no further action recommended
Comparison of American robin dietary exposures (based on 95 percent UCL of the mean ecological COC concentrations in the tissue of earthworms exposed to SWMU 1 surface soil during toxicity testing) to literature-based toxicity reference values	Do dietary dose estimates using earthworm tissue data exceed NOAEL-based ingestion screening values?	Site-specific bioaccumulation; confounding influences may include earthworm exposure point concentrations (were earthworms exposed to maximum concentrations?)	HQ > 1.0	Indication of unacceptable risk
			HQ ≤ 1.0	Indication of acceptable/minimal risk
Comparison of West Indian manatee dietary exposures (based on maximum ecological COC concentrations in field collected turtle grass tissue samples) to to literature-based toxicity reference values	Do dietary dose estimates using turtle grass tissue data exceed NOAEL-based ingestion screening values?	Site-specific bioaccumulation; confounding factors may include turtle grass exposure point concentrations (was turtle grass tissue collected from areas with ecological COC concentrations representative of historical sediment data?)	HQ > 1.0	Indication of unacceptable risk
			HQ ≤ 1.0	Indication of acceptable/minimal risk

Notes:

HQ = Hazard Quotient
UCL = Upper Confidence Limit
TOC = Total Organic Carbon
COC = Chemical of Concern
LOAEL = Lowest Observed Adverse Effect Levels
NOAEL = No Observed Adverse Effect Concentration

TABLE 3-1
SWMU 1 AND UPLAND REFERENCE AREA SURFACE SOIL SAMPLING AND ANALYTICAL PROGRAM: VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

		Analyses Requested								
Sample Media/Type	**Sample Identification**	**PAHs**	**Appendix IX Organochlorine Pesticides**	**Appendix IX Metals**	**Sb, Cd, Cu, Pb, Hg, Sn, Zn**	**4,4'-DDD, 4,4'-DDE, and 4,4'-DDT**	**Total Organic Carbon**	**Grain Size**	**pH**	**Comments**
Surface Soil Samples (Solid)	**SWMU 1:**									
	1V-SS01						X	X	X	
	1V-SS02						X	X	X	
	1V-SS03						X	X	X	
	1V-SS04						X	X	X	
	1V-SS05						X	X	X	
	1V-SS06						X	X	X	
	Refernce Area No. 1:									
	REF-SS01	X	X	X			X	X	X	
	REF-SS01D	X	X	X						Duplicate
	REF-SS01MS	X	X	X						Matrix spike
	REF-SS01MSD									Matrix spike duplicate
	REF-SS02	X	X	X			X	X	X	
	REF-SS03				X	X	X	X	X	
	REF-SS03D				X	X				Duplicate
	REF-SS04				X	X	X	X	X	
	Reference Area No. 2:									
	REF-SS05	X	X	X			X	X	X	
	REF-SS06	X	X	X			X	X	X	
	REF-SS07				X	X	X	X	X	
	REF-SS08				X	X	X	X	X	
	Reference Area No. 3:									
	REF-SS09	X	X	X			X	X	X	
	REF-SS010	X	X	X			X	X	X	
	REF-SS011				X	X	X	X	X	
	REF-SS012				X	X	X	X	X	
QA/QC Samples (Aqueous)	**Equipment Rinsate Blanks:**									
	1V-ER01 (1)	X	X	X						Stainless steel spoon
	2V-ER01 (2)	X	X	X						Stainless steel bucket auger
	Field Blanks:									
	1V-FB01	X	X	X						Laboratory-grade deionized water

TABLE 3-1
SWMU 1 AND UPLAND REFERENCE AREA SURFACE SOIL SAMPLING AND ANALYTICAL PROGRAM: VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Notes:

Sb = Antimony
Cd = Cadmium
Cu = Copper
Pb = Lead
Hg = mercury
Sn = Tin
Zn = Zinc
QA/QC = Quality Assurance/Quality Control
SWMU = Solid Waste Management Unit

(1) The equipment rinsate blank was collected by passing laboratory-grade deionized water over an unused stainless steel spoon.

(2) The equipment rinsate blank was collected by passing laboratory-grade deionized water through an unused stainless steel hand auger.

TABLE 3-2
ANALYTICAL METHODOLOGY: VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Sample Medium/Type	Analyte	Analytical Method	Preparation Method
Verification of the Field Sampling Design: SWMU 1 and Upland Reference Areas			
Suface Soil Samples (Solid)	Appendix IX PAHs (low level)	SW-846 8270C	SW-846 3550B
	Appendix IX organochlorine pesticides	SW-846 8081A	SW-846 3550B
	Appendix IX metals (except mercury)	SW-846 6020	SW-846 3050B
	Mercury	SW-846 7471A	SW-846 7471A
	Grain size	ASTM D-422	NA
	Total organic carbon	Lloyd Kahn	NA
	pH	SW-846 9045C	NA
QA/QC Samples [1] (Aqueous)	Appendix IX PAHs (low level)	SW-846 8270C	SW-846 3520C
	Appendix IX organochlorine pesticides	SW-846 8081A	SW-846 3520C
	Appendix IX metals (except mercury)	SW-846 6020	SW-846 3005A
	Mercury	SW-846 7470A	SW-846 7470A
Verification of the Field Sampling Design: Open Water Reference Areas [2]			
Sediment Samples (Solid)	Appendix IX metals (except mercury)	SW-846 6020	SW-846 3050B
	Mercury	SW-846 7471A	SW-846 7471A
	Grain size	ASTM D-422	NA
	Total organic carbon	SW-846 9060	NA
	pH	SW-846 9045C	NA
QA/QC Samples [1] (Aqueous)	Appendix IX metals (except mercury)	SW-846 6020	SW-846 3005A
	Mercury	SW-846 7470A	SW-846 7470A

Notes:

QA/QC = Quality Assurance/Quality Control
ASTM = American Society for Testing and Materials
SW-846 = Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods
PAH = Polynuclear Aromatic Hydrocarbon
NA = Not Applicable

(1) The aqueous QA/QC samples consist of equipment rinsate and field blanks.

(2) Open water reference area sediment samples and associated QA/QC samples were collected on September 20, 2006 and September 21, 2006 during verification of the field sampling design for a baseline ecological risk assessment at SWMU 45

TABLE 3-3
OPEN WATER REFERENCE AREA SEDIMENT SAMPLING AND ANALYTICAL PROGRAM:
VERIFICATION OF THE FIELD SAMPLIING DESIGN
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

		Analyses Requested			
Sample Media/Type	**Sample Identification [1]**	**As, Cd, Cu, Hg, Se, and Zn**	**Total Organic Carbon**	**Grain Size**	**Comments**
Sediment Samples (Solid)	**Reference Area No. 1:**				
	REF1-SD01V	X	X	X	
	REF1-SD02V	X	X	X	
	REF1-SD03V	X	X	X	
	REF1-SD04V	X	X	X	
	REF1-SD05V	X	X	X	
	REF1-SD06V	X	X	X	
	Reference Area No. 2:				
	REF2-SD01V	X	X	X	
	REF2-SD02V	X	X	X	
	REF2-SD03V	X	X	X	
	REF2-SD04V	X	X	X	
	REF2-SD04VD	X			Duplicate
	REF2-SD04VMS	X			Matrix spike
	REF2-SD04VMSD	X			Matrix spike duplicate
	REF2-SD05V	X	X	X	
	REF2-SD06V	X	X	X	
	Reference Area No. 3:				
	REF3-SD01V	X	X	X	
	REF3-SD01VD	X			Duplicate
	REF3-SD02V	X	X	X	
QA/QC Samples (Aqueous)	**Equipment Rinsate Blanks:**				
	45B-ER01V [2]	X			Sediment core liner
	Field Blanks:				
	45B-FB01V	X			Laboratory-grade deionized water

Notes:

As = Arsenic
Cd = Cadmium
Cu = Copper
Hg = Mercury
Se = Selenium
Zn = Zinc
QA/QC = Quality Assurance/Quality Control

(1) Open water reference area sediment samples and associated QA/QC samples were collected on September 20, 2006 and September 21, 2006 during verification of the field sampling design for a BERA at SWMU 45. Analytical data from this sampling event were used to identifiy an appropriate open water reference area for the BERA at SWMU 1.

(2) The equipment rinsate blank was collected by passing laboratory-grade deionized water through an unused sediment core liner.

TABLE 3-4
SOIL SCREENING VALUES FOR METALS, PAHS, AND ORGANOCHLORINE PESTICDES
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Chemical	Surface Soil Screening Value	Reference	Comment
PAHs (mg/kg):			
Low Molecular Weight PAHs	29.0 (1)	USEPA 2007a	Ecological soil screening level for terrestrial invertebrates
High Molecular weight PAHS	18.0 (2)	USEPA 2007a	Ecological soil screening level for terrestrial invertebrates
Pesticides (ug/kg):			
4,4'-DDD	401 (3)	MHSPE 2000	Value for total DDD, DDE, and DDT
4,4'-DDE	401 (3)	MHSPE 2000	Value for total DDD, DDE, and DDT
4,4'-DDT	401 (3)	MHSPE 2000	Value for total DDD, DDE, and DDT
Aldrin	400 (3)	MHSPE 2000	Value for total aldrin, endrin, and dieldrin
alpha-BHC	201 (3)	MHSPE 2000	Value for total BHC compounds
Chlordane (technical)	100	Friday 1998	Background-based value
beta-BHC	201 (3)	MHSPE 2000	Value for total BHC compounds
Chlorobenzilate	NA	---	---
delta-BHC	201 (3)	MHSPE 2000	Value for total BHC compounds
Dieldrin	400 (3)	MHSPE 2000	Value for total aldrin, endrin, and dieldrin
Endosulfan I	100	Friday 1998	Background-based value
Endosulfan II	100	Friday 1998	Background-based value
Endosulfan sulfate	100	Friday 1998	Background-based value
Endrin	400 (3)	MHSPE 2000	Value for total aldrin, endrin, and dieldrin
Endrin aldehyde	100	Friday 1998	Background-based value
gamma-BHC (lindane)	201 (3)	MHSPE 2000	Value for total BHC compounds
gamma-Chlordane	100	Friday 1998	Background-based value
Heptachlor	100	Friday 1998	Background-based value
Heptachlor epoxide	100	Friday 1998	Background-based value
Isodrin	100	Friday 1998	Background-based value
Kepone	100	Friday 1998	Background-based value
Methoxychlor	100	Friday 1998	Background-based value
Toxaphene	100	Friday 1998	Background-based value
Metals (mg/kg):			
Antimony	78.0	USEPA 2005a	Ecological soil screening level for terrestrial invertebrates
Arsenic	18.0	USEPA 2005b	Ecological soil screening level for terrestrial plants
Barium	330	USEPA 2005c	Ecological soil screening level for terrestrial invertebrates
Beryllium	40.0	USEPA 2005d	Ecological soil screening level for terrestrial invertebrates
Cadmium	140	USEPA 2005e	Ecological soil screening level for terrestrial invertebrates
Chromium	57.0	USEPA 2008	Reproduction-based MATC for *Eisenia andrei* (earthworm)
Cobalt	13.0	USEPA 2005f	Ecological soil screening level for terrestrial plants

TABLE 3-4
SOIL SCREENING VALUES FOR METALS, PAHS, AND ORGANOCHLORINE PESTICDES
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Chemical	Surface Soil Screening Value	Reference	Comment
Metals (mg/kg):			
Copper	80.0	USEPA 2007b	Ecological soil screening level for terrestrial invertebrates
Lead	1,700	USEPA 2005g	Ecological soil screening level for terrestrial invertebrates
Mercury	0.1	Efroymson et al. 1997a	Toxicological threshold for earthworms
Nickel	280	USEPA 2007c	Ecological soil screening-level for terrestrial invertebrates
Selenium	4.1	USEPA 2007d	Ecololgical soil screening-level for terrestrial invertebrates
Silver	560	USEPA 2006	Ecological soil screening level for terrestrial plants
Thallium	1.0	Efroymson et al. 1997b	Toxicological threshold for plants
Tin	50.0	Efroymson et al. 1997b	Toxicological threshold for plants
Vanadium	10.0	USEPA 2005h	Growth-based LOAEC for *Brassica oleracea* (broccoli) with a safety factor of 10
Zinc	120	USEPA 2007e	Ecological soil screening-level for terrestrial invertebrates

Notes:

MHSPE = Ministry of Housing, Spatial Planning and Environment
USEPA = United States Environmental Protection Agency
LOAEC = Lowest Observed Adverse Effect Concentration
MATC = Maximum Acceptable Toxicant Concentration
ug/kg = micrograms per kilogram
mg/kg = milligram per kilogram
PAH = Polycyclic Aromatic Hydrocarbon

(1) Low molecular weight PAHs are defined by the USEPA (2007a) as PAH compounds composed of fewer than four rings. The low molecular weight PAH compounds analyzed for in SWMU 1 surface soil were 1-methylnaphthalene, 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, fluoranthene, fluorene, naphthalene, and phenanthrene.

(2) High molecular weight PAHs are defined by the USEPA (2007a) as PAH compounds composed of four or more rings. The high molecular weight PAH compounds analyzed for in SWMU 1 surface soil were benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, and pyrene.

(3) The screening value shown is an average of the target and intervention soil standards. The value is based on a default organic carbon content of 0.02 (2.0 percent), which represents a minimum value (adjustment range is 2 to 30 percent).

Table References:

Efroymson, R.A., M.E. Will, and G.W. Suter II. 1997a. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process: 1997 Revisions. Oak Ridge National Laboratory, Oak Ridge, TN. ES/ER/TM-126/R2.

Efroymson, R.A., M.E. Will, G.W. Suter II, and A.C. Wooten. 1997b. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revisions. Oak Ridge National Laboratory, Oak Ridge, TN. ES/ER/TM-85/R3

TABLE 3-4
SOIL SCREENING VALUES FOR METALS, PAHS, AND ORGANOCHLORINE PESTICDES
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Table References (continued):

Friday, G.P. 1998. Ecological Screening Values for Surface Water, Sediment, and Soil. Westinghouse Savannah River Company, Savannah River Site, Aiken, SC. WSRC-TR-98-00110.

Ministry of Housing, Spatial Planning and Environment (MHSPE). 2000. Circular on Target Values and Intervention Values for Soil Remediation. Directorate-General for Environmental Protection, Department of Soil Protection, The Hague, Netherlands. February 4, 2000.

United States Environmental Protection Agency (USEPA). 2008. Ecological Soil Screening Levels for Chromium (Interim Final). Officeof Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-66.

USEPA. 2007a. Ecological Soil Screening Levels for Polycyclic Aromatic Hydrocarbons (PAHs) (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-78.

USEAP. 2007b. Ecological Soil Screening Levels for Copper (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-68.

USEAP. 2007c. Ecological Soil Screening Levels for Nickel (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-76.

USEAP. 2007d. Ecological Soil Screening Levels for Selenium (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-72.

USEPA. 2007e. Ecological Soil Screening Levels for Zinc (Interim Final). Office of Solid Waste and Emergecny Response, Washington, D.C. OSWER Directive 9285.7-73.

USEPA. 2006. Ecological Soil Screening Levels for Silver (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWEER Directive 9285.7-77.

USEPA. 2005a. Ecological Soil Screening Levels for Antimony (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-61.

USEPA. 2005b. Ecological Soil Screening Levels for Arsenic (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-62.

USEPA. 2005c. Ecological Soil Screening Levels for Barium (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-63.

USEPA. 2005d. Ecological Soil Screening Levels for Beryllium (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-64.

USEPA. 2005e. Ecological Soil Screening Levels for Cadmium (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-65.

USEPA. 2005f. Ecological Soil Screening Levels for Cobalt (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-67

USEPA. 2005g. Ecological Soil Screening Levels for Lead (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-70.

USEPA. 2005h. Ecological Soil Screening Levels for Vanadium (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-75.

TABLE 3-5
SWMU 1 AND UPLAND REFERENCE AREA NO. 2 SAMPLING AND ANALYTICAL PROGRAM: BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

		Analyses Requested							
Sample Media/Type	**Sample Identification**	**Sb, Cd, Cu, Pb, Hg, Sn, Zn**	**4,4'-DDD, 4,4'-DDE, and 4,4'-DDT**	**TOC, pH, and Grain Size**	**Earthworm Toxicity Test**	**Percent Lipids**	**As, Cd, Cu, Hg, Se, and Zn**	**As, Cd, Cu, Hg, Pb, Sb, Se, Sn, and Zn**	**Comments**
Surface Soil Samples (Solid)	**SWMU 1:**								
	1B-SS01	X	X						Historic sample location 1SS04
	1B-SS02	X	X						Grid location near 1B-SS01
	1B-SS03	X	X						Grid location near 1B-SS01
	1B-SS04	X	X						Grid location near 1B-SS01
	1B-SS04D	X	X						Duplicate
	1B-SS05	X	X						Grid location near 1B-SS01
	1B-SS06	X	X						Historic sample location 1SS06
	1B-SS07	X	X						Grid location near 1B-SS06
	1B-SS08	X	X						Grid location near 1B-SS06
	1B-SS09	X	X	X	X				Grid location near 1B-SS06
	1B-SS10	X	X						Grid location near 1B-SS06
	1B-SS11	X	X						Historic sample lcoation 1SS10
	1B-SS12	X	X						Grid location near 1B-SS11
	1B-SS13	X	X	X	X				Grid location near 1B-SS11
	1B-SS14	X	X						Grid location near 1B-SS11
	1B-SS14D	X	X						Duplicate
	1B-SS14MS	X	X						Matric spike
	1B-SS14MSD	X	X						Matrix spike duplicate
	1B-SS15	X	X	X	X				Grid location near 1B-SS011
	1B-SS16	X	X						Historic sample location 1SS16
	1B-SS17	X	X						Grid location near 1B-SS16
	1B-SS18	X	X	X	X				Grid location near 1B-SS16
	1B-SS19	X	X	X	X				Grid location near 1B-SS16
	1B-SS20	X	X						Grid location near 1B-SS16
	1B-SS21	X	X						Historic sample location 1SS09
	1B-SS22	X	X						Grid location near 1B-SS21
	1B-SS23	X	X						Grid location near 1B-SS21
	1B-SS24	X	X						Grid location near 1B-SS21
	1B-SS24D	X	X						Duplicate

TABLE 3-5
SWMU 1 AND UPLAND REFERENCE AREA NO. 2 SAMPLING AND ANALYTICAL PROGRAM: BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

		Analyses Requested							
Sample Media/Type	Sample Identification	Sb, Cd, Cu, Pb, Hg, Sn, Zn	4,4'-DDD, 4,4'-DDE, and 4,4'-DDT	TOC, pH, and Grain Size	Earthworm Toxicity Test	Percent Lipids	As, Cd, Cu, Hg, Se, and Zn	As, Cd, Cu, Hg, Pb, Sb, Se, Sn, and Zn	Comments
Surface Soil Samples (Solid)	**SWMU 1 (continued):**								
	1B-SS25	X	X						Grid location near 1B-SS21
	1B-SS26	X	X						Historic sample location 1SD02
	1B-SS27	X	X						Grid location near 1B-SS26
	1B-SS28	X	X						Grid location near 1B-SS26
	1B-SS29	X	X	X	X				Grid location near 1B-SS26
	1B-SS30	X	X						Grid location near 1B-SS26
	1B-SS31	X	X						Historic sample location 1SS11
	1B-SS32	X	X						Grid location near 1B-SS31
	1B-SS33	X	X	X	X				Grid location near 1B-SS31
	1B-SS34	X	X						Grid location near 1B-SS31
	1B-SS34D	X	X						Duplicate
	1B-SS34MS	X	X						Matric spike
	1B-SS34MSD	X	X						Matrix spike duplicate
	1B-SS35	X	X						Grid location near 1B-SS31
	1B-SS36	X	X						Historic sample location 1SS07
	1B-SS37	X	X	X	X				Grid location near 1B-SS37
	1B-SS38	X	X						Grid location near 1B-SS37
	1B-SS39	X	X	X	X				Grid location near 1B-SS37
	1B-SS40	X	X						Grid location near 1B-SS37
	1B-SS41	X	X						Historic sample location 1SD01
	1B-SS42	X	X						Grid location near 1B-SS41
	1B-SS43	X	X						Grid location near 1B-SS41
	1B-SS44	X	X						Grid location near 1B-SS41
	1B-SS44D	X	X						Duplicate
	1B-SS45	X	X						Grid location near 1B-SS41
	1B-SS46	X	X	X	X				Historic sample location 1SS13
	1B-SS47	X	X						Grid location near 1B-SS46
	1B-SS48	X	X	X	X				Grid location near 1B-SS46
	1B-SS49	X	X	X	X				Grid location near 1B-SS46

TABLE 3-5
SWMU 1 AND UPLAND REFERENCE AREA NO. 2 SAMPLING AND ANALYTICAL PROGRAM: BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

		Analyses Requested							
Sample Media/Type	**Sample Identification**	**Sb, Cd, Cu, Pb, Hg, Sn, Zn**	**4,4'-DDD, 4,4'-DDE, and 4,4'-DDT**	**TOC, pH, and Grain Size**	**Earthworm Toxicity Test**	**Percent Lipids**	**As, Cd, Cu, Hg, Se, and Zn**	**As, Cd, Cu, Hg, Pb, Sb, Se, Sn, and Zn**	**Comments**
Surface Soil Samples (Solid)	**SWMU 1 (continued):**								
	1B-SS50	X	X	X	X				Grid location near 1B-SS46
	1B-SS51	X	X	X	X				Historic sample location 1SS12
	1B-SS52	X	X						Grid location near 1B-SS51
	1B-SS53	X	X						Grid location near 1B-SS51
	1B-SS54	X	X						Grid location near 1B-SS51
	1B-SS54D	X	X						Duplicate
	1B-SS54MS	X	X						Matric spike
	1B-SS54MSD	X	X						Matrix spike duplicate
	1B-SS55	X	X						Grid location near 1B-SS51
	Upland Reference Area No. 2:								
	1B-REF-SS01	X	X						
	1B-REF-SS02	X	X						
	1B-REF-SS03	X	X	X	X				
	1B-REF-SS04	X	X						
	1B-REF-SS04D	X	X						Duplicate
	1B-REF-SS04MS	X	X						Matrix spike
	1B-REF-SS04MSD	X	X						Matrix spike duplicate
	1B-REF-SS05	X	X	X	X				
	1B-REF-SS06	X	X	X	X				
Earthworm Tissue Samples (Solid)	**SWMU 1:**								
	1B-SS09	X	X			X			Earthworms from toxicity tests
	1B-SS13	X	X			X			Earthworms from toxicity tests
	1B-SS15	X	X			X			Earthworms from toxicity tests
	1B-SS18	X	X			X			Earthworms from toxicity tests
	1B-SS19	X	X			X			Earthworms from toxicity tests
	1B-SS29	X	X			X			Earthworms from toxicity tests
	1B-SS33	X	X			X			Earthworms from toxicity tests
	1B-SS37	X	X			X			Earthworms from toxicity tests
	1B-SS39	X	X			X			Earthworms from toxicity tests

TABLE 3-5
SWMU 1 AND UPLAND REFERENCE AREA NO. 2 SAMPLING AND ANALYTICAL PROGRAM: BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

		Analyses Requested							
Sample Media/Type	**Sample Identification**	**Sb, Cd, Cu, Pb, Hg, Sn, Zn**	**4,4'-DDD, 4,4'-DDE, and 4,4'-DDT**	**TOC, pH, and Grain Size**	**Earthworm Toxicity Test**	**Percent Lipids**	**As, Cd, Cu, Hg, Se, and Zn**	**As, Cd, Cu, Hg, Pb, Sb, Se, Sn, and Zn**	**Comments**
Earthworm Tissue Samples (Solid)	**SWMU 1 (continued):**								
	1B-SS46	X	X			X			Earthworms from toxicity tests
	1B-SS48	X	X			X			Earthworms from toxicity tests
	1B-SS49	X	X			X			Earthworms from toxicity tests
	1B-SS50	X	X			X			Earthworms from toxicity tests
	1B-SS51	X	X			X			Earthworms from toxicity tests
	Upland Reference Area No. 2:								
	1B-REF-03	X	X			X			Earthworms from toxicity tests
	1B-REF-05	X	X			X			Earthworms from toxicity tests
	1B-REF-06	X	X			X			Earthworms from toxicity tests
Trutle Grass Tissue Samples (Solid)	**SWMU 1:**								
	1B-SG01-AG						X		Above ground tissue sample
	1B-SG01-WP						X		Whole-plant tissue samples
	1B-SG02-AG						X		Above ground tissue sample
	1B-SG02-WP						X		Whole-plant tissue samples
	1B-SG03-AG						X		Above ground tissue sample
	1B-SG03-WP						X		Whole-plant tissue samples
Sediment Samples (Solid)	**SWMU 1:**								
	1B-OWSD01			X			X		Co-located with 1B-SG01-AG and 1B-SG01-WP
	1B-OWSD02			X			X		Co-located with 1B-SG02-AG and 1B-SG02-WP
	1B-OWSD03			X			X		Co-located with 1B-SG03-AG and 1B-SG03-WP
	IB-OWSD03D						X		Duplicate
QA/QC Samples (Aqueous)	**Equipment Rinsate Blanks:**								
	IB-ER01 (1)		X					X	Stainless steel spoon
	Field Blanks:								
	1B-FB01		X					X	Laboratory-grade deionized water

TABLE 3-5
SWMU 1 AND UPLAND REFERENCE AREA NO. 2 SAMPLING AND ANALYTICAL PROGRAM: BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Notes:

As = Arsenic
Cd = Cadmium
Cu = Copper
Hg = Mercury
Pb = Lead
Sb = Antimony
Se = Selenium
Sn = Tin
Zn = Zinc
QA/QC = Quality Assurance/Quality Control
TOC = Total Organic Carbon

(1) The equipment rinsate blank was collected by passing laboratory-grade deionized water over an unused stainless steel spoon.

TABLE 3-6
ANALYTICAL METHODOLOGY: BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Sample Medium/Type	Analyte	Analytical Method	Preparation Method
Suface Soil Samples (Solid)	Appendix IX organochlorine pesticides	SW-846 8081A	SW-846 3550B/3541
	Appendix IX metals (except mercury)	SW-846 6020	SW-846 3050B
	Mercury	SW-846 7471A	SW-846 7471A
	Grain size	ASTM D-422	NA
	Total organic carbon	Lloyd Kahn	NA
	pH	SW-846 9045C	NA
Earthworm Tissue Samples (Solid)	Appendix IX organochlorine pesticides	SW-846 8081A	SW-846 3550B
	Appendix IX metals (except mercury)	SW-846 6020	SW-846 3050B
	Mercury	SW-846 7471A	SW-846 7471A
	Percent lipids	STL SOP	NA
Open Water Sediment Samples (Solid)	Appendix IX metals (except mercury)	SW-846 6020	SW-846 3050B
	Mercury	SW-846 7471A	SW-846 7471A
	Grain size	ASTM D-422	NA
	Total organic carbon	Lloyd Kahn	NA
	pH	SW-846 9045C	NA
Turtle Grass Tissue Samples (Solid)	Appendix IX metals (except mercury)	SW-846 6020	SW-846 3050B
	Mercury	SW-846 7471A	SW-846 7471A
	Percent Moisture	EPA 160.4	NA
QA/QC Samples [1] (Aqueous)	Appendix IX organochlorine pesticides	SW-846 8081A	SW-846 3520C
	Appendix IX metals (except mercury)	SW-846 6020	SW-846 3005A
	Mercury	SW-846 7470A	SW-846 7470A

Notes:

QA/QC = Quality Assurance/Quality Control
ASTM = American Society for Testing and Materials
SW-846 = Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods
EPA = Environmental Protection Agency
STL = Severn Trent Laboratories, Inc.
SOP = Standard operating Procedure
NA = Not Applicable

(1) The aqueous QA/QC samples consist of equipment rinsate and field blanks.

TABLE 3-7
OPEN WATER REFERENCE AREA NO. 2 TURTLE GRASS AND SEDIMENT SAMPLING AND ANALYTICAL PROGRAM: BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

		Analyses Requested		
Sample Media/Type	**Sample Identification [1]**	**TOC and Grain Size**	**As, Cd, Cu, Hg, Se, and Zn**	**Comment**
Turtle Grass Tissue Samples (Solid)	REF2-VEG-AB01		X	Above ground tissue sample
	REF2-VEG-WB01		X	Whole-plant tissue sample
	REF2-VEG-AB02		X	Above ground tissue sample
	REF2-VEG-WB02		X	Whole-plant tissue sample
	REF2-VEG-AB03		X	Above ground tissue sample
	REF2-VEG-WB03		X	Whole plant tissue sample
Co-located Sediment Samples (Solid)	REF2-VEG-SED01	X	X	Co-located with REF2-VEG-AB01 and REF2-VEG-WB01
	REF2-VEG-SED02	X	X	Co-located with REF2-VEG-AB02 and REF2-VEG-WB02
	REF2-VEG-SED03	X	X	Co-located with REF2-VEG-AB03 and REF2-VEG-WB03
QA/QC Samples (Aqueous)	**Field Blanks:**			
	45B-FB01		X	Laboratory-grade deionized water

Notes:

As= Arsenic
Cd = Cadmium
Cu = Copper
Hg = Mercury
Se = Selenium
Zn = Zinc
QA/QC = Quality Assurance/Quality Control
TOC = Total Organic Carbon

[1] The open water reference area turtle grass tissue and sediment samples, as well as athe ssociated QA/QC sample were collected on January 31, 2007 during the BERA field investigation at SWMU 45.

TABLE 3-8
DATA QUALIFIER DEFINITIONS
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Sample Data Qualifiers:

[none]	The analyte was positively detected.
J	The analyte was positiviely identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit
R	The sample result is rejected (the presence or absence of the analyte cannot be verified)
U	The analyte was analyzed for, but not detected at the reported sample quantitation limit
UJ	The analyte was analyzed for, but not detected; The reported sample quantitation limit is qualified as estimated
NJ	Presumptive evidence for the presence of the analyte at an estimated concentration
CD	Analytical result confirmed by Gas Chromatography/Mass Spectrometry (GC/MS); Analyte identified in an analysis at a secondary dilution factor

TABLE 4-1
SWMU 1 SURFACE SOIL ANALYTICAL RESULTS: VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	1V-SS01	1V-SS02	1V-SS03	1V-SS04	1V-SS05	1V-SS06
Sample ID	1V-SS01	1V-SS02	1V-SS03	1V-SS04	1V-SS05	1V-SS06
Sampling Date	2/27/2007	2/27/2007	2/27/2007	2/27/2007	2/27/2007	2/27/2007
Depth Range (feet bgs)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
General Chemistry						
pH	7.56	7.66	7.76	8.02	7.49	7.55
TOC (mg/kg)	39000	26000	31000	59000	25000	38000
Grain Size (percent)						
Gravel	28.3	12.8	25.1	38.6	0.9	44.4
Sand	27.6	16.5	28.7	40.1	33.5	26.4
Coarse Sand	7.3	1.6	3.8	15.7	3.8	7.4
Medium Sand	7.0	3.5	7.2	11.3	5.5	7.1
Fine Sand	13.3	11.4	17.7	13.0	24.2	11.9
Silt	28.4	26.9	25.1	17.2	43.3	18.4
Clay	15.7	43.9	21.1	4.1	22.3	10.8

Notes:

TOC = Total Organic Carbon
mg/kg = milligram per kilogram
bgs = below ground surface

TABLE 4-2
UPLAND REFERENCE AREA NO. 1 SURFACE SOIL ANALYTICAL RESULTS: VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	REF-SS01	REF-SS01D	REF-SS02	REF-SS03	REF-SS03	REF-SS04
Sample ID	REF-SS01	REF-SS01D	REF-SS02	REF-SS03	REF-SS03D	REF-SS04
Sampling Date	2/28/2007	2/28/2007	2/28/2007	2/28/2007	2/28/2007	2/28/2007
Depth Range (feet bgs)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
PAHs (ug/kg)						
1-Methylnaphthalene	1.3 U	1.3 U	2.6 U	NA	NA	NA
2-Methylnaphthalene	1.1 U	1.1 U	2.3 U	NA	NA	NA
Acenaphthene	1.2 U	1.2 U	2.4 U	NA	NA	NA
Acenaphthylene	1.2 U	1.1 U	2.3 U	NA	NA	NA
Anthracene	1.2 U	1.2 U	2.4 U	NA	NA	NA
Benzo(a)anthracene	1.2 U	1.2 U	2.4 U	NA	NA	NA
Benzo(a)pyrene	0.98 U	0.97 U	2 U	NA	NA	NA
Benzo(b)fluoranthene	1.3 U	1.3 U	3.9 J	NA	NA	NA
Benzo(g,h,i)perylene	1.2 U	1.2 U	2.4 U	NA	NA	NA
Benzo(k)fluoranthene	1 U	1 U	2 U	NA	NA	NA
Chrysene	1.1 U	1.1 U	2.2 U	NA	NA	NA
Dibenz(a,h)anthracene	1.7 U	1.6 U	3.3 U	NA	NA	NA
Fluoranthene	1.3 U	1.3 U	3 J	NA	NA	NA
Fluorene	1.4 U	1.4 U	2.8 U	NA	NA	NA
Indeno(1,2,3-cd)pyrene	1.9 U	1.9 U	3.8 U	NA	NA	NA
Naphthalene	1.4 U	1.4 U	2.8 U	NA	NA	NA
Phenanthrene	1.5 U	1.5 U	3.1 U	NA	NA	NA
Pyrene	1.4 U	1.4 U	2.8 J	NA	NA	NA
LMW PAHs (1)	11.6	11.5	23.7	NA	NA	NA
HMW PAHs (2)	11.8	11.7	24.8	NA	NA	NA
Pesticides (ug/kg)						
4,4'-DDD	0.35 U	0.35 U	0.71 U	0.31 U	0.32 U	0.35 U
4,4'-DDE	0.35 U	0.35 U	0.71 U	0.31 U	0.32 U	0.35 U
4,4'-DDT	0.45 J	0.87 J	0.64 U	0.52 J	2 J	0.91 J
Aldrin	0.16 U	0.16 U	0.33 U	NA	NA	NA
alpha-BHC	0.61 U	0.61 U	1.2 U	NA	NA	NA
beta-BHC	0.55 U	0.55 U	1.1 U	NA	NA	NA
Chlordane (technical)	3.5 U	3.5 U	7.1 U	NA	NA	NA
delta-BHC	0.27 U	0.27 U	0.55 U	NA	NA	NA
Dieldrin	0.41 U	0.41 U	0.83 U	NA	NA	NA

TABLE 4-2
UPLAND REFERENCE AREA NO. 1 SURFACE SOIL ANALYTICAL RESULTS: VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	REF-SS01		REF-SS01		REF-SS02		REF-SS03		REF-SS03D		REF-SS04	
Sample ID	REF-SS01		REF-SS01D		REF-SS02		REF-SS03		REF-SS03D		REF-SS04	
Sampling Date	2/28/2007		2/28/2007		2/28/2007		2/28/2007		2/28/2007		2/28/2007	
Depth Range (feet bgs)	0.0-1.0		0.0-1.0		0.0-1.0		0.0-1.0		0.0-1.0		0.0-1.0	
Pesticides (ug/kg)												
Endosulfan I	0.19	U	0.19	U	0.38	U	NA		NA		NA	
Endosulfan II	0.32	U	0.32	U	0.64	U	NA		NA		NA	
Endosulfan sulfate	0.44	U	0.43	U	0.88	U	NA		NA		NA	
Endrin	0.38	U	0.38	U	0.76	U	NA		NA		NA	
Endrin aldehyde	0.77	U	0.76	U	1.5	U	NA		NA		NA	
Endrin ketone	0.38	U	0.38	U	0.76	U	NA		NA		NA	
gamma-BHC (Lindane)	0.16	U	0.16	U	0.33	U	NA		NA		NA	
Heptachlor	0.38	U	0.38	U	0.76	U	NA		NA		NA	
Heptachlor epoxide	0.25	U	0.25	U	0.5	U	NA		NA		NA	
Isodrin	0.39	U	0.39	U	0.78	U	NA		NA		NA	
Kepone	7.9	U	7.9	U	16	U	NA		NA		NA	
Methoxychlor	0.55	U	0.55	U	1.1	U	NA		NA		NA	
Toxaphene	14	U	14	U	28	U	NA		NA		NA	
Metals (mg/kg)												
Antimony	0.45	U	0.42	U	0.87	UJ	0.39	U	0.39	U	0.42	U
Arsenic	4.6		4.8		4.6	J	NA		NA		NA	
Barium	18	J	18	J	17	J	NA		NA		NA	
Beryllium	0.067	U	0.063	U	0.13	UJ	NA		NA		NA	
Cadmium	0.078	J	0.079	J	0.087	UJ	0.039	U	0.04	J	0.1	J
Chromium	8.6		9.2		4.9	J	NA		NA		NA	
Cobalt	3.5		3.5		2.4	J	NA		NA		NA	
Copper	17		18		10	J	9.5		6.5		54	
Lead	6.1		8.3		5.8	J	2.4		1.7		7.1	
Mercury	0.039		0.039		0.068	J	0.021		0.015	J	0.062	
Nickel	3.7		3.7		2.3	J	NA		NA		NA	
Selenium	0.36	J	0.36	J	0.44	UJ	NA		NA		NA	
Silver	0.11	U	0.11	U	0.22	UJ	NA		NA		NA	
Thallium	0.11	U	0.11	U	0.22	UJ	NA		NA		NA	
Tin	11	U	11	U	22	UJ	9.7	U	9.7	U	10	U
Vanadium	27		27		17	J	NA		NA		NA	
Zinc	18		17		16	J	10		7.3	J	60	

TABLE 4-2
UPLAND REFERENCE AREA NO. 1 SURFACE SOIL ANALYTICAL RESULTS: VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	REF-SS01	REF-SS01	REF-SS02	REF-SS03	REF-SS03D	REF-SS04
Sample ID	REF-SS01	REF-SS01D	REF-SS02	REF-SS03	REF-SS03D	REF-SS04
Sampling Date	2/28/2007	2/28/2007	2/28/2007	2/28/2007	2/28/2007	2/28/2007
Depth Range (feet bgs)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
General Chemistry						
pH	7.86	NA	7.49	8.4	NA	7.77
TOC (mg/kg)	71000	NA	38000	9400	NA	38000
Grain Size (percent)						
Gravel	7.1	NA	2.2	29.5	NA	13.8
Sand	62.4	NA	87.7	63	NA	28.1
Coarse Sand	3.6	NA	2.4	4.3	NA	3.7
Medium Sand	18.0	NA	19.8	19.3	NA	7.0
Fine Sand	40.8	NA	65.5	39.4	NA	9.1
Silt	21.8	NA	5.1	4.1	NA	30.4
Clay	8.7	NA	5.0	3.4	NA	27.7

Notes:

J = The analyte was positiviely identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit.
U = The analyte was analyzed for, but not detected at the reported sample quantitation limit
UJ = The analyte was analyzed for, but not detected; The reported sample quantitation limit is qualified as estimated

PAH = Polycyclic Aromatic Hydrocarbon
TOC = Total Organic Carbon
ug/kg = microgram per kilogram
mg/kg = milligram per kilogram
LMW = Low Molecular Weight
HMW = High Molecular Weight
NA = Not Analyzed
bgs = below ground surface

(1) Low molecular weight (LMW) PAHs are defined by the USEPA (2007) as PAH compounds composed of fewer than four rings. The LMW PAH compounds analyzed for in SWMU 1 surface soil were 1-methylnaphthalene, 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, fluoranthene, fluorene naphthalene, and phenanthrene. For a given sample, the LWM PAH concentration was derived by summing reported concentrations (reporting limit used for non-detected LMW PAHs).

TABLE 4-2
UPLAND REFERENCE AREA NO. 1 SURFACE SOIL ANALYTICAL RESULTS: VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Notes (continued):

(2) High molecular weight (HMW) PAHs are defined by the USEPA (2007) as PAH compounds composed of four or more rings. The HMW PAH compounds analyzed for in SWMU 1 surface soil were benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene dibenz(a,h)anthracene, pyrene, and indeno(1,2,3-cd)pyrene. For a given sample, the high molecular weight PAH concentration was derived by summing reported concentrations (reporting limit used for non-detected HMW PAHs).

Table References:

USEPA. 2007. Ecological Soil Screening Levels for Polycyclic Aromatic Hydrocarbons (PAHs) (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-78.

TABLE 4-3
UPLAND REFERENCE AREA NO. 2 SURFACE SOIL ANALYTICAL RESULTS: VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	REF-SS05	REF-SS06	REF-SS07	REF-SS08
Sample ID	REF-SS05	REF-SS06	REF-SS07	REF-SS08
Sampliing Date	2/28/2007	2/28/2007	2/28/2007	2/28/2007
Depth Range (feet bgs)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
PAHs (ug/kg)				
1-Methylnaphthalene	1.5 U	1.5 U	NA	NA
2-Methylnaphthalene	1.3 U	1.3 U	NA	NA
Acenaphthene	1.4 U	1.4 U	NA	NA
Acenaphthylene	1.4 U	1.3 U	NA	NA
Anthracene	1.4 U	1.4 U	NA	NA
Benzo(a)anthracene	3.1 J	3.6 J	NA	NA
Benzo(a)pyrene	2.7 J	3 J	NA	NA
Benzo(b)fluoranthene	3.9 J	4.8 J	NA	NA
Benzo(g,h,i)perylene	1.7 J	2.3 J	NA	NA
Benzo(k)fluoranthene	1.7 J	1.7 J	NA	NA
Chrysene	3 J	3.4 J	NA	NA
Dibenz(a,h)anthracene	1.9 U	1.9 U	NA	NA
Fluoranthene	5.5 J	5.7 J	NA	NA
Fluorene	1.7 U	1.6 U	NA	NA
Indeno(1,2,3-cd)pyrene	2.2 U	2.2 U	NA	NA
Naphthalene	1.7 U	1.6 U	NA	NA
Phenanthrene	2.1 J	2.3 J	NA	NA
Pyrene	4.5 J	4.9 J	NA	NA
LMW PAHs (1)	18	18.1	NA	NA
HMW PAHs (2)	24.7	27.8		
Pesticides (ug/kg)				
4,4'-DDD	0.62 J	0.41 U	0.35 U	0.37 U
4,4'-DDE	0.41 U	0.41 U	0.35 U	0.37 U
4,4'-DDT	5.5 J	0.37 U	2.2 J	0.33 U
Aldrin	0.19 U	0.19 U	NA	NA
alpha-BHC	0.72 U	0.71 U	NA	NA
beta-BHC	0.65 U	0.64 U	NA	NA
Chlordane (technical)	4.1 U	4.1 U	NA	NA
delta-BHC	0.32 U	0.31 U	NA	NA
Dieldrin	0.48 U	0.48 U	NA	NA
Endosulfan I	0.22 U	0.22 U	NA	NA
Endosulfan II	0.37 U	0.37 U	NA	NA
Endosulfan sulfate	0.51 U	0.51 U	NA	NA
Endrin	0.44 U	0.44 U	NA	NA
Endrin aldehyde	0.89 U	0.89 U	NA	NA
Endrin ketone	0.44 U	0.44 U	NA	NA
gamma-BHC (Lindane)	0.19 U	0.19 U	NA	NA
Heptachlor	0.44 U	0.44 U	NA	NA
Heptachlor epoxide	0.29 U	0.29 U	NA	NA
Isodrin	0.45 U	0.45 U	NA	NA
Kepone	9.2 U	9.2 U	NA	NA
Methoxychlor	0.65 U	0.64 U	NA	NA
Toxaphene	17 U	16 U	NA	NA

TABLE 4-3
UPLAND REFERENCE AREA NO. 2 SURFACE SOIL ANALYTICAL RESULTS: VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	REF-SS05	REF-SS06	REF-SS07	REF-SS08
Sample ID	REF-SS05	REF-SS06	REF-SS07	REF-SS08
Sampling Date	2/28/2007	2/28/2007	2/28/2007	2/28/2007
Depth Range (feet bgs)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Metals (mg/kg)				
Antimony	0.52 U	0.5 U	0.45 U	0.46 U
Arsenic	3.3	1.9	NA	NA
Barium	100 J	110 J	NA	NA
Beryllium	0.32	0.25	NA	NA
Cadmium	0.15 J	0.11 J	0.09 J	0.085 J
Chromium	35	27	NA	NA
Cobalt	33	31	NA	NA
Copper	100	110	44	65
Lead	5.7	6	12	8.9
Mercury	0.032	0.016 J	0.057	0.026
Nickel	28	19	NA	NA
Selenium	0.67 J	0.48 J	NA	NA
Silver	0.13 U	0.13 U	NA	NA
Thallium	0.13 U	0.13 U	NA	NA
Tin	13 U	13 U	11 U	12 U
Vanadium	180	180	NA	NA
Zinc	65	65	54	59
General Chemistry				
pH	8.52	8.58	6.47	7.11
TOC (mg/kg)	20000	9800	26000	21000
Grain Size (percent)				
Gravel	10.4	0.0	0.9	2.7
Sand	19.5	21.7	20.8	12.5
Coarse Sand	3.4	0.2	3.2	3.0
Medium Sand	7	3.5	8.8	3.6
Fine Sand	9.1	18.0	8.9	5.8
Silt	31.5	44.3	29.1	29.4
Clay	35.0	34.0	49.2	55.5

Notes:

J = The analyte was positiviely identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit.
U = The analyte was analyzed for, but not detected at the reported sample quantitation limit

PAH = Polycyclic Aromatic Hydrocarbon
TOC = Total Organic Carbon
ug/kg = microgram per kilogram
mg/kg = milligram per kilogram
LMW = Low Molecular Weight
HMW = High Molecular Weight
NA = Not Analyzed
bgs = below ground surface

TABLE 4-3
UPLAND REFERENCE AREA NO. 2 SURFACE SOIL ANALYTICAL RESULTS: VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Notes (continued):

(1) Low molecular weight (LMW) PAHs are defined by the USEPA (2007) as PAH compounds composed of fewer than four rings. The LMW PAH compounds analyzed for in SWMU 1 surface soil were 1-methylnaphthalene, 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, fluoranthene, fluorene, naphthalene, and phenanthrene. For a given sample, the LWM PAH concentration was derived by summing reported concentrations (reporting limit used for non-detected LMW PAHs).

(2) High molecular weight (HMW) PAHs are defined by the USEPA (2007) as PAH compounds composed of four or more rings. The HMW PAH compounds analyzed for in SWMU 1 surface soil were benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenz(a,h)anthracene, pyrene, and indeno(1,2,3-cd)pyrene. For a given sample, the high molecular weight PAH concentration was derived by summing reported concentrations (reporting limit used for non-detected HMW PAHs).

Table References:

USEPA. 2007. Ecological Soil Screening Levels for Polycyclic Aromatic Hydrocarbons (PAHs) (Interim Final.) Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-78.

TABLE 4-4
UPLAND REFERENCE AREA NO. 3 SURFACE SOIL ANALYTICAL RESULTS: VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	REF-SS09	REF-SS010	REF-SS011	REF-SS012
Sample ID	REF-SS09	REF-SS010	REF-SS011	REF-SS012
Sampling Date	2/28/2007	2/28/2007	2/28/2007	2/28/2007
Depth Range (feet bgs)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
PAHs (ug/kg)				
1-Methylnaphthalene	1.3 U	1.4 U	NA	NA
2-Methylnaphthalene	1.2 U	1.2 U	NA	NA
Acenaphthene	1.2 U	1.3 U	NA	NA
Acenaphthylene	1.2 U	1.2 U	NA	NA
Anthracene	1.2 U	1.3 U	NA	NA
Benzo(a)anthracene	1.2 U	1.3 U	NA	NA
Benzo(a)pyrene	1 U	1 U	NA	NA
Benzo(b)fluoranthene	1.3 U	1.4 U	NA	NA
Benzo(g,h,i)perylene	1.2 U	1.3 U	NA	NA
Benzo(k)fluoranthene	1 U	1.1 U	NA	NA
Chrysene	1.1 U	1.2 U	NA	NA
Dibenz(a,h)anthracene	1.7 U	1.8 U	NA	NA
Fluoranthene	1.3 U	1.4 U	NA	NA
Fluorene	1.5 U	1.5 U	NA	NA
Indeno(1,2,3-cd)pyrene	2 U	2 U	NA	NA
Naphthalene	1.5 U	1.5 U	NA	NA
Phenanthrene	1.6 U	1.6 U	NA	NA
Pyrene	1.5 U	1.5 U	NA	NA
LMW PAHs (1)	12	12.4	NA	NA
HMW PAHs (2)	12	12.6	NA	NA
Pesticides (ug/kg)				
4,4'-DDD	4 U	0.38 U	0.34 U	0.35 U
4,4'-DDE	4 U	0.38 U	0.34 U	0.35 U
4,4'-DDT	4 U	0.34 U	0.31 U	0.41 J
Aldrin	2.1 U	0.18 U	NA	NA
alpha-BHC	2.1 U	0.66 U	NA	NA
beta-BHC	2.1 U	0.6 U	NA	NA
Chlordane (technical)	21 U	3.8 U	NA	NA
delta-BHC	2.1 U	0.29 U	NA	NA
Dieldrin	4 U	0.44 U	NA	NA
Endosulfan I	2.1 U	0.2 U	NA	NA
Endosulfan II	4 U	0.34 U	NA	NA
Endosulfan sulfate	4 U	0.47 U	NA	NA
Endrin	4 U	0.41 U	NA	NA
Endrin aldehyde	4 U	0.82 U	NA	NA
Endrin ketone	4 U	0.41 U	NA	NA
gamma-BHC (Lindane)	2.1 U	0.18 U	NA	NA
Heptachlor	2.1 U	0.41 U	NA	NA
Heptachlor epoxide	2.1 U	0.27 U	NA	NA
Isodrin	4 U	0.42 U	NA	NA
Kepone	210 U	8.5 U	NA	NA
Methoxychlor	21 U	0.6 U	NA	NA
Toxaphene	210 U	15 U	NA	NA

TABLE 4-4
UPLAND REFERENCE AREA NO. 3 SURFACE SOIL ANALYTICAL RESULTS: VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	REF-SS09		REF-SS010		REF-SS011		REF-SS012	
Sample ID	REF-SS09		REF-SS010		REF-SS011		REF-SS012	
Sampling Date	2/28/2007		2/28/2007		2/28/2007		2/28/2007	
Depth Range (feet bgs)	0.0-1.0		0.0-1.0		0.0-1.0		0.0-1.0	
Metals (mg/kg)								
Antimony	0.45	U	0.46	U	0.42	U	0.44	U
Arsenic	1.1	J	1.1		NA		NA	
Barium	170	J	240	J	NA		NA	
Beryllium	0.28		0.35		NA		NA	
Cadmium	0.074	J	0.095	J	0.095	J	0.094	J
Chromium	58		43		NA		NA	
Cobalt	30		26		NA		NA	
Copper	100		110		72		72	
Lead	2.7		3.5		4.8		8.3	
Mercury	0.027		0.061		0.044		0.029	
Nickel	17		13		NA		NA	
Selenium	0.76	J	1.2		NA		NA	
Silver	0.11	U	0.11	U	NA		NA	
Thallium	0.11	U	0.11	U	NA		NA	
Tin	11	U	11	U	10	U	11	U
Vanadium	260		230		NA		NA	
Zinc	33		43		120		61	
General Chemistry								
pH	8.55		6.07		7.91		7.95	
TOC (mg/kg)	13000		34000		17000		13000	
Grain Size (percent)								
Gravel	0.0		0.8		27		13.1	
Sand	37.5		21.9		28.7		23.2	
Coarse Sand	0.6		0.9		8.2		5.4	
Medium Sand	7.0		2.8		7.6		7.0	
Fine Sand	29.9		18.2		12.9		10.7	
Silt	22.8		34.5		17.3		22.8	
Clay	39.6		42.7		27		40.9	

Notes:

J = The analyte was positiviely identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit.
U = The analyte was analyzed for, but not detected at the reported sample quantitation limit

PAH = Polycyclic Aromatic Hydrocarbon
TOC = Total Organic Carbon
ug/kg = microgram per kilogram
mg/kg = milligram per kilogram
LMW = Low Molecular Weight
HMW = High Molecular Weight
NA = Not Analyzed
bgs = below ground surface

TABLE 4-4
UPLAND REFERENCE AREA NO. 3 SURFACE SOIL ANALYTICAL RESULTS: VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Notes (continued):

(1) Low molecular weight (LMW) PAHs are defined by the USEPA (2007) as PAH compounds composed of fewer than four rings. The LMW PAH compounds analyzed for in SWMU 1 surface soil were 1-methylnaphthalene, 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, fluoranthene, fluorene, naphthalene, and phenanthrene. For a given sample, the LWM PAH concentration was derived by summing reported concentrations (reporting limit used for non-detected LMW PAHs).

(2) High molecular weight (HMW) PAHs are defined by the USEPA (2007) as PAH compounds composed of four or more rings. The HMW PAH compounds analyzed for in SWMU 1 surface soil were benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenz(a,h)anthracene, pyrene, and indeno(1,2,3-cd)pyrene. For a given sample, the high molecular weight PAH concentration was derived by summing reported concentrations (reporting limit used for non-detected HMW PAHs).

Table References:

USEPA. 2007. Ecological Soil Screening Levels for Polycyclic Aromatic Hydrocarbons (PAHs) (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-78.

TABLE 4-5
QUALITY ASSURANCE/QUALITY CONTROL ANALYTICAL RESULTS FOR SURFACE SOIL COLLECTION ACTIVITIES: VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Sample ID	1V-ER01 [1]		2V-ER01 [2]		1V-FB01 [3]	
Sampling Date	2/27/2007		2/28/2007		2/27/2007	
PAHs (ug/L)						
1-Methylnaphthalene	0.19	U	0.19	U	0.19	U
2-Methylnaphthalene	0.19	U	0.19	U	0.19	U
Acenaphthene	0.19	U	0.19	U	0.19	U
Acenaphthylene	0.19	U	0.19	U	0.19	U
Anthracene	0.19	U	0.19	U	0.19	U
Benzo[a]anthracene	0.19	U	0.19	U	0.19	U
Benzo[a]pyrene	0.19	U	0.19	U	0.19	U
Benzo[b]fluoranthene	0.19	U	0.19	U	0.19	U
Benzo[g,h,i]perylene	0.19	U	0.19	U	0.19	U
Benzo[k]fluoranthene	0.19	U	0.19	U	0.19	U
Chrysene	0.19	U	0.19	U	0.19	U
Dibenz(a,h)anthracene	0.19	U	0.19	U	0.19	U
Fluoranthene	0.19	U	0.19	U	0.19	U
Fluorene	0.19	U	0.19	U	0.19	U
Indeno[1,2,3-cd]pyrene	0.19	U	0.19	U	0.19	U
Naphthalene	0.19	U	0.19	U	0.19	U
Phenanthrene	0.19	U	0.19	U	0.19	U
Pyrene	0.19	U	0.19	U	0.19	U
Pesticides (ug/L)						
4,4'-DDD	0.098	U	0.097	U	0.097	U
4,4'-DDE	0.098	U	0.097	U	0.097	U
4,4'-DDT	0.098	U	0.097	U	0.097	U
Aldrin	0.049	U	0.049	U	0.049	U
alpha-BHC	0.049	U	0.049	U	0.049	U
beta-BHC	0.049	U	0.049	U	0.049	U
Chlordane (technical)	0.49	U	0.49	U	0.49	U
delta-BHC	0.049	U	0.049	U	0.049	U
Dieldrin	0.098	U	0.097	U	0.097	U
Endosulfan I	0.049	U	0.049	U	0.049	U
Endosulfan II	0.098	U	0.097	U	0.097	U
Endosulfan sulfate	0.098	U	0.097	U	0.097	U
Endrin	0.098	U	0.097	U	0.097	U
Endrin aldehyde	0.098	U	0.097	U	0.097	U
Endrin ketone	0.098	U	0.097	U	0.097	U
gamma-BHC (Lindane)	0.049	U	0.049	U	0.049	U
Heptachlor	0.049	U	0.049	U	0.049	U
Heptachlor epoxide	0.049	U	0.049	U	0.049	U
Isodrin	0.049	U	0.049	U	0.049	U
Kepone	0.98	U	0.97	U	0.97	U
Methoxychlor	0.49	U	0.49	U	0.49	U
Toxaphene	4.9	U	4.9	U	4.9	U

TABLE 4-5
QUALITY ASSURANCE/QUALITY CONTROL ANALYTICAL RESULTS FOR SURFACE SOIL COLLECTION ACTIVITIES: VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Sample ID	1V-ER01		2V-ER01		1V-FB01	
Sampling Date	2/27/2007		2/28/2007		2/27/2007	
Metals (ug/L)						
Antimony	2.5	U	2.5	U	2.5	U
Arsenic	2.5	U	2.5	U	2.5	U
Barium	0.97	J	1	J	0.86	J
Beryllium	0.5	U	0.5	U	0.5	U
Cadmium	0.5	U	0.5	U	0.5	U
Chromium	5	U	5	U	5	U
Cobalt	0.5	U	0.5	U	0.5	U
Copper	0.66	J	0.62	J	2.5	U
Lead	1.5	U	1.5	U	1.5	U
Mercury	0.24	U	0.24	U	0.24	U
Nickel	1	U	0.64	J	1	U
Selenium	2.5	U	2.5	U	2.5	U
Silver	1	U	1	U	1	U
Thallium	1	U	1	U	1	U
Tin	6.6		3.9	J	2.5	J
Vanadium	5	U	5	U	5	U
Zinc	7.6	J	5.6	J	5.9	J

Notes:

J = The analyte was positiviely identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit.
U = The analyte was analyzed for, but not detected at the reported sample quantitation limit

PAH = Polycyclic Aromatic Hydrocarbon
ug/L = microgram per liter

(1) The equipment rinsate blank was collected by passing laboratory-grade deionized water over an unused stainless steel spoon.

(2) The equipment rinsate blank was collected by passing laboratory-grade deionized water through an unused stainless steel hand auger.

(3) The field blank was collected using laboratory-grade deionized water.

TABLE 4-6
OPEN WATER REFERENCE AREA NO. 1 SEDIMENT ANALYTICAL RESULTS: VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	REF1-SD01V	REF1-SD02V	REF1-SD03V	REF1-SD04V	REF1-SD05V	REF1-SD06V
Sample ID	REF1-SD01V	REF1-SD02V	REF1-SD03V	REF1-SD04V	REF1-SD05V	REF1-SD06V
Sampling Date [(1)]	9/20/2006	9/20/2006	9/20/2006	9/20/2006	9/20/2006	9/20/2006
Depth Range (feet bgs)	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5
Metals (mg/kg)						
Arsenic	9 J	6.3	6.4	8.9	6.9 J	6.4
Cadmium	0.039 J	0.061 J	0.054 J	0.093 J	0.076 J	0.06 J
Copper	25 J	35	35	59	33 J	25
Mercury	0.047 J	0.039	0.023 J	0.015 J	0.031 J	0.019 J
Selenium	0.33 J	0.32 J	0.35 J	0.47 J	0.38 J	0.26 J
Zinc	31 J	38	33	36	31 J	25
General Chemistry (mg/kg)						
TOC	66000	27000	64000	60000	43000	64000
Grain Size (percent)						
Gravel	0.4	0.6	1	0.2	15.8	5.3
Sand	53.2	54.8	59.1	57.5	52.7	57.7
Coarse Sand	3.1	4.4	5.8	2.9	4.6	6.2
Medium Sand	11.8	9.3	9.4	12.6	17.7	21.8
Fine Sand	38.3	41.1	43.9	42	30.4	29.7
Silt	29.6	30.5	26.6	29.9	18.7	24.7
Clay	16.8	14.1	13.3	12.5	12.8	12.3

Notes:

J = The analyte was positiviely identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit.

TOC = Total Organic Carbon
mg/kg = milligram per kilogram
bgs = below ground surface

(1) Open water reference area sediment samples and associated QA/QC samples were collected during verification of the field sampling design for a BERA at SWMU 45. Analytical data from this sampling event were used to identifiy an appropriate open water reference area for the BERA at SWMU 1.

TABLE 4-7
OPEN WATER REFERENCE AREA NO. 2 SEDIMENT ANALYTICAL RESULTS: VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	REF2-SD01V	REF2-SD02V	REF2-SD03V	REF2-SD04V	REF2-SD04V	REF2-SD05V	REF2-SD06V
Sample ID	REF2-SD01V	REF2-SD02V	REF2-SD03V	REF2-SD04V	REF2-SD04VD	REF2-SD05V	REF2-SD06V
Sampling Date [(1)]	9/20/2006	9/20/2006	9/20/2006	9/20/2006	9/20/2006	9/20/2006	9/20/2006
Depth Range (feet bgs)	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5
Metals (mg/kg)							
Arsenic	2.2 J	2.1 J	2.1	0.84 J	0.95	1.4	2.6 J
Cadmium	0.19 UJ	0.2 UJ	0.17 U	0.18 U	0.17 U	0.18 U	0.22 UJ
Copper	4.4 J	7.4 J	3.3	1.2	1.6	2.2	5.1 J
Mercury	0.036 UJ	0.011 J	0.032 U	0.033 U	0.037 U	0.037 U	0.041 UJ
Selenium	0.28 J	0.3 J	0.22 J	0.89 U	0.87 U	0.88 U	0.29 J
Zinc	7.7 UJ	9.4 J	6.8 U	7.1 U	7 U	7 U	8.8 UJ
General Chemistry (mg/kg)							
TOC	20000	17000	17000	9300	NA	12000	67000
Grain Size (percent)							
Gravel	3.7	8.7	2.8	0.9	NA	3.7	0.3
Sand	73.5	60.4	77.8	70.9	NA	69.9	69.7
Coarse Sand	2.9	3.8	10.0	4.9	NA	5.2	3.2
Medium Sand	9.6	20.0	18.9	24.0	NA	16.8	15.5
Fine Sand	61.0	36.6	48.8	41.9	NA	47.9	51
Silt	11.5	20.3	8.1	19.4	NA	18.4	16.1
Clay	11.3	10.6	11.2	8.9	NA	8.0	13.9

Notes:

J = The analyte was positiviely identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit.
U = The analyte was analyzed for, but not detected at the reported sample quantitation limit
UJ = The analyte was analyzed for, but not detected; The reported sample quantitation limit is qualified as estimated

TOC = Total Organic Carbon
bgs = below ground surface
mg/kg = milligram per kilogram

(1) Open water reference area sediment samples were collected during verification of the field sampling design for a BERA at SWMU 45. Analytical data from this sampling event were used to identifiy an appropriate open water reference area for the BERA at SWMU 1.

TABLE 4-8
OPEN WATER REFERENCE AREA NO. 3 SEDIMENT ANALYTICAL RESULTS: VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	REF3-SD01V	REF3-SD01V	REF3-SD02V
Sample ID	REF3-SD01V	REF3-SD01VD	REF3-SD02V
Sampling Date	9/21/2006	9/21/2006	9/21/2006
Depth Range (feet bgs)	0.0-0.5	0.0-0.5	0.0-0.5
Metals (mg/kg)			
Arsenic	4.3	5	3.1
Cadmium	0.15 U	0.15 U	0.16 U
Copper	16	31	12
Mercury	0.028 U	0.012 J	0.03 U
Selenium	0.73 U	0.32 J	0.78 U
Zinc	14 J	23 J	11
General Chemistry (mg/kg)			
TOC	5100	NA	24000
Grain Size (percent)			
Gravel	34.7	NA	32.5
Sand	59.7	NA	46.8
Coarse Sand	5.8	NA	7.3
Medium Sand	18.9	NA	12.1
Fine Sand	34.9	NA	27.4
Silt	2.4	NA	10.5
Clay	3.3	NA	10.2

Notes:

J = The analyte was positiviely identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit.
U = The analyte was analyzed for, but not detected at the reported sample quantitation limit

TOC = Total Organic Carbon
mg/kg = milligram per kilogram
bgs = below ground surface

(1) Open water reference area sediment samples were collected during verification of the field sampling design for a BERA at SWMU 45. Analytical data from this sampling event were used to identifiy an appropriate open water reference area for the BERA at SWMU 1.

TABLE 4-9
QUALITY ASSURANCE/QUALITY CONTROL ANALYTICAL RESULTS FOR OPEN WATER SEDIMENT COLLECTION ACTIVITIES: VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Sample ID	45B-ER01V [1]		45B-FB01V [2]	
Sampling Date	9/20/2006		9/20/2006	
Metals (ug/L)				
Arsenic	2.5	U	2.5	U
Cadmium	0.5	U	0.5	U
Copper	2.5	U	0.52	J
Mercury	0.2	U	0.2	U
Selenium	2.5	U	2.5	U
Zinc	20	U	20	U

Notes:

J = The analyte was positiviely identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit.
U = The analyte was analyzed for, but not detected at the reported sample quantitation limit

ug/L = microgram per liter

(1) The equipment rinsate blank was collected by passing laboratory-grade deionized water through an unused sediment core liner.
(2) The field blank was collected using laboratory-grade deionized water.

TABLE 4-10
TOTAL ORGANIC CARBON AND GRAIN SIZE ANALYTICAL DATA FOR SWMU 1 OPEN WATER SEDIMENT SAMPLES
COLLECTED DURING THE 2003 AND 2004 ADDITIONAL DATA COLLECTION FIELD INVESTIGATIONS
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	1OW01	1OW02	1OW03	1OW04	1OW05	1OW06
Sample ID	01OWSD01	01OWSD02	01OWSD03	01OWSD04	01OWSD05	01OWSD06
Sampling Date	7/25/2003	7/25/2003	7/25/2003	7/25/2003	7/25/2003	7/25/2003
Sample Depth (feet bgs)	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5
General Chemistry (mg/kg)						
TOC	85000	67000	45000	52000	27000	48000
Grain Size (percent)						
Gravel	0.0	0.0	0.4	0.0	1.2	0.0
Sand	42.8	52.7	60.9	94.6	73.3	41.4
Coarse Sand	0.0	0.0	10.3	3.8	10.6	0.0
Medium Sand	19.8	19.3	20.1	26.3	20.6	20.2
Fine Sand	22.9	33.4	30.5	64.5	42.0	21.1
Silt/Clay	57.2	47.3	38.7	5.4	25.5	58.6

TABLE 4-10
TOTAL ORGANIC CARBON AND GRAIN SIZE ANALYTICAL DATA FOR SWMU 1 OPEN WATER SEDIMENT SAMPLES
COLLECTED DURING THE 2003 AND 2004 ADDITIONAL DATA COLLECTION FIELD INVESTIGATIONS
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	1OW07	1OW08	1OW09	1OW10	10W11	1OW12
Sample ID	01OWSD07	01OWSD08	01OWSD09	01OWSD10	01OWSD11	01OWSD12
Sampling Date	7/25/2003	7/25/2003	7/25/2003	10/5/2004	10/5/2004	10/5/2004
Sample Depth (feet bgs)	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5
General Chemistry (mg/kg)						
TOC	70000	14000	27000	110000	44000	41000
Grain Size (percent)						
Gravel	0.0	6.1	0.7	NA	NA	NA
Sand	47.2	71.9	55.0	NA	NA	NA
Coarse Sand	0.0	3.4	8.6	NA	NA	NA
Medium Sand	19.5	28.6	21.7	NA	NA	NA
Fine Sand	27.6	39.9	24.7	NA	NA	NA
Silt/Clay	52.8	22.1	44.3	NA	NA	NA

Notes:

TOC = Total Organic Carbon
bgs = below ground surface
mg/kg = milligram per kilogram

TABLE 4-11
SWMU 1 QUICK-TURN SURFACE SOIL ANALYTICAL RESULTS: BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	1B-SS01	1B-SS02	1B-SS03	1B-SS04	1B-SS04D	1B-SS05	1B-SS06
Sample ID	1B-SS01	1B-SS02	1B-SS03	1B-SS04	1B-SS04D	1B-SS05	1B-SS06
Sampling Date	4/28/2007	4/28/2007	4/28/2007	4/28/2007	4/28/2007	4/28/2007	4/28/2007
Sample Depth (feet bgs)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Pesticides (ug/kg)							
4,4'-DDD	12 U	9.6 U	11 U	9.8 U	9.7 U	10 U	21 U
4,4'-DDE	12 U	9.6 U	11 U	2.9 J	9.7 U	10 U	43
4,4'-DDT	12 U	9.6 U	11 U	6.9 J	9.7 U	10 U	34
Metals (mg/kg)							
Antimony	0.018 J	0.022 J	0.012 J	0.23 UJ	0.23 UJ	0.24 UJ	0.45 J
Cadmium	0.1 J	0.094 J	0.082 J	0.026 J	0.02 J	0.039 J	0.46
Copper	69.8 J	63.1 J	89.1 J	89.9 J	86.9 J	84.4 J	47.1 J
Lead	2.1 J	6.5 J	1.9 J	0.78 J	0.7 J	0.89 J	57.5 J
Mercury	0.06	0.054	0.056	0.028 J	0.028 J	0.034 J	0.32
Tin	0.24 J	0.23 J	0.2 J	0.58 UJ	0.57 UJ	0.13 J	1.5 J
Zinc	25.1 J	16 J	19.2 J	20.4 J	19.2 J	17.2 J	52.2 J

TABLE 4-11
SWMU 1 QUICK-TURN SURFACE SOIL ANALYTICAL RESULTS: BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	1B-SS07	1B-SS08	1B-SS09	1B-SS10	1B-SS11	1B-SS12	1B-SS13
Sample ID	1B-SS07	1B-SS08	1B-SS09	1B-SS10	1B-SS11	1B-SS12	1B-SS13
Sampling Date	4/28/2007	4/28/2007	4/28/2007	4/28/2007	4/28/2007	4/28/2007	4/28/2007
Sample Depth (feet bgs)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Pesticides (ug/kg)							
4,4'-DDD	30	9.9 J	22 J	3.6 J	180 R	75 NJ	51
4,4'-DDE	410	140	48	20	1100	380	390
4,4'-DDT	120	56	22	23	440 J	170 J	230 NJ
Metals (mg/kg)							
Antimony	1 J	0.33 J	1.1 J	0.41 J	10 J	4.6 J	47.7 J
Cadmium	2.5	0.37	0.75	0.6	5.1	3.1	9.4 J
Copper	55.8 J	54.7 J	77.7 J	39.7 J	581 J	256 J	779
Lead	67.4 J	38.6 J	109 J	30.3 J	488 J	409 J	1060
Mercury	0.15	0.059	0.19	0.54	0.56	0.18	0.59
Tin	4.5 J	1 J	7.3 J	1.1 J	63.5 J	48.4 J	208 J
Zinc	79 J	60 J	180 J	57.2 J	1400 J	770 J	4460

TABLE 4-11
SWMU 1 QUICK-TURN SURFACE SOIL ANALYTICAL RESULTS: BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	1B-SS14	1B-SS14D	1B-SS15	1B-SS16	1B-SS17	1B-SS18	1B-SS19
Sample ID	1B-SS14	1B-SS14D	1B-SS15	1B-SS16	1B-SS17	1B-SS18	1B-SS19
Sampling Date	4/28/2007	4/28/2007	4/28/2007	4/28/2007	4/28/2007	4/28/2007	4/28/2007
Sample Depth (feet bgs)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Pesticides (ug/kg)							
4,4'-DDD	52	69	42	76	1.3 J	120	1900
4,4'-DDE	1100	1700	420	720	9.6	2200	9100
4,4'-DDT	150 NJ	190 NJ	240 NJ	370	7.3	360	15000
Metals (mg/kg)							
Antimony	35.4 J	37.9 J	35.5 J	2.3	0.23 U	8.2 J	10 J
Cadmium	7.7 J	11.4 J	9.9 J	1.1 J	0.49 J	3.2 J	3.9 J
Copper	1030 R	22300 R	2340	61.3	39.6	212	140
Lead	1330	929	1100	91.1	4.6	210	276
Mercury	0.87	0.82	0.49	0.083	0.043	0.19	0.2
Tin	148 J	119 J	104 J	4.1 J	1.7 J	30.2 J	12.8 J
Zinc	2940	2710	5410	365	28.5	3090	490

TABLE 4-11
SWMU 1 QUICK-TURN SURFACE SOIL ANALYTICAL RESULTS: BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	1B-SS20	1B-SS21	1B-SS22	1B-SS23	1B-SS24	1B-SS24D	1B-SS25
Sample ID	1B-SS20	1B-SS21	1B-SS22	1B-SS23	1B-SS24	1B-SS24D	1B-SS25
Sampling Date	4/28/2007	4/28/2007	4/28/2007	4/28/2007	4/28/2007	4/28/2007	4/28/2007
Sample Depth (feet bgs)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Pesticides (ug/kg)							
4,4'-DDD	6.3	20	4.1 J	3.8 J	16	12	9.6
4,4'-DDE	45	210	49	41	170	90	49
4,4'-DDT	23	110	53	37	110	70	26
Metals (mg/kg)							
Antimony	1.5 U	10 J	2.7	3.1	11.2 J	3.6	5.8 J
Cadmium	0.65 J	1.6 J	0.63 J	1.3 J	1.1 J	1.3 J	1.1 J
Copper	56.8	178	51.4	86.4	78	80.1	70.6
Lead	27	117	225	81.6	929 R	57.4 R	53.1
Mercury	0.11	0.12	0.069	0.075	0.084	0.087	0.083
Tin	2.8 J	15.7 J	2.9 J	6.6	223 J	6.3 J	21.5 J
Zinc	88.8	227	123	667	116	106	93.3

TABLE 4-11
SWMU 1 QUICK-TURN SURFACE SOIL ANALYTICAL RESULTS: BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	1B-SS26	1B-SS27	1B-SS28	1B-SS29	1B-SS30	1B-SS31	1B-SS32
Sample ID	1B-SS26	1B-SS27	1B-SS28	1B-SS29	1B-SS30	1B-SS31	1B-SS32
Sampling Date	4/28/2007	4/28/2007	4/28/2007	4/28/2007	4/28/2007	4/28/2007	4/28/2007
Sample Depth (feet bgs)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Pesticides (ug/kg)							
4,4'-DDD	98	32	71	79	310	23	10
4,4'-DDE	250	91	470	230	1800	150	38
4,4'-DDT	59	37	230	58 J	640	140	31
Metals (mg/kg)							
Antimony	5.5	4.3	11.1 J	5.2	4.5	13	4
Cadmium	1.1 J	1.5 J	1.6 J	2 J	1.1 J	4.9	1
Copper	68.1	272	155	99.9	66	210	120
Lead	79.7	73.6	154	111	76.2	160	57
Mercury	0.14	0.14	0.15	0.16	0.21	0.15	0.11
Tin	5.9 J	4.8 J	11.5 J	7.1 J	5.7 J	56 R	8.1 R
Zinc	154	173	286	270	195	250	130

TABLE 4-11
SWMU 1 QUICK-TURN SURFACE SOIL ANALYTICAL RESULTS: BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	1B-SS33	1B-SS34	1B-SS34D	1B-SS35	1B-SS36	1B-SS37	1B-SS38
Sample ID	1B-SS33	1B-SS34	1B-SS34D	1B-SS35	1B-SS36	1B-SS37	1B-SS38
Sampling Date	4/28/2007	4/28/2007	4/28/2007	4/28/2007	4/28/2007	4/28/2007	4/28/2007
Sample Depth (feet bgs)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Pesticides (ug/kg)							
4,4'-DDD	150	29	45	13	22	100 J	23 J
4,4'-DDE	4300	400	590	69	110	600	280
4,4'-DDT	1400	230	320	77	19	350	99
Metals (mg/kg)							
Antimony	32	32	41	12	27	27	17
Cadmium	4.8	3.2	3	1.2	2.7	2.5	1.9
Copper	230	210	210	220	290	360	920
Lead	290	210	250	99	530	430	1000
Mercury	0.13	0.28 J	0.13 J	0.063	0.34	0.31	0.42
Tin	36 R	25 R	37 R	9 R	250 R	85 R	75 R
Zinc	510	470	420	150	610	680	600

TABLE 4-11
SWMU 1 QUICK-TURN SURFACE SOIL ANALYTICAL RESULTS: BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	1B-SS39	1B-SS40	1B-SS41	1B-SS42	1B-SS43	1B-SS44	1B-SS44D
Sample ID	1B-SS39	1B-SS40	1B-SS41	1B-SS42	1B-SS43	1B-SS44	1B-SS44D
Sampling Date	4/28/2007	4/28/2007	4/28/2007	4/28/2007	4/28/2007	4/28/2007	4/28/2007
Sample Depth (feet bgs)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Pesticides (ug/kg)							
4,4'-DDD	20	55	0.43 U	0.41 U	0.43 U	0.45 U	0.45 U
4,4'-DDE	150	270	0.43 U	0.71 J	0.62 J	0.78 J	2.2 J
4,4'-DDT	25	88	0.39 U	0.37 U	2.5 J	0.41 U	1.4 J
Metals (mg/kg)							
Antimony	15	21	0.27 U	0.24 U	0.56 J	0.28 U	0.29 U
Cadmium	1.7	1.8	0.1 J	0.042 J	0.081 J	0.08 J	0.076 J
Copper	210	240	50	44	40 J	35 J	38 J
Lead	600	580	8.2	7.9	33	9.5 J	6 J
Mercury	0.34	0.41	0.04	0.059	0.035	0.023 J	0.037
Tin	67 R	100 R	6.7 R	6 R	6.4 R	7.1 R	7.3 R
Zinc	530	580	48	41	39	37	37

TABLE 4-11
SWMU 1 QUICK-TURN SURFACE SOIL ANALYTICAL RESULTS: BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	1B-SS45	1B-SS46	1B-SS47	1B-SS48	1B-SS49	1B-SS50	1B-SS51
Sample ID	1B-SS45	1B-SS46	1B-SS47	1B-SS48	1B-SS49	1B-SS50	1B-SS51
Sampling Date	4/28/2007	4/28/2007	4/28/2007	4/28/2007	4/28/2007	4/28/2007	4/28/2007
Sample Depth (feet bgs)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Pesticides (ug/kg)							
4,4'-DDD	0.37 U	170	78	210	110	59	0.38 U
4,4'-DDE	0.37 U	3700	880	4200	1500	1600	0.38 U
4,4'-DDT	0.33 U	1200	410	1500	1100	370	0.34 U
Metals (mg/kg)							
Antimony	0.22 U	93	59	220	65	130	0.24 U
Cadmium	0.13	18	11	25	7	15	0.19
Copper	41 J	940 J	540 J	580 J	490 J	1000 J	33 J
Lead	8.7 J	2600 J	890 J	2300 J	1300 J	1500 J	7.7 J
Mercury	0.037	0.43	0.7	0.44	5.7 J	0.55 J	0.11 J
Tin	5.5 U	190 J	120 J	250 J	300 J	1500 J	6 U
Zinc	38	2700	2200	2300	1700	3000	38

TABLE 4-11
SWMU 1 QUICK-TURN SURFACE SOIL ANALYTICAL RESULTS: BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	1B-SS52	1B-SS53	1B-SS54	1B-SS54D	1B-SS55
Sample ID	1B-SS52	1B-SS53	1B-SS54	1B-SS54D	1B-SS55
Sampling Date	4/28/2007	4/28/2007	4/28/2007	4/28/2007	4/28/2007
Sample Depth (feet bgs)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Pesticides (ug/kg)					
4,4'-DDD	0.38 U	0.38 U	0.45 U	0.38 U	0.39 U
4,4'-DDE	0.38 U	0.38 U	0.45 U	0.38 U	0.39 U
4,4'-DDT	0.34 U	0.34 U	0.4 U	0.34 U	0.35 U
Metals (mg/kg)					
Antimony	0.23 U	0.23 U	0.27 U	0.24 U	0.23 U
Cadmium	0.11 J	0.24	0.19	0.16	0.14
Copper	34 J	34 J	34 J	32 J	35 J
Lead	6.2 J	5.6 J	8 J	7.6 J	6.7 J
Mercury	0.097 J	0.065 J	0.069 J	0.066 J	0.095 J
Tin	5.7 U	5.7 U	6.6 U	6 U	5.8 U
Zinc	37	37	38	36	41

Notes:

J = The analyte was positiviely identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit.
U = The analyte was analyzed for, but not detected at the reported sample quantitation limit
R = The sample result is rejected (the presence or absence of the analyte cannot be verified)
NJ = Presumptive evidence for the presence of the analyte at an estimated concentration

ug/kg = microgram per kilogram
mg/kg = milligram per kilogram
bgs = below ground surface

TABLE 4-12
UPLAND REFERENCE AREA NO. 2 QUICK-TURN SURFACE SOIL ANALYTICAL RESULTS: BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	1B-REF-SS01	1B-REF-SS02	1B-REF-SS03	1B-REF-SS04	1B-REF-SS04D	1B-REF-SS05	1B-REF-SS06
Sample ID	1B-REF-SS01	1B-REF-SS02	1B-REF-SS03	1B-REF-SS04	1B-REF-SS04D	1B-REF-SS05	1B-REF-SS06
Sampling Date	4/29/2007	4/29/2007	4/29/2007	4/29/2007	4/29/2007	4/29/2007	4/29/2007
Sample Depth (feet bgs)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Pesticides (ug/kg)							
4,4'-DDD	12 U	11 U	11 U	11 U	12 U	12 U	13 U
4,4'-DDE	12 U	11 U	11 U	11 U	12 U	12 U	13 U
4,4'-DDT	12 U	11 U	11 U	11 U	12 U	12 U	13 U
Metals (mg/kg)							
Antimony	0.033 J	0.01 J	0.019 J	0.017 J	0.034 J	0.02 J	0.024 J
Cadmium	0.18	0.16	0.095 J	0.1 J	0.11 J	0.13 J	0.11 J
Copper	44.4 J	47 J	68.5 J	78.3 J	78.2 J	64.2 J	66.3 J
Lead	6.2 J	2.7 J	3.8 J	3.6 J	4.1 J	4.3 J	4.9 J
Mercury	0.074	0.039 J	0.025 J	0.027 J	0.032 J	0.025 J	0.033 J
Tin	0.47 J	0.32 J	0.23 J	0.22 J	0.36 J	0.24 J	0.23 J
Zinc	19.3 J	21.4 J	40.4 J	40.3 J	42.6 J	42.1 J	38.5 J

Notes:

J = The analyte was positiviely identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit.
U = The analyte was analyzed for, but not detected at the reported sample quantitation limit

ug/kg = microgram per kilogram
mg/kg = milligram per kilogram
bgs = below ground surface

TABLE 4-13
QUALITY ASSURANCE/QUALITY CONTROL ANALYTICAL RESULTS FOR SURFACE SOIL COLLECTION ACTIVITIES: BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Sample ID	1B-ER01 [(1)]		1B-FB01 [(2)]	
Sampling Date	4/29/2007		4/29/2007	
Pesticides (ug/L)				
4,4'-DDD	0.011	U	0.01	U
4,4'-DDE	0.012	U	0.011	U
4,4'-DDT	0.013	U	0.013	U
Metals (ug/L)				
Antimony	1	U	1	U
Cadmium	0.1	U	0.1	U
Copper	1.8	J	3.4	
Lead	0.5	U	0.5	U
Mercury	0.08	U	0.08	U
Tin	1	U	1	U
Zinc	6.2	J	6.6	J

Notes:

J = The analyte was positiviely identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit.
U = The analyte was analyzed for, but not detected at the reported sample quantitation limit

ug/L = microgram per liter

(1) The equipment rinsate blank was collected by passing laboratory-grade deionized water over an unused stainless steel spoon.

(2) The field blank was collected using laboratory-grade deionized water.

TABLE 4-14
MAXIMUM, 95 PERCENT UCL OF THE MEAN, AND ARITHMETIC MEAN HAZARD QUOTIENT VALUES FOR SOIL INVERTEBRATE EXPOSURES TO ECOLOGICAL CHEMICALS OF CONCERN IN SWMU 1 SURFACE SOIL
SWMU 1 - ARMY CREMATOR DISPOSAL UNIT
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

	Contaminant Frequency/Range [1]									
Analyte	No. of Positive Detects/No. of Samples [1]	Range of Positive Detections	Range of Non-Detects	Maximum Detected Concentration	95 Percent UCL of the Mean Concentration [2]	Arithmetic Mean Concentration [3]	Soil Screening Values (SSV) [4]	Max. HQ [5]	95 Percent UCL HQ [6]	Arithmetic Mean HQ [7]
Pesticides (ug/kg)										
4,4'-DDD	52/88	0.9J - 13,000	0.37U - 21U	13,000	1,134	202.71	894 [8]	14.54	1.27	0.23
4,4'-DDE	68/89	0.62J - 28,000	0.37U - 12U	28,000	2,937	836.99	894 [8]	31.32	3.29	0.94
4,4-DDT	67/89	1.2J - 43,000	0.33U - 12U	43,000J	3,981	798.94	894 [8]	48.10	4.45	0.89
Metals (mg/kg)										
Antimony	64/85	0.012J - 220	0.22U - 1.9UJ	220	28.67	14.07	78	2.82	0.37	0.06
Cadmium	80/85	0.02J - 83.8	0.19U - 0.25U	83.8	10.24	3.58	140	0.59	0.07	0.03
Copper	83/83	19.8 - 2,340	NA	2,340	383.1	220.55	80	29.25	4.79	2.76
Lead	82/82	0.7J - 2,600J	NA	2,600J	632.6	286.72	1,700	1.53	0.37	0.17
Mercury	82/85	0.023J - 5.7J	0.02U - 0.03U	5.7J	0.553	0.25	0.1	57.00	5.53	2.50
Tin	49/69	0.12J - 1,500J	0.57UJ - 6.6U	1,500J	199.4	57.02	50	30.00	3.99	1.14
Zinc	85/85	13.9J - 5,410	NA	5,410	1,296	585.42	120	45.08	10.80	4.88

Notes:

J = The analyte was positiviely identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit.
U = The analyte was analyzed for, but not detected at the reported sample quantitation limit
UJ = The analyte was analyzed for, but not detected; The reported sample quantitation limit is qualified as estimated

SSV = Soil Screening Value
UCL = Upper Confidence Limit
HQ = Hazard Quotient
µg/kg = microgram per kilogram
mg/kg = milligram per kilogram

(1) The analytical data used in the evaluation represents a combined data set for surface soil collected during Step 6 of the baseline ecological risk assessment, the 1996 RFI field investigation, and 2003 additional data collection field investigation. These data are presented in Tables 2-3 (1996 RFI and 2003 additional data collection field investigations) and 4-11 (baseline ecological risk assessment field investigation).
(2) 95% UCL of the mean concentrations were calculated using USEPA ProUCL Version 4.00.02 software (USEPA, 2007).
(3) One-half the reporting limit was used for non-detected results when calculating arithmetic mean concentrations.
(4) See Table 3-4 for a description, source, and reference citation for each of the screening values listed below.
(5) For a given chemical, the maximum HQ value was derived by dividing the maximum detected concentration by the soil screening value.
(6) For a given chemical, the 95 percent UCL of the mean HQ value was derived by dividing the 95 percent UCL of the mean cocnentration by the soil screening value.
(7) For a given chemical, the arithmetic mean HQ value was derived by dividing the arithmetic mean concentration by the soil screening value.
(8) Site-specific soil screening value based on a soil organic carbon content of 4.46 percent (see Section 4.2.1).

Table References

United States Environmental Protection Agency (USEPA). 2007. ProUCLVersion 4.00.02. April 2007. http://www.epa.gov/esd/tsc/software.htm.

TABLE 4-15
***EISENIA FETIDA* TOXICITY TEST RESULTS AND ASSOCIATED ANALYTICAL DATA**
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

	Negative Control	1B-REF-SS03	1B-REF-SS05	1B-REF-SS06	1B-SS09	1B-SS13	1B-SS15	1B-SS18	1B-SS19
Pesticides (ug/kg):									
4,4'-DDD	NA	11 U	12 U	13 U	22 J	51	42	120	1900
4,4'-DDE	NA	11 U	12 U	13 U	48	390	420	2200	9100
4,4-DDT	NA	11 U	12 U	13 U	22	230 NJ	240 NJ	360	15000
Metals (mg/kg):									
Antimony	NA	0.019 J	0.02 J	0.024 J	1.1 J	47.7 J	35.5 J	8.2 J	10 J
Cadmium	NA	0.095 J	0.13 J	0.11 J	0.75	9.4 J	9.9 J	3.2 J	3.9 J
Copper	NA	68.5 J	64.2 J	66.3 J	77.7 J	779	2340	212	140
Lead	NA	3.8 J	4.3 J	4.9 J	109 J	1060	1100	210	276
Mercury	NA	0.025 J	0.025 J	0.033 J	0.19	0.59	0.49	0.19	0.2
Tin	NA	0.23 J	0.24 J	0.23 J	7.3 J	208 J	104 J	30.2 J	12.8 J
Zinc	NA	40.4 J	42.1 J	38.5 J	180 J	4460	5410	3090	490
General Chemistry:									
pH (SU) (1)	7.2/7.6	8.5/8.0	7.9/8.2	8.8/8.5	6.3/7.9	7.1/7.9	7.4/8.2	9.1/8.5	8.7/8.5
TOC (mg/kg)	NA	43300	20900	21000	35100	95100	71500	6470	45200
Grain Size (percent)									
Gravel	NA	5.9	13.6	0.1	8.7	41.2	14.4	4.8	23.1
Sand	NA	34.5	23.4	11.7	31.9	40.4	47.6	39.2	34.50
Fines (silt and clay)	NA	59.4	62.9	88.3	59.4	18.5	38.0	56.0	42.40
Toxicity Test Results:									
Survival (percent):									
Replicate A	100	100	100	100	100	100	100	70	100
Replicate B	100	100	100	100	100	100	90	60	90
Replicate C	100	100	100	100	100	100	100	70	100
Replicate D	100	100	90	80	100	100	90	70	100
Replicate E	100	100	100	100	100	100	100	90	100
Replicate F	100	100	90	100	100	100	100	70	100
Replicate G	100	100	100	100	100	100	100	90	90
Replicate H	100	100	100	100	100	100	100	90	80
Mean	100.00	100.00	97.50	97.50	100.00	100.00	97.50	76.25	95.00
Growth (wet weight loss per surviving worm in grams):									
Replicate A	0.0895	0.1172	0.1459	0.1503	0.1982	0.1223	0.1536	0.2239	0.0785
Replicate B	0.0927	0.1606	0.1583	0.1526	0.1616	0.1382	0.1402	0.2553	0.1260
Replicate C	0.1219	0.1412	0.1640	0.1823	0.1773	0.1153	0.1304	0.1966	0.1363
Replicate D	0.1528	0.1380	0.1785	0.2006	0.1679	0.1224	0.1223	0.2507	0.1548
Replicate E	0.0973	0.1216	0.1521	0.1457	0.1644	0.1329	0.1333	0.2609	0.1761
Replicate F	0.1042	0.1233	0.1399	0.1372	0.1720	0.1245	0.1218	0.3031	0.1354
Replicate G	0.1182	0.1378	0.1480	0.1760	0.1848	0.1003	0.1354	0.1826	0.2514
Replicate H	0.0947	0.1207	0.1737	0.1478	0.1969	0.1245	0.1673	0.2315	0.1941
Mean	0.1089	0.1325	0.1576	0.1616	0.1779	0.1226	0.1380	0.2381	0.1566
Reproduction (jueveniles/cocoons per surviving worms):									
Replicate A	0.400	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Replicate B	0.200	0.100	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Replicate C	0.500	0.000	0.100	0.000	0.000	0.000	0.100	0.000	0.000
Replicate D	0.600	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Replicate E	0.500	0.100	0.200	0.000	0.000	0.000	0.000	0.000	0.000
Replicate F	0.300	0.200	0.222	0.000	0.000	0.000	0.000	0.000	0.000
Replicate G	0.400	0.000	0.000	0.200	0.000	0.000	0.000	0.000	0.000
Replicate H	0.400	0.100	0.000	0.100	0.000	0.000	0.000	0.000	0.000
Mean	0.413	0.063	0.065	0.038	0.000	0.000	0.013	0.000	0.000

TABLE 4-15
***EISENIA FETIDA* TOXICITY TEST RESULTS AND ASSOCIATED ANALYTICAL DATA**
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

	1B-SS29	18-SS33	1B-SS37	1B-SS39	1B-SS46	1B-SS48	1B-SS49	1B-SS50	1B-SS51
Pesticides (ug/kg):									
4,4'-DDD	79	150	100 J	20	170	210	110	59	0.38 U
4,4'-DDE	230	4300	600	150	3700	4200	1500	1600	0.38 U
4,4-DDT	58 J	1400	350	25	1200	1500	1100	370	0.34 U
Metals (mg/kg):									
Antimony	5.2	32	27	15	93	220	65	130	0.24 U
Cadmium	2 J	4.8	2.5	1.7	18	25	7	15	0.19
Copper	99.9	230	360	210	940 J	580 J	490 J	1000 J	33 J
Lead	111	290	430	600	2600 J	2300 J	1300 J	1500 J	7.7 J
Mercury	0.16	0.13	0.31	0.34	0.43	0.44	5.7 J	0.55 J	0.11 J
Tin	7.1 J	36 R	85 R	67 R	190 J	250 J	300 J	1500 J	6 U
Zinc	270	510	680	530	2700	2300	1700	3000	38
General Chemistry:									
pH (SU) (1)	8.3/8.3	7.7/7.6	8.3/8.4	8.1/8.2	8.3/8.2	7.9/8.2	7.7/7.8	8.7/8.5	7.6/6.5
TOC (mg/kg)	42600	43000	27300	10600	50500	71900	94500	39000	42200
Grain Size (percent)									
Gravel	53.8	12.1	16.1	8.7	33.4	26.9	21.8	35.3	0.4
Sand	35.8	46.7	44.9	48	50.5	50	51.6	48.7	41.4
Fines (silt and clay)	10.5	41.2	38.9	43.4	16.1	23.1	26.5	15.9	58.2
Toxicity Test Results:									
Survival (percent):									
Replicate A	90	100	100	100	100	100	100	80	100
Replicate B	100	100	100	100	100	100	100	100	100
Replicate C	100	100	90	90	100	100	100	100	100
Replicate D	100	90	100	100	100	100	100	100	100
Replicate E	90	90	90	90	100	100	100	100	100
Replicate F	100	100	100	100	100	100	100	100	100
Replicate G	100	90	100	100	100	100	100	100	100
Replicate H	100	100	100	100	100	100	100	100	100
Mean	97.50	96.25	97.50	97.50	100.00	100.00	100.00	97.50	100.00
Growth (wet weight loss per surviving worm in grams):									
Replicate A	0.1913	0.1214	0.1263	0.1951	0.1283	0.1602	0.1525	0.1770	0.1279
Replicate B	0.1810	0.1218	0.1403	0.2086	0.1511	0.0954	0.2048	0.1495	0.1087
Replicate C	0.1859	0.1632	0.1630	0.2484	0.1510	0.1129	0.1700	0.1342	0.0902
Replicate D	0.1633	0.1484	0.1397	0.2000	0.1284	0.1305	0.1857	0.1491	0.1280
Replicate E	0.1932	0.1708	0.1469	0.2468	0.1652	0.1169	0.1696	0.1230	0.0695
Replicate F	0.1841	0.1654	0.1601	0.2063	0.1739	0.1563	0.1580	0.1262	0.1136
Replicate G	0.1795	0.1555	0.1100	0.2142	0.1800	0.1053	0.1391	0.1350	0.1205
Replicate H	0.1823	0.1462	0.1655	0.1866	0.1788	0.1283	0.1777	0.1652	0.1086
Mean	0.1826	0.1491	0.1440	0.2132	0.1571	0.1257	0.1687	0.1449	0.1084
Reproduction (jueveniles/cocoons per surviving worms):									
Replicate A	0.000	0.000	0.500	0.000	0.000	0.000	0.000	0.000	0.000
Replicate B	0.000	0.000	0.700	0.000	0.000	0.000	0.000	0.000	0.000
Replicate C	0.000	0.100	0.667	0.000	0.000	0.000	0.000	0.000	0.000
Replicate D	0.000	0.222	1.200	0.000	0.000	0.000	0.000	0.000	0.000
Replicate E	0.000	0.000	0.667	0.000	0.000	0.000	0.000	0.000	0.000
Replicate F	0.000	0.100	0.400	0.000	0.000	0.000	0.000	0.000	0.000
Replicate G	0.000	0.111	0.800	0.000	0.000	0.000	0.000	0.000	0.000
Replicate H	0.000	0.000	0.300	0.000	0.000	0.000	0.000	0.000	0.000
Mean	0.000	0.067	0.654	0.000	0.000	0.000	0.000	0.000	0.000

TABLE 4-15
***EISENIA FETIDA* TOXICITY TEST RESULTS AND ASSOCIATED ANALYTICAL DATA**
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Notes:

Shading indicates endpoint is significantly different than 1B-REF-SS03 ($\alpha = 0.05$) as determined by a multiple comparison method (i.e., Dunn's Method).
Underline indicates endpoint is significantly different than 1B-REF-SS06 ($\alpha = 0.05$) as determined by a multiple comparison method (i.e., Dunn's Method).

J = The analyte was positiviely identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit.
U = The analyte was analyzed for, but not detected at the reported sample quantitation limit
R = The sample result is rejected (the presence or absence of the analyte cannot be verified)
NJ = Presumptive evidence for the presence of the analyte at an estimated concentration

ug/kg = microgram per kilogram
mg/kg = milligram per kilogram
NA = Not Analyzed
SU = Standard Units

(1) The values shown (pH at test initiation/pH at test termination) were measured by the toxicity testing laboratory.

TABLE 4-16
CORRELATION COEFFICIENT AND COEFFICIENT OF DETERMINATION VALUES: EARTHWORM SURVIVAL AND WEIGHT LOSS PER SURVIVING EARTHWORM VERSUS SURFACE SOIL VARIABLES
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

	Earthworm Survival			Weight Loss Per Surviving Earthworm		
Variable (1)	**Correlation Coefficient Value (unitless)**	**Coefficient of Determination Value (unitless)**	**Significant at Alpha = 0.05 (Yes/No)**	**Correlation Coefficient Value (unitless)**	**Coefficient of Determination Value (unitless)**	**Significant at Alpha = 0.05 (Yes/No)**
Ecological COCs:						
4,4'-DDD	-0.2010	0.0404	No	-0.0015	0.0000	No
4,4'-DDE	-0.1923	0.0370	No	-0.0176	0.0003	No
4,4'-DDT	-0.1695	0.0287	No	-0.0284	0.0008	No
Antimony	0.2929	0.0858	No	-0.3035	0.0921	No
Cadmium	0.2652	0.0704	No	-0.2951	0.0871	No
Copper	0.0662	0.0044	No	-0.2532	0.0641	No
Lead	0.3525	0.1243	No	0.0692	0.0048	No
Mercury	0.2566	0.0658	No	-0.2130	0.0454	No
Tin	0.0153	0.0002	No	-0.1464	0.0214	No
Zinc	-0.0850	0.0072	No	-0.0941	0.0088	No
Physical/Chemical Properties:						
TOC	0.5948	0.3538	Yes	-0.5500	0.3025	Yes
pH (test initiation) (1)	-0.6023	0.3628	Yes	0.3668	0.1346	No
pH (test termination) (2)	-0.5024	0.2524	Yes	0.4928	0.2428	Yes
Percent gravel	0.2244	0.0504	No	-0.1161	0.0135	No
Percent sand	0.1619	0.0262	No	-0.0914	0.0084	No
Percent fines	-0.1998	0.0399	No	0.1298	0.0168	No

Notes:

TOC = Total Organic Carbon
COC = Chemical of Concern

(1) The pH was measured by the toxicity testing laboratory at test initiation.
(2) The pH was measured by the toxicity testing laboratory at test termination.

TABLE 4-17
SWMU 1 EARTHWORM TISSUE ANALYTICAL RESULTS (WET WEIGHT AND DRY WEIGHT BASIS): BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Sample ID [1]	1B-SS09	1B-SS13	1B-SS15	1B-SS18	1B-SS19	1B-SS29	1B-SS33
Sampling Date	6/22/2007	6/22/2007	6/22/2007	6/22/2007	6/22/2007	6/22/2007	6/22/2007
<u>Wet Weight Basis</u>:							
Pesticides (ug/kg)							
4,4'-DDD	5.9 U	5.9 U	12 U	130 U	2000	5.9 U	29 U
4,4'-DDE	11 U	52 U	190 U	1700 U	7800 J	18 U	660 J
4,4'-DDT	15 U	140	150 J	320 U	4400 J	15 U	74 U
Metals (mg/kg)							
Antimony	0.065 U	0.46	0.98	0.19 U	0.15 U	0.09 U	0.15 U
Cadmium	0.49	1	0.98	0.58	1.7	0.64	1.7
Copper	1.6	12	27	4.3	3.7	4.6	2.3
Lead	0.14 J	5.4	17	1.6	1.3	0.47	1.2
Mercury	0.015 J	0.04 J	0.025 J	0.0097 J	0.035 J	0.0083 J	0.017 J
Tin	3.4 U	65 J	62 J	60 J	60 J	61 J	67 J
Zinc	15	36	75	22	20	17	17
<u>Dry Weight Basis</u> [2]:							
Pesticides (ug/kg)							
4,4'-DDD	37 U	37 U	75 U	813 U	12500	37 U	181 U
4,4'-DDE	69 U	325 U	1188 U	10625 U	48750 J	113 U	4125 J
4,4'-DDT	94 U	875	938 J	2000 U	27500 J	94 U	463 U
Metals (mg/kg)							
Antimony	0.406 U	2.9	6.1	1.2 U	0.94 U	0.56 U	0.94 U
Cadmium	3.1	6.3	6.1	3.6	11	4.0	10.6
Copper	10	75	169	27	23	29	14.4
Lead	0.88 J	34	106	10	8.1	2.9	7.5
Mercury	0.094 J	0.250 J	0.16 J	0.061 J	0.22 J	0.052 J	0.106 J
Tin	21 U	406 J	388 J	375 J	375 J	381 J	419 J
Zinc	94	225	469	138	125	106	106
Lipids (%)	0.12	0.016	0.031	NA	0.058	0.088	0.018

TABLE 4-17
SWMU 1 EARTHWORM TISSUE ANALYTICAL RESULTS (WET WEIGHT AND DRY WEIGHT BASIS): BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Sample ID [1]	1B-SS37	1B-SS39	1B-SS46	1B-SS48	1B-SS49	1B-SS50	1B-SS51
Date	6/22/2007	6/22/2007	6/22/2007	6/22/2007	6/22/2007	6/22/2007	6/22/2007
Wet Weight Basis:							
Pesticides (ug/kg)							
4,4'-DDD	29 U	12 U	33 J	29 U	29 U	59 U	5.9 U
4,4'-DDE	440 J	150 U	1500 J	630 J	500 J	900 J	9.7 U
4,4'-DDT	84 J	30 U	190 J	75 U	74 U	150 U	15 U
Metals (mg/kg)							
Antimony	0.15 U	0.88	0.20 U	0.53	0.45 U	0.86	0.069 U
Cadmium	0.61	0.42	0.66	1.5	0.64	0.68	0.38
Copper	4.6	4.7	7.2	7.5	6.6	14	2.1
Lead	1.7	1.2	4.8	8.8	6.7	12	0.28
Mercury	0.052 J	0.014 J	0.051 J	0.059 J	0.19 J	0.10 J	0.015 J
Tin	56 J	60 J	61 J	57 J	68 J	72 J	67 J
Zinc	17	16	22	38	27	43	18
Dry Weight Basis [2]:							
Pesticides (ug/kg)							
4,4'-DDD	181 U	75 U	206 U	181 U	181 U	369 U	37 U
4,4'-DDE	2750 J	938 U	9375 J	3938 J	3125 J	5625 J	61 U
4,4'-DDT	525 J	188 U	1188 J	469 U	463 U	938 U	94 U
Metals (mg/kg)							
Antimony	0.94 U	5.5	1.3 U	3.3	2.8 U	5.4	0.43 U
Cadmium	3.8	2.6	4.1	9.4	4.0	4.3	2.4
Copper	29	29	45	47	41	88	13
Lead	11	7.5	30	55	42	75	1.8
Mercury	0.33 J	0.088 J	0.32 J	0.37 J	1.2 J	0.63 J	0.094 J
Tin	350 J	375 J	381 J	356 J	425 J	450 J	419 J
Zinc	106	100	138	238	169	269	113
Lipids (%)	0.056	0.13	0.041	0.062	<0.01	<0.01	0.077

TABLE 4-17
SWMU 1 EARTHWORM TISSUE ANALYTICAL RESULTS (WET WEIGHT AND DRY WEIGHT BASIS): BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Notes:

J = The analyte was positively identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit
U = The analyte was analyzed for, but not detected above the reported sample quamtitation limit

ug/kg = microgram per kilogram
mg/kg = milligram per kilogram
NA = Not Analyzed
% = Percent
< = Less Than

(1) Earthworm tissue sample identification numbers correspond to the surface soil samples earthworms were exposed to during the toxicity tests.
(2) For a given earthworm tissue sample, dry weight concentrations were derived by dividing the wet weight concentrations reported by the analytical laboratory by 0.16 (estimated solids content of earthworms [USEPA, 1993]).

Table References:

United States Environmental Protection Agency (USEPA). 1993. Wildlife Exposure Factors Handbook. Office of Research and Development, Washington, D.C. EPA/600/R-93/187a.

TABLE 4-18
UPLAND REFERENCE AREA N0. 2 EARTHWORM TISSUE ANALYTICAL RESULTS (WET WEIGHT AND DRY WEIGHT BASIS): BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Sample ID [1]	1B-REF-03		1B-REF-05		1B-REF-06	
Date	6/22/2007		6/22/2007		6/22/2007	
<u>Wet Weight Basis</u>:						
Pesticides (ug/kg)						
4,4'-DDD	5.9	U	5.8	U	6.5	U
4,4'-DDE	9.7	U	9.7	U	11	U
4,4'-DDT	15	U	15	U	17	U
Metals (mg/kg)						
Antimony	0.13	U	0.071	U	0.1	J
Cadmium	0.43		0.27		0.41	
Copper	2.7		1.5		2.7	
Lead	1		0.19	J	0.39	
Mercury	0.0093	J	0.0049	J	0.0065	J
Tin	68	J	68	J	3.5	U
Zinc	20		15		19	
<u>Dry Weight Basis</u> [2]:						
Pesticides (ug/kg)						
4,4'-DDD	37	U	36	U	41	U
4,4'-DDE	61	U	61	U	69	U
4,4'-DDT	94	U	94	U	106	U
Metals (mg/kg)						
Antimony	0.81	U	0.44	U	0.63	J
Cadmium	2.7		1.7		2.6	
Copper	17		9.4		17	
Lead	6.3		1.2	J	2.4	
Mercury	0.058	J	0.031	J	0.041	J
Tin	425	J	425	J	22	U
Zinc	125		94		119	
Lipids (%)	NA		<0.01		0.047	

Notes:

J = The analyte was positiviely identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit.

U = The analyte was analyzed for, but not detected at the reported sample quantitation limit

TABLE 4-18
UPLAND REFERENCE AREA EARTHWORM TISSUE ANALYTICAL RESULTS (WET WEIGHT AND DRY WEIGHT BASIS): BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Notes (continued):

ug/kg = microgram per kilogram
mg/kg = milligram per kilogram
NA = Not Analyzed
% = Percent
< = Less Than

(1) Earthworm tissue sample identification numbers correspond to the surface soil samples earthworms were exposed to during the toxicity tests.

(2) For a given earthworm tissue sample, dry weight concentrations were derived by dividing the wet weight concentrations reported by the analytical laboratory by 0.16 (estimated solids content of earthworms [USEPA, 1993]).

Table References:

United States Environmental Protection Agency (USEPA). 1993. Wildlife Exposure Factors Handbook. Office of Research and Development, Washington, D.C. EPA/600/R-93/187a.

TABLE 4-19
SUMMARY OF 95 PERCENT UCL OF THE MEAN HAZARD QUOTIENT VALUES FOR AMERICAN ROBIN DIETARY EXPOSURES TO ECOLOGICAL CHEMICALS OF CONCERN IN SWMU 1 SURFACE SOIL
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Chemical	NOAEL-Based Hazard Quotient Values [(1)]
Pesticides:	
4,4'-DDD	11.37
4,4'-DDE	11.98
4,4'-DDT	14.32
Metals:	
Antimony	<0.01
Cadmium	0.25
Copper	1.19
Lead	3.22
Mercury	0.88
Tin	2.81
Zinc	0.24

Shaded cells indicate a Hazard Quotient (HQ) greater than 1.0.

Notes:

NOAEL = No Observed Adverse Effect Level

(1) Risk estimates (i.e., HQ values) were estimated using 95 percent UCL of the mean surface soil and earthworm tissue concentrations.

Revised: April 5, 2010

TABLE 4-20
SUMMARY OF MAXIMUM HAZARD QUOTIENT VALUES FOR AMERICAN ROBIN DIETARY EXPOSURES TO COPPER, LEAD, AND TIN IN SWMU 1 AND UPLAND REFERENCE AREA NO. 2 SURFACE SOIL
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Chemical	NOAEL-Based Hazard Quotient Values [1]		Residual Risk [3][4]
	SWMU 1	Reference Area No. 2	
Organochlorine Pesticides:			
4,4'-DDD	12.45	0.04	12.45
4,4'-DDE	46.49	0.06	46.49
4,4'-DDT	28.68	0.10	28.68
Metals:			
Copper	4.49	0.28	4.21
Lead	10.14	0.19	9.95
Tin	3.98	2.98	1.00

Shaded cells indicate a SWMU 1, Upland Reference Area No. 2, or residual risk hazard quotient (HQ) greater than 1.0.

Notes:

NOAEL = No Observed Adverse Effect Level

(1) SWMU 1 and Upland Reference Area No. 2 risk estimates (i.e., HQ values) were estimated using maximum detected surface soil and earthworm tissue concentrations unless otherwise noted.

(2) Organochlorine pesticides were not detected in Upland Reference Area No. 2 surface soil or in the tissue of earthworms exposed to Upland Reference Area surface soil. The risk estimates shown were derived using maximum reporting limits.

(3) Residual risk estimates were derived by subtracting the Upland Reference Area No. 2 NOAEL-based risk estimates from the SWMU 2 NOAEL-based risk estimates unless otherwise noted (the value represents that component of risk which is site-related).

(4) Because Upland Reference Area No. 2 risk estimates for organochlorine pesticides are based on maximum reporting limits, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT risks presented at SWMU 1 were assumed to be entirely site-related (i.e., SWMU 1 NOAEL-based risk estimates were used as residual risk estimates).

TABLE 4-21
SWMU 1 TURTLE GRASS TISSUE ANALYTICAL RESULTS (WET WEIGHT AND DRY WEIGHT BASIS): BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	1B-SG01	1B-SG01	1B-SG02	1B-SG02	1B-SG03	1B-SG03
Sample ID	1B-SG01-AG	1B-SG01-WP	1B-SG02-AG	1B-SG02-WP	1B-SG03-AG	1B-SG03-WP
Sampling Date	4/30/2007	4/30/2007	4/30/2007	4/30/2007	4/30/2007	4/30/2007
<u>Wet Weight Basis</u>:						
Metals (mg/kg)						
Arsenic	0.26 J	0.47	0.41 J	0.49	0.43 J	0.37 J
Cadmium	0.019 U	0.019 U	0.018 U	0.02 J	0.025 J	0.019 U
Copper	0.59	0.72	0.83	0.96	0.84	0.5
Selenium	0.095 U	0.093 U	0.091 U	0.094 U	0.091 U	0.095 U
Zinc	6	3.1 J	4.4	3.4 J	5.9	3.7 J
Mercury	0.0036 U	0.0071 J	0.01 J	0.0066 J	0.0037 U	0.0039 U
General Chemistry						
Percent Moisture - %	88	86	88	87	87	89
<u>Dry Weight Basis</u>: (1)						
Metals (mg/kg)						
Arsenic	2.2 J	3.4	3.4 J	3.8	3.3 J	3.4 J
Cadmium	0.2 U	0.14 U	0.15 U	0.15 J	0.19 J	0.17 U
Copper	4.9	5.1	6.9	7.4	6.5	4.5
Selenium	0.79 U	0.66 U	0.76 U	0.72 U	0.70 U	0.86 U
Zinc	50.0	22.1 J	36.7	26.2 J	45.4	33.6 J
Mercury	0.03 U	0.0507 J	0.0833 J	0.0508 J	0.0285 U	0.0355 U

Notes:

J = The analyte was positively identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit
U = The analyte was analyzed for, but not detected above the reported sample quamtitation limit

TABLE 4-21
SWMU 1 SEAGRASS TISSUE ANALYTICAL RESULTS (WET WEIGHT AND DRY WEIGHT BASIS): BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Notes (continued):

mg/kg = miligram per kilogram
% = percent

(1) For a given turtle grass tissue sample, dry weight concentrations were derived by dividing the wet weight concentrations reported by the analytical laboratory by the solids fraction of the sample.

TABLE 4-22
REFERENCE AREA NO. 2 TURTLE GRASS TISSUE ANALYTICAL RESULTS (WET WEIGHT AND DRY WEIGHT BASIS): BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	REF2-VEG-AB01	REF2-VEG-WB01	REF2-VEG-AB02	REF2-VEG-WB02	REF2-VEG-AB03	REF2-VEG-WB03
Sample ID	REF2-VEG-AB01	REF2-VEG-WB01	REF2-VEG-AB02	REF2-VEG-WB02	REF2-VEG-AB03	REF2-VEG-WB03
Sampling Date	1/31/2007	1/31/2007	1/31/2007	1/31/2007	1/31/2007	1/31/2007
<u>Wet Weight Basis</u>:						
Metals (mg/kg)						
Arsenic	0.31 J	0.36 J	0.2 J	0.38 J	0.33 J	0.35 J
Cadmium	0.038 J	0.029 J	0.026 J	0.09 U	0.037 J	0.03 J
Copper	0.65	0.49	0.57	0.45 U	0.62	0.48
Selenium	0.48 U	0.46 U	0.48 U	0.45 U	0.46 U	0.45 U
Zinc	4.2	3.7 U	3.8 U	3.6 U	4.3	3.6 U
Mercury	0.019 U	0.02 U	0.019 U	0.018 U	0.019 U	0.02 U
General Chemistry						
Percent Moisture - %	86	87	85	89	84	84
<u>Dry Weight Basis</u>: [(1)]						
Metals (mg/kg)						
Arsenic	2.2 J	2.8 J	1.3 J	3.5 J	2.1 J	2.2 J
Cadmium	0.27 J	0.22 J	0.17 J	0.82 U	0.23 J	0.19 J
Copper	4.6	3.8	3.8	4.1 U	3.9	3.0
Selenium	3.4 U	3.5 U	3.2 U	4.1 U	2.9 U	2.8 U
Zinc	30.0	28.5 U	25.3 U	32.7 U	26.9	22.5 U
Mercury	0.14 U	0.2 U	0.13 U	0.16 U	0.12 U	0.13 U

Notes:

J = The analyte was positively identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit
U = The analyte was analyzed for, but not detected above the reported sample quamtitation limit

TABLE 4-22
REFERENCE AREA NO. 2 TURTLE GRASS TISSUE ANALYTICAL RESULTS (WET WEIGHT AND DRY WEIGHT BASIS: BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Noes (continued):

mg/kg = milligram per kilogram
% = percent

(1) For a given turtle grass tissue sample, dry weight concentrations were derived by dividing the wet weight concentrations reported by the analytical laboratory by the solids fraction of the sample.

TABLE 4-23
SWMU 1 OPEN WATER SEDIMENT ANALYTICAL RESULTS: BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	1B-OWSD01	1B-OWSD02	1B-OWSD03	1B-OWSD03D
Sample ID	1B-OWSD01	1B-OWSD02	1B-OWSD03	1B-OWSD03D
Sampling Date	4/30/2007	4/30/2007	4/30/2007	4/30/2007
Sample Depth (feet bgs)	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5
Metals (mg/kg)				
Arsenic	4.7 J	5.7 J	7 J	7.9 J
Cadmium	0.13 J	0.11 J	0.085 J	0.087 J
Copper	20 J	30 J	12 J	14 J
Mercury	0.037 J	0.024 J	0.02 J	0.025 J
Selenium	0.59 J	0.7 J	1.1 J	1.0 J
Zinc	32 J	40 J	9.8 J	3.4 J
General Chemistry				
TOC (mg/kg)	68400	73500	67100	NA
pH (SU)	7.5	7.8	7.8	NA
Grain Size (percent)				
Gravel	2.6	2.1	1.7	NA
Sand	59.8	47.7	51.7	NA
Coarse Sand	21.4	13.0	7.1	NA
Medium Sand	15.7	14.4	16.1	NA
Fine Sand	22.7	20.3	28.6	NA
Fines (silt and clay)	37.6	50.2	46.6	NA

Notes:

J = The analyte was positiviely identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit.
U = The analyte was analyzed for, but not detected at the reported sample quantitation limit

NA = Not Analyzed
SU = Standard Units
TOC = Total Organic Carbon
mg/kg = milligram per kilogram
bgs = below ground surface

TABLE 4-24
OPEN WATER REFERENCE AREA NO. 2 SEDIMENT ANALYTICAL RESULTS:
BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	REF2-VEG-SED01	REF2-VEG-SED02	REF2-VEG-SED03
Sample ID	REF2-VEG-SED01	REF2-VEG-SED02	REF2-VEG-SED03
Sampling Date	1/31/2007	1/31/2007	1/31/2007
Sample Depth (feet bgs)	0.0-0.5	0.0-0.5	0.0-0.5
Metals (mg/kg)			
Arsenic	21	1.1	0.96
Cadmium	0.046 J	0.14 U	0.17 U
Copper	4.9 J	1.6	1.4 J
Mercury	0.041 U	0.032 U	0.035 U
Selenium	0.21 J	0.72 U	0.87 U
Zinc	7.3 J	2.1 J	1.7 J
General Chemistry			
TOC (mg/kg)	29000	13000	30000
pH (SU)	NA	NA	NA
Grain Size (percent)			
Gravel	2.4	1.6	0.6
Sand	72.2	82.5	79.6
Coarse Sand	2.7	6.2	6.3
Medium Sand	14.3	35.2	27
Fine Sand	55.2	41	46.4
Silt	10.7	8	13.2
Clay	14.7	7.9	6.5

Notes:

J = The analyte was positiviely identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit.
U = The analyte was analyzed for, but not detected at the reported sample quantitation limit

SU = Standard Units
TOC = Total Organic Carbon
mg/kg = milligram per kilogram
bgs = below ground surface

Revised: April 5, 2010

TABLE 4-25
SUMMARY OF MAXIMUM HAZARD QUOTIENT VALUES FOR WEST INDIAN MANATEE DIETARY EXPOSURES TO ECOLOGICAL CHEMICALS OF CONCERN IN SWMU 1 SEDIMENT
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Chemical	NOAEL-Based Hazard Quotient Values [1]
Metals:	
Arsenic	0.30
Cadmium	0.21
Copper	0.06
Mercury	0.81
Selenium	0.43
Zinc	0.25

Shaded cells indicate a Hazard Quotient (HQ) greater than 1.0.

Notes:

NOAEL = No Observed Adverse Effect Level

[1] Risk estimates (i.e., HQ values) were derived using maximum sediment and turtle grass tissue concentrations.

FIGURES

Figure 1-1
Navy Ecological Risk Assessment Tiered Approach

Remedial Project Manager Input and Risk Management Consideration[3]

Tier 1. Screening-Level Ecological Risk Assessment (SERA): Identify pathways and compare exposure point concentrations to bench marks.

Step 1: Site visit; Pathway Identification/Problem Formulation; Toxicity Evaluation

Step 2: Exposure Estimate; Risk Calculation (SMDP) [1]

Proceed to Exit Criteria for SERA

Exit Criteria for the Screening-Level Ecological Risk Assessment: Decision for exiting or continuing the ecological risk assessment.

1) Site passes screening-level risk assessment: A determination is made that the site poses acceptable risk and shall be closed out for ecological concerns.

2) Site fails screening-level risk assessment: The site must have both complete pathway and unacceptable risk. As a result the site will either have an interim cleanup or moves to the second tier.

Tier 2. Baseline Ecological Risk Assessment (BERA): Detailed assessment of exposure and hazard to "assessment endpoints" (ecological qualities to be protected). Develop site specific values that are protective of the environment.

Step 3a: Refinement of Conservative Exposure Assumptions[2]
Proceed to Exit Criteria for Step 3a

Step 3b: Problem Formulation - Toxicity Evaluation; Assessment Endpoints; Conceptual Model; Risk Hypothesis (SMDP)

Step 4: Study Design/Data Quality Objectives - Lines of Evidence; Measurement Endpoints; Work Plan and Sampling & Analysis Plan (SMDP)

Step 5: Verification of Field Sampling Design (SMDP)

Step 6: Site Investigation and Data Analysis (SMDP)

Step 7: Risk Characterization

Proceed to Exit Criteria for BERA

Exit Criteria Step 3a Refinement

1) If re-evaluation of the conservative exposure assumptions support an acceptable risk determination then the site exits the ecological risk assessment process.

2) If re-evaluation of the conservative exposure assumptions do not support an acceptable risk determination then the site continues in the Baseline Ecological Risk Assessment process.

Proceed to Step 3b.

Exit Criteria Baseline Ecological Risk Assessment

1) If the site poses acceptable risk then no further evaluation and no remediation from an ecological perspective is warranted.

2) If the site poses unacceptable ecological risk and additional evaluation in the form of remedy development and evaluation is appropriate, proceed to third tier.

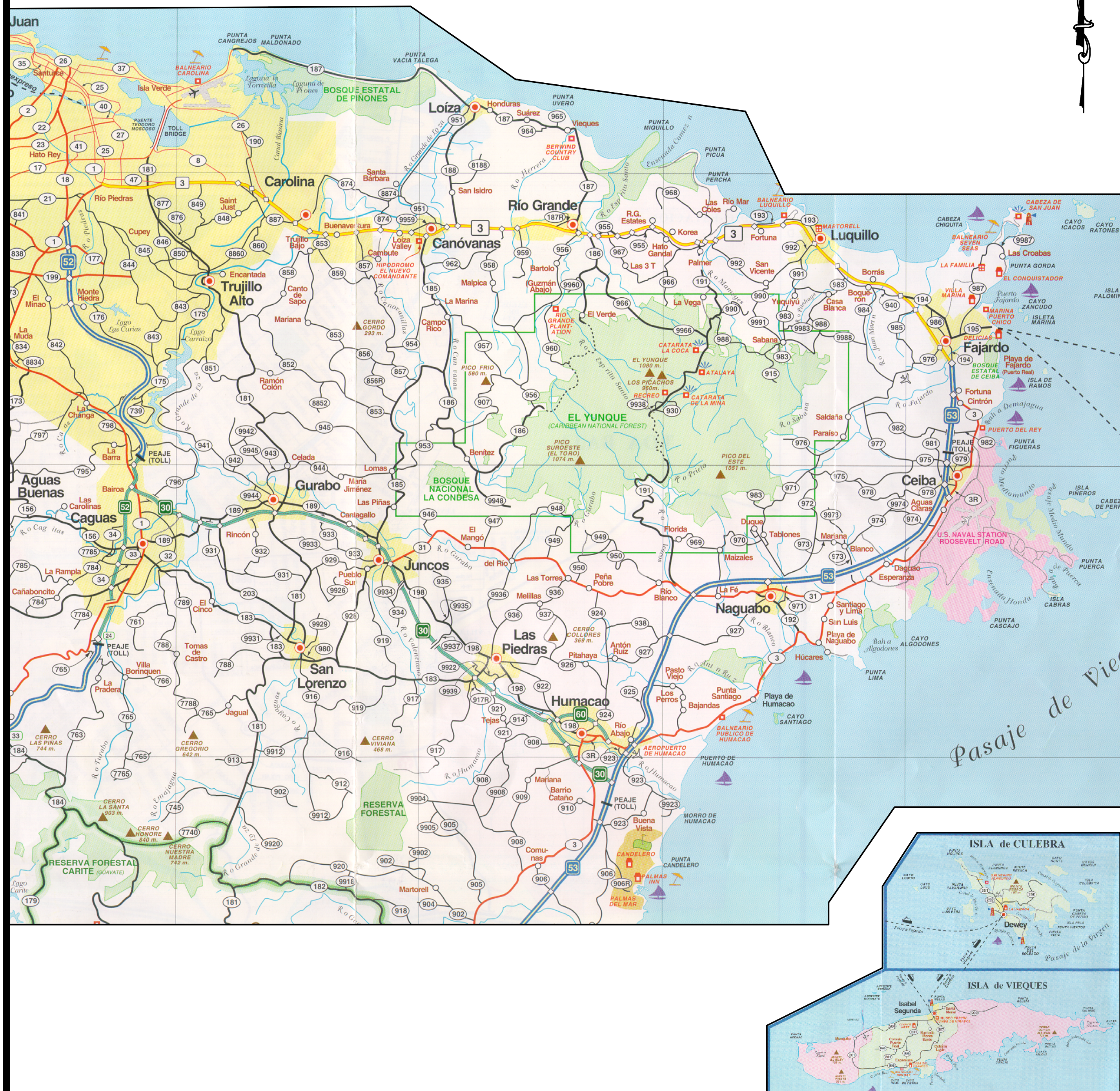
Tier 3. Evaluation of Remedial Alternative (RAGs C)

a. Develop site specific risk based cleanup values.

b. Qualitatively evaluate risk posed to the environment by implementation of each alternative (short term) impacts and estimate risk reduction provided by each (long-term) impacts; provide quantitative evaluation where appropriate. Weigh alternative using the remaining CERCLA 9 Evaluation Criteria. Plan for monitoring and site closeout.

Notes: 1) See USEPA's 8 Step ERA Process for requirements for each Scientific Management Decision Point (SMDP).
2) Refinement includes but is not limited to background, bioavailability, etc.
3) Risk management is incorporated throughout the tiered approach.

K:_CH2M Hill CLEAN III\CTO 108 (106547)\SWMU 1 Steps 6 and 7 Report\CAD\ 106547_01_01.DWG



4 0 2 4 8

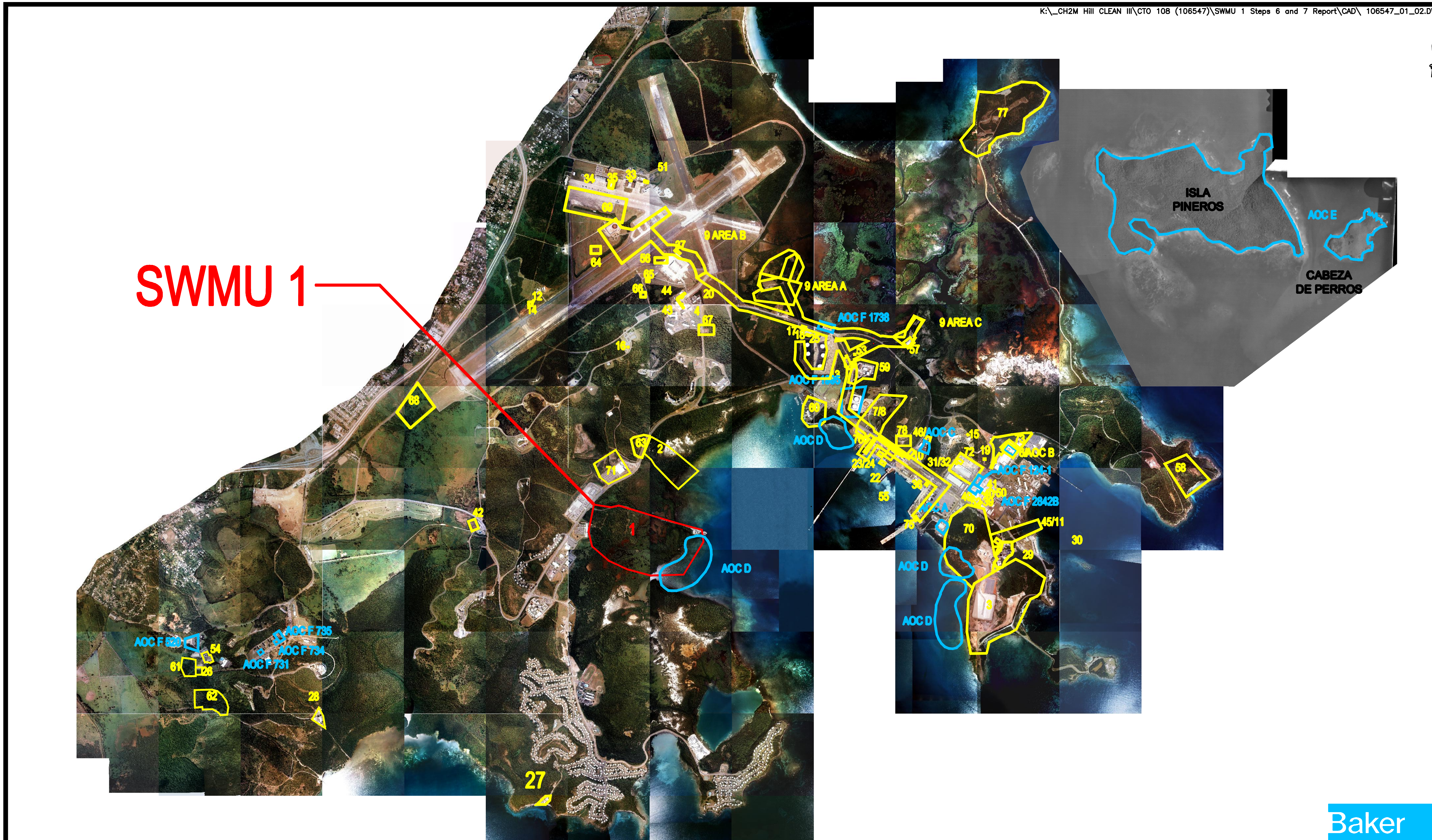
1 inch = 4 miles

Baker

FIGURE 2–1
REGIONAL LOCATION MAP
SWMU 1–ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT

SOURCE: METRODATA, INC., 1999.

NAVAL ACTIVITY PUERTO RICO



LEGEND

1 – SWMUs

AOC D – AOCs

– AREA TO WHICH THIS INVESTIGATION PERTAINS

SOURCE: GEO-MARINE, INC., SEPTEMBER 6, 2000.

3000 0 1500 3000

1 inch = 3000 ft.

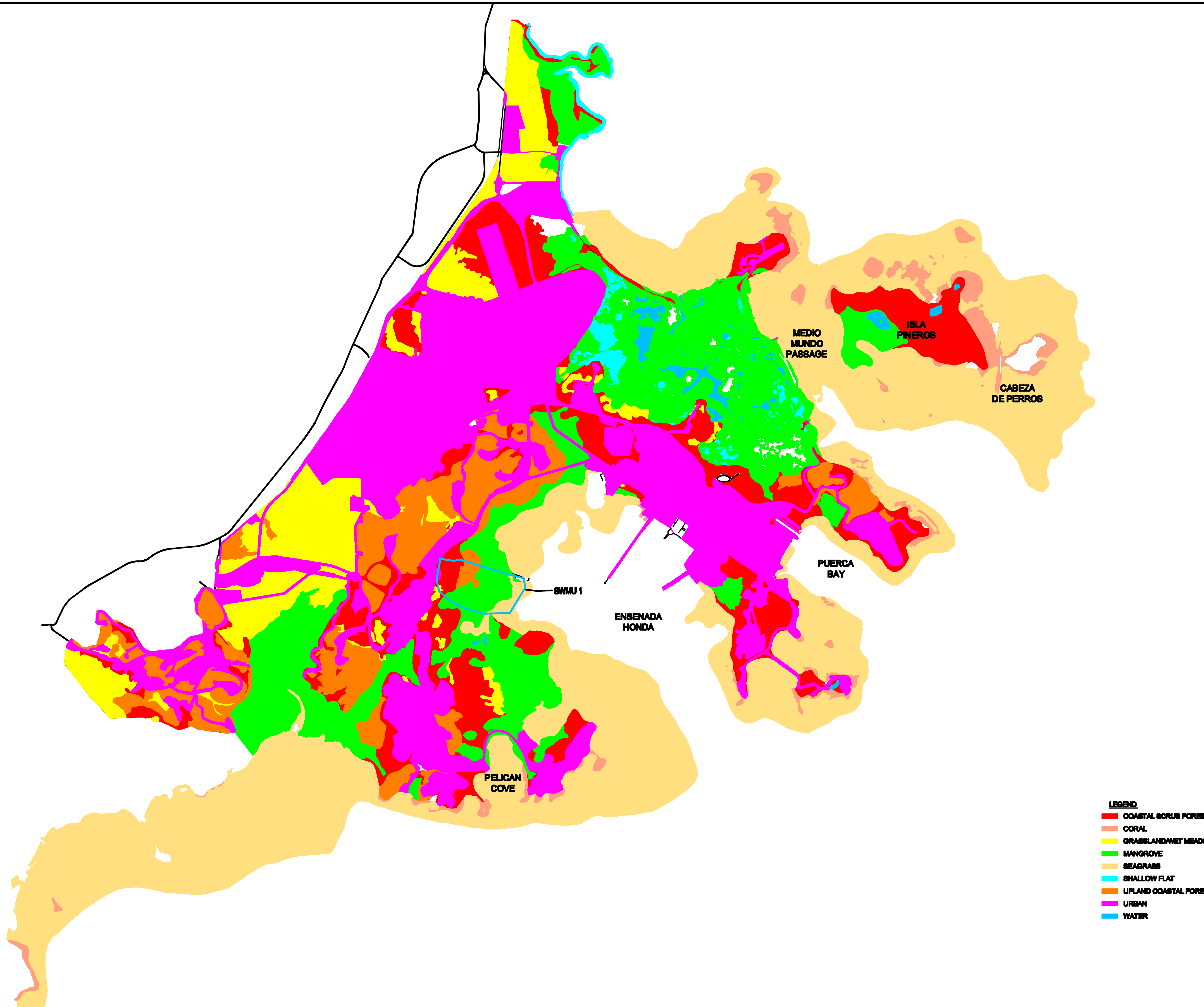
FIGURE 2–2

SWMU/AOC LOCATION MAP

SWMU 1–ARMY CREMATOR DISPOSAL SITE

STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT

NAVAL ACTIVITY PUERTO RICO



SOURCE: GEO-MARINE, INC.

REVISIONS			NORTH	SWMU 1-ARMY CREMATOR DISPOSAL SITE NAVAL ACTIVITY PUERTO RICO	Baker	"TERRESTRIAL AND AQUATIC HABITAT OCCURRING AT NAVAL ACTIVITY PUERTO RICO" STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT	FIGURE
K:_CH2M Hill CLEAN III\CTO 108 (108547)\SWMU 1 Steps 6 and 7 Report\CAD\	DRAWN	/RRR		BAKER ENVIRONMENTAL, Inc. Coraopolis, Pennsylvania		SCALE 1" = 2000'	2-3
	REVIEWED	MEK				DATE SEPTEMBER 2006	
	S.O.#	108547					
	CADD#	108547_01_03.DWG					

1500 0 700 1500

1 inch = 1500 ft.

Baker
Michael Baker Jr., Inc.

LEGEND

◎ – APPROX. LOCATION OF COBANA NEGRA

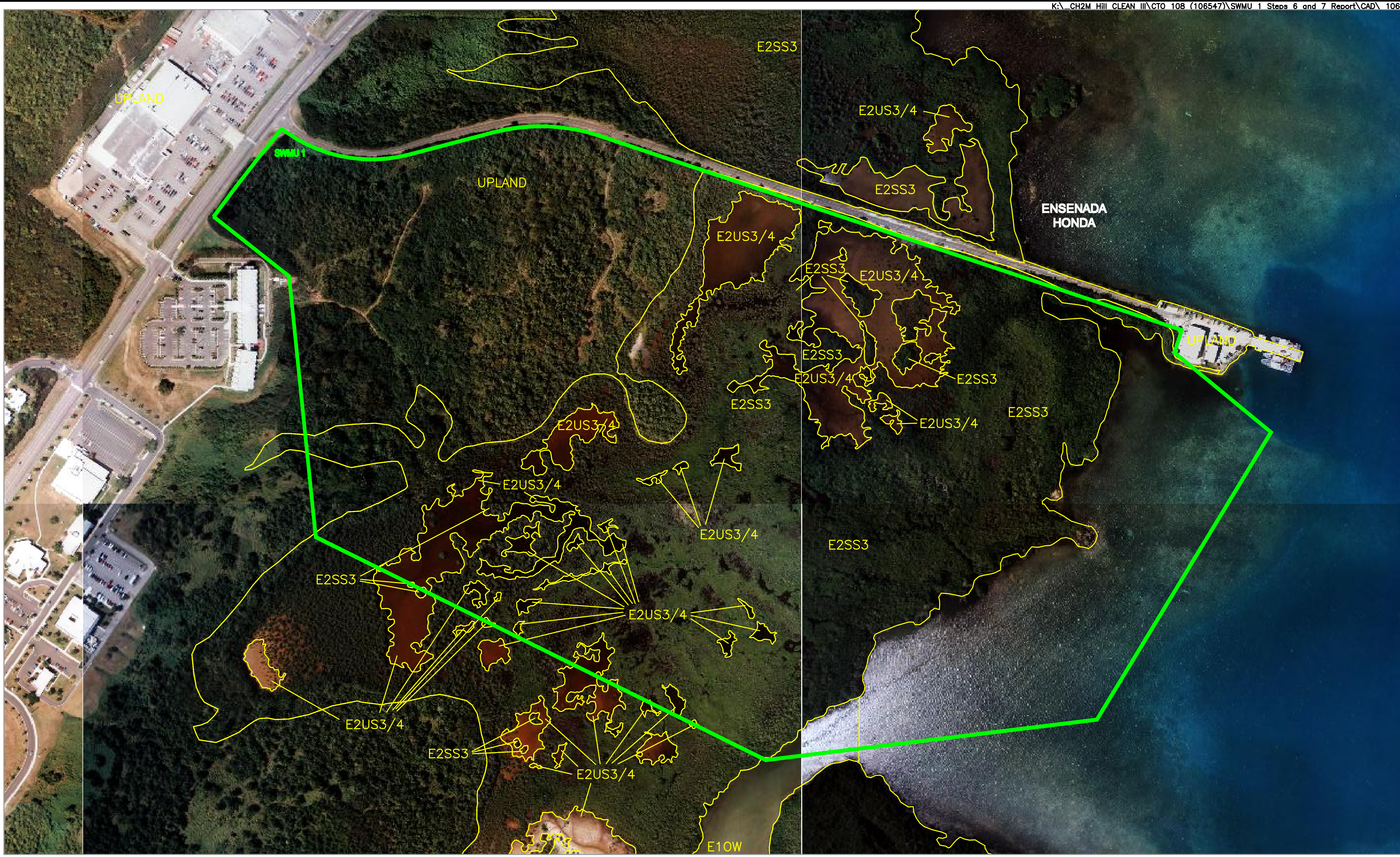
▭ – AREA TO WHICH THIS INVESTIGATION PERTAINS

SOURCE: GEO-MARINE, INC., SEPTEMBER 6, 2000.

FIGURE 2–4
APPROXIMATE LOCATION OF
COBANA NEGRA
SWMU 1–ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE
ECOLOGICAL RISK ASSESSMENT

NAVAL ACTIVITY PUERTO RICO

K:_CH2M Hill CLEAN III\CTO 108 (106547)\SWMU 1 Steps 6 and 7 Report\CAD_106547_01_10.DWG



LEGEND

1 – SWMU

E2SS3 – E2SS3 WETLANDS BOUNDARIES (SEE FIGURE 2-6 FOR CLASSIFICATIONS)

SOURCE: GEO-MARINE, INC., SEPTEMBER 6, 2000.

350 0 175 350

1 inch = 350 ft.

Baker

FIGURE 2-5
WETLAND LOCATION MAP
SWMU 1-ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO

M - MARINE

SUBSYSTEM	1 - SUBTIDAL					2 - INTERTIDAL			
CLASS	RB - Rock Bottom	UB - Uncon-solidated Bottom	AB - Aquatic Bed	RF - Reef	OW - Open Water (unknown bottom)	AB - Aquatic Bed	RF - Reef	RS - Rocky Shore	US - Uncon-solidated Shore
Subclass	1 Bedrock 2 Rubble	1 Cobble - Gravel 2 Sand 3 Mud 4 Organic	1 Algal 3 Rooted Vasc 5 Unknown	1 Coral 3 Worm		1 Algal 3 Rooted Vasc 5 Unknown	1 Coral 3 Worm	1 Bedrock 2 Rubble	1 Cobble - Gravel 2 Sand 3 Mud 4 Organic

E - ESTUARINE

SUBSYSTEM	1 - SUBTIDAL					2 - INTERTIDAL							
CLASS	RB - Rock Bottom	UB - Uncon-solidated Bottom	AB - Aquatic Bed	RF - Reef	OW - Open Water *(unknown bottom)*	AB - Aquatic Bed	RF - Reef	SB - Streambed	RS - Rocky Shore	US - Uncon-solidated Shore	EM - Emergent	SS - Scrub-Shrub	FO - Forested
Subclass	1 Bedrock 2 Rubble	1 Cobble - Gravel 2 Sand 3 Mud 4 Organic	1 Algal 3 Rooted Vasc 4 Floating Vasc 5 *Unknown Submerg.* 6 *Unknown Surface*	2 Mollusk 3 Worm		1 Algal 3 Rooted Vasc 4 Floating Vasc 5 *Unknown Submerg.* 6 *Unknown Surface*	2 Mollusk 3 Worm	1 Cobble - Gravel 2 Sand 3 Mud 4 Organic	1 Bedrock 2 Rubble	1 Cobble - Gravel 2 Sand 3 Mud 4 Organic 5 Dead	1 Persistent 2 Nonpersistent	1 Broad-leaved Decid. 2 Needle-leaved Decid. 3 Broad-leaved Everg. 4 Needle-leaved Everg. 5 Dead 6 *Deciduous* 7 *Evergreen*	1 Broad-leaved Decid. 2 Needle-leaved Decid. 3 Broad-leaved Everg. 4 Needle-leaved Everg. 5 Dead 6 *Deciduous* 7 *Evergreen*

R - RIVERINE

SUBSYSTEM	1 - TIDAL	2 - LOWER PERENNIAL		3 - UPPER PERENNIAL		4 INTERMITTENT		5 - UNKNOWN PERENNIAL
CLASS	RB - Rock	UB - Uncon-solidated Bottom	SB - Streambed	AB - Aquatic Bed	RS - Rocky Shore	US - Uncon-solidated Shore	OW - Open Water *(unknown bottom)*	**EM - Emergent
Subclass	1 Bedrock 2 Rubble	1 Cobble - Gravel 2 Sand 3 Mud 4 Organic	1 Bedrock 2 Rubble 3 Cobble - Gravel 4 Sand 5 Mud 6 Organic 7 Vegetated	1 Algal 2 Aquatic Moss 3 Rooted Vasc 4 Floating Vasc 5 *Unknown Submerg.* 6 *Unknown Surface*	1 Bedrock 2 Rubble	1 Cobble - Gravel 2 Sand 3 Mud 4 Organic		2 Nonpersistent

L - LACUSTRINE

SUBSYSTEM	1 - LIMNETIC				2 - LITTORAL						
CLASS	RB - Rock Bottom	UB - Uncon-solidated Bottom	AB - Aquatic Bed	OW - Open Water *(unknown bottom)*	RB - Rock Bottom	RS - Rocky Shore	UB - Uncon-solidated Bottom	AB - Aquatic Bed	US - Uncon-solidated Shore	EM - Emergent	OW - Open Water *(unknown bottom)*
Subclass	1 Bedrock 2 Rubble	1 Cobble - Gravel 2 Sand 3 Mud 4 Organic	1 Algal 2 Aquatic Moss 3 Rooted Vasc 4 Floating Vasc 5 *Unknown Submerg.* 6 *Unknown Surface*		1 Bedrock 2 Rubble	1 Bedrock 2 Rubble	1 Cobble - Gravel 2 Sand 3 Mud 4 Organic	1 Algal 2 Aquatic Moss 3 Rooted Vasc 4 Floating Vasc 5 *Unknown Submerg.* 6 *Unknown Surface*	1 Cobble - Gravel 2 Sand 3 Mud 4 Organic 5 Vegetated	2 Nonpersistent	

P - PALUSTRINE

CLASS	RB - Rock Bottom	UB - Uncon-solidated Bottom	AB - Aquatic Bed	US - Uncon-solidated Shore	ML - Moss-Lichen	EM - Emergent	SS - Scrub-Shrub	FO - Forested	OW - Open Water *(unknown bottom)*
Subclass	1 Bedrock 2 Rubble	1 Cobble - Gravel 2 Sand 3 Mud 4 Organic	1 Algal 2 Aquatic Moss 3 Rooted Vasc 4 Floating Vasc 5 *Unknown Submerg.* 6 *Unknown Surface*	1 Cobble - Gravel 2 Sand 3 Mud 4 Organic 5 Vegetated	1 Moss 2 Lichen	1 Persistent 2 Nonpersistent	1 Broad-leaved Decid. 2 Needle-leaved Decid. 3 Broad-leaved Everg. 4 Needle-leaved Everg. 5 Dead 6 *Deciduous* 7 *Evergreen*	1 Broad-leaved Decid. 2 Needle-leaved Decid. 3 Broad-leaved Everg. 4 Needle-leaved Everg. 5 Dead 6 *Deciduous* 7 *Evergreen*	

MODIFIERS

WATER REGIME				WATER CHEMISTRY			SOIL	SPECIAL
	Non-Tidal		**Tidal**	**Coastal Halinity**	**Inland Salinity**	**pH (fresh water)**		
A Temp. Flooded B Saturated C Seasonally Flooded D Seasonally Flooded/ Well Drained E Seasonally Flooded/ Saturated F Semipermanently Flooded G Intermittently Exposed	H Permanently Flooded J Intermittently Flooded K Artificially Flooded W Intermittently Flooded/ Temporary Y Saturated/Semipermanent/ Seasonal Z Intermittently Exposed Permanent U Unknown	K Artificially Flooded L Subtidal M Irregularly Flooded N Regularly Flooded P Irregularly Flooded * These water regimes are only used in tidally influenced, freshwater systems.	*S Temporary-Tidal *R Seasonal-Tidal *T Semipermanent- Tidal *V Permanent-Tidal U Unknown	1 Hyperhaline 2 Euhaline 3 Mixohaline 4 Polyhaline 5 Mesohaline 6 Oligohaline 0 Fresh	7 Hypersaline 8 Eusaline 9 Mixosaline 0 Fresh	a Acid t circumneutral i Alkaline	g Organic n Mineral	b Beaver d partially drained/ditched f Farmed h Diked/Impounded r Artificial Substrate s Spoil x Excavated

SOURCE: UNITED STATES, FISH AND WILDLIFE SERVICE. CLASSIFICATION OF WETLANDS AND DEEPWATER HABITATS OF THE UNITED STATES, 1985

Baker

FIGURE 2-6
THE COWARDIN WETLAND CLASSIFICATION SYSTEM
SWMU 1-ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO

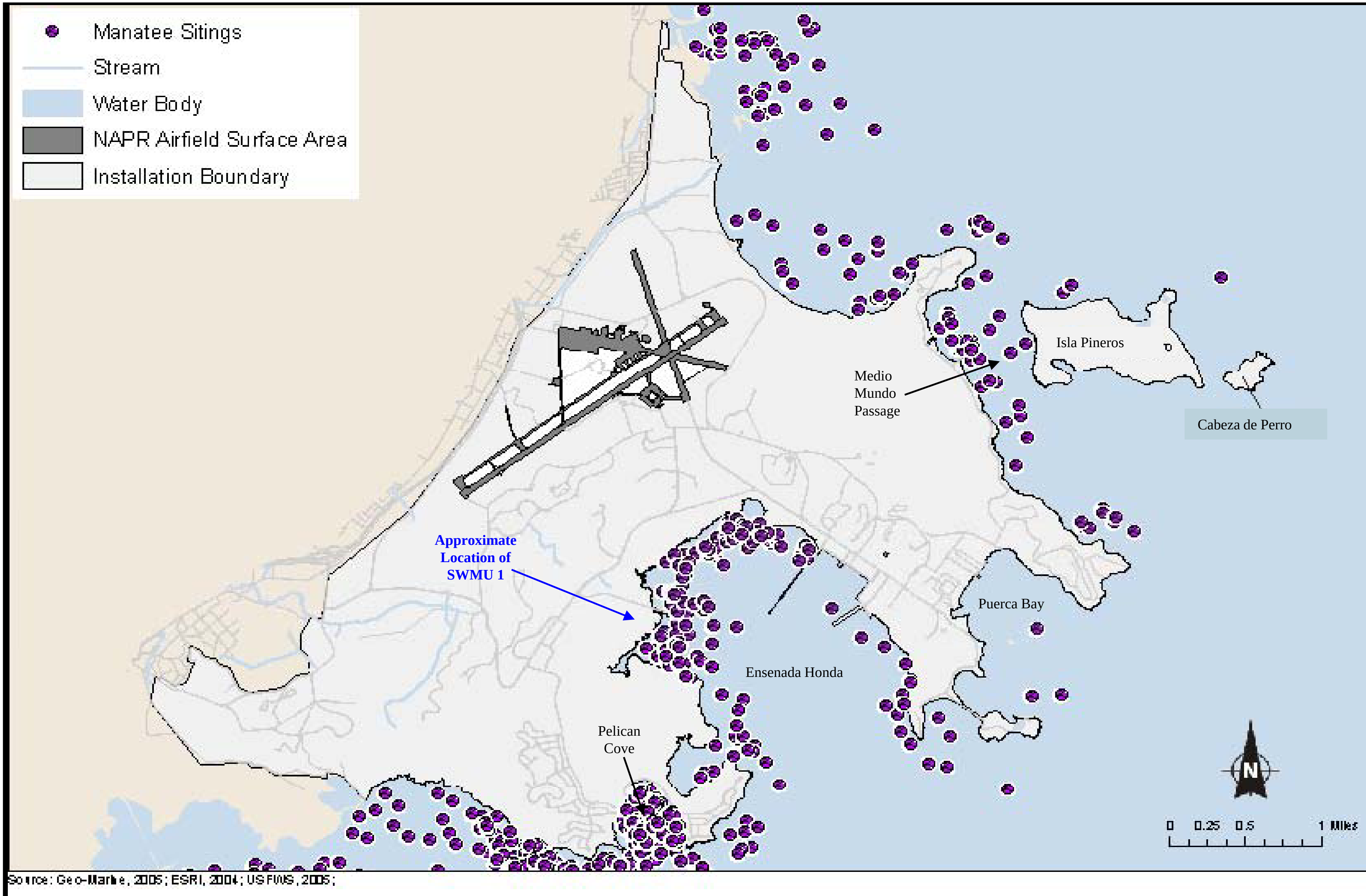
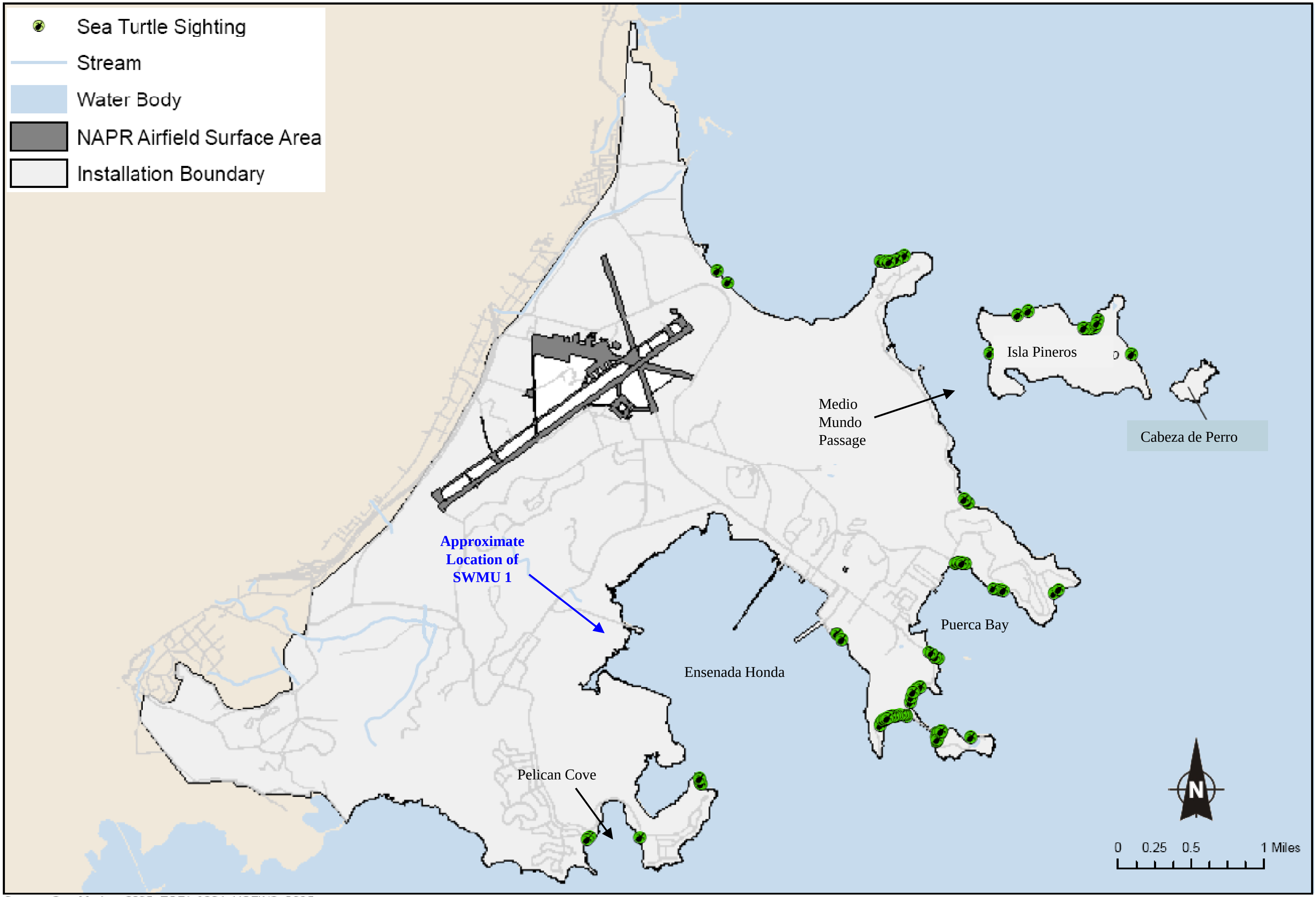


Figure from: Department of the Navy (DoN). 2007. *Environmental Assessment for the Disposal of Naval Activity Puerto Rico (formerly Naval Station Roosevelt Roads).* April 2007.

FIGURE 2-7
HISTORICAL MANATEE SIGHTINGS IN EASTERN PUERTO RICO
SWMU 1 – ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO

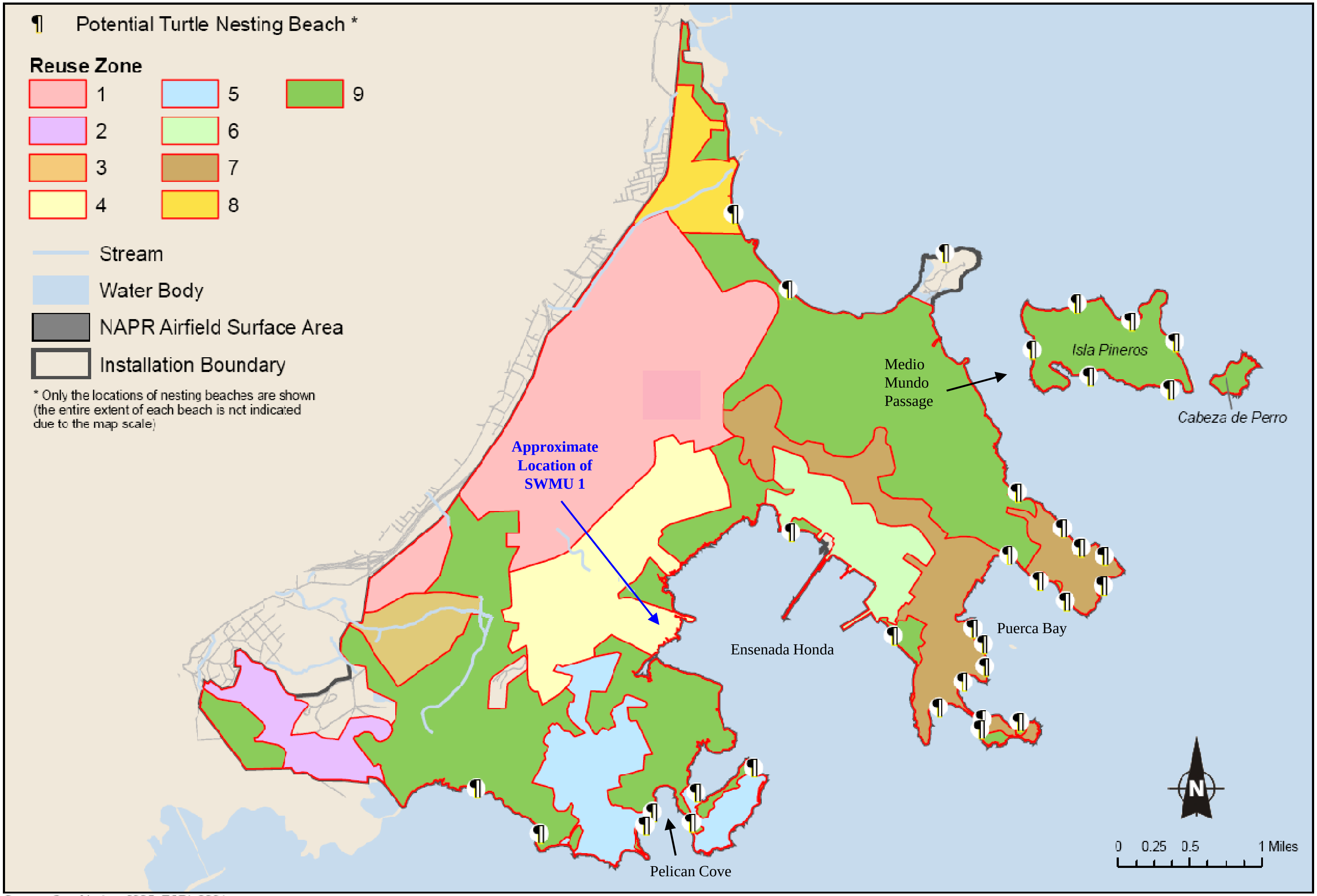


Source: Geo-Marine, 2005; ESRI, 2004; USFWS, 2005;

Cumulative sea turtle sightings from March 1984 through March 1995 obtained from weekly aerial surveys of the Former Naval station Roosevelt Roads.

Figure from: Department of the Navy (DoN). 2007. *Environmental Assessment for the Disposal of Naval Activity Puerto Rico (formerly Naval Station Roosevelt Roads).* April 2007.

FIGURE 2-8
SEA TURTLE SIGHTINGS AT NAVAL ACTIVITY PUERTO RICO
SWMU 1 – ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO

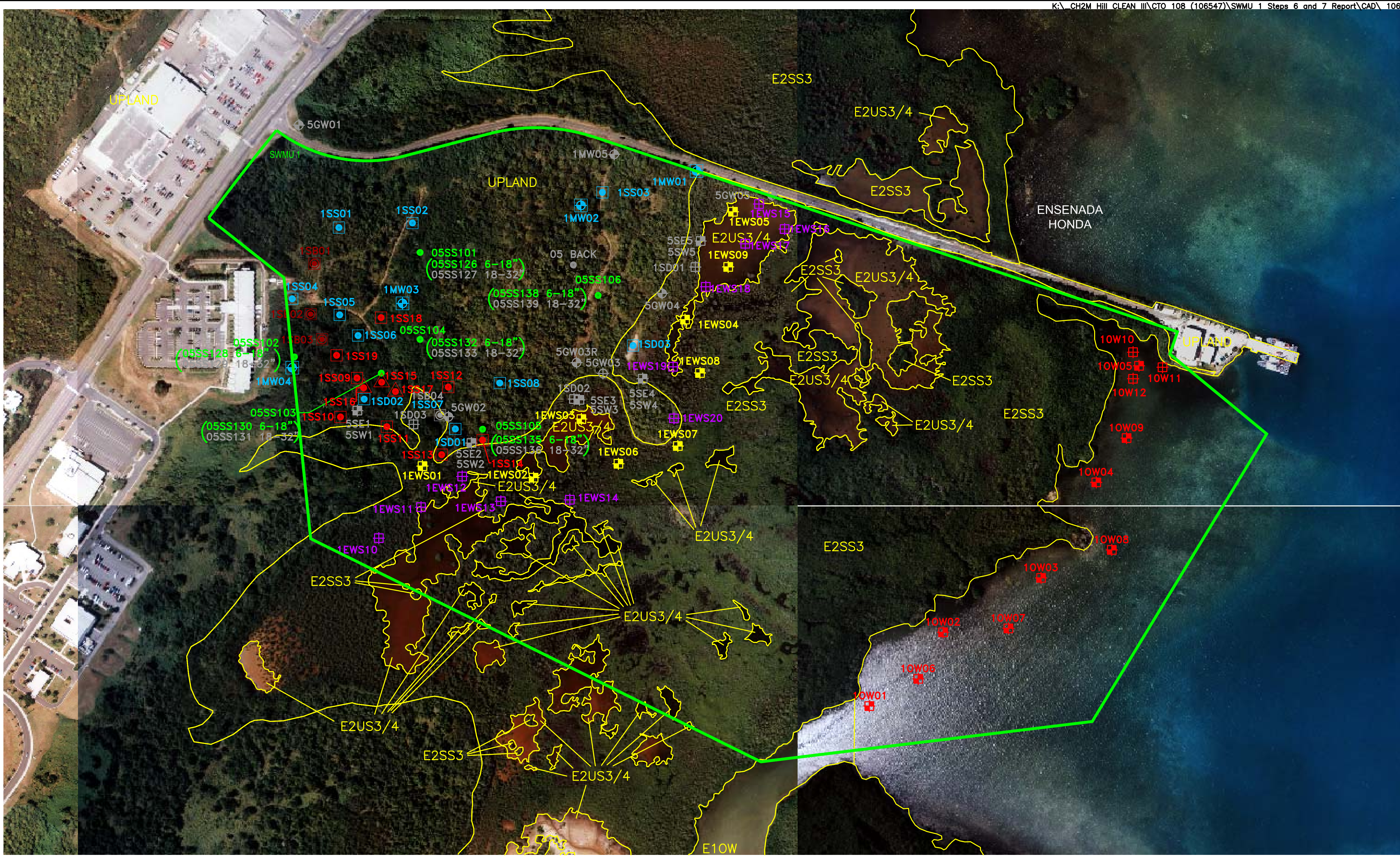


Source: Geo-Marine, 2005; ESRI, 2004;

Figure from: Department of Navy (DoN). 2007. *Environmental Assessment for the Disposal of Naval Activity Puerto Rico (formerly Naval Station Roosevelt Roads).* April 2007

FIGURE 2-9
POTENTIAL TURTLE NESTING SITES
SWMU 1 – ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO

K:_CH2M_Hill_CLEAN_III\CTO_108_(106547)\SWMU_1_Steps_6_and_7_Report\CAD_106547_01_04.DWG



LEGEND

- SWMU
- E2SS3 WETLANDS BOUNDARIES (SEE FIGURE 2-6 FOR CLASSIFICATIONS)
- REPORTED LOCATION OF 5GW03 (NOT LOCATED DURING 1996 RFI FIELD INVESTIGATION)
- SEDIMENT SAMPLE LOCATION (RELATIVE RISK RANKING)
- SURFACE WATER/SEDIMENT SAMPLE LOCATION (CONFIRMATION STUDY)
- SOIL SAMPLE LOCATION (SUPPLEMENTAL INVESTIGATION)
- SOIL BORING LOCATION (1996 RFI)
- MONITORING WELL/SURFACE SOIL LOCATION (1996 RFI)
- EXISTING MONITORING WELL LOCATION (CONFIRMATION STUDY)
- SURFACE SOIL SAMPLE LOCATION (1996 RFI)
- SURFACE SOIL SAMPLE LOCATION (2004 ADDITIONAL DATA COLLECTION)
- SURFACE AND SUBSURFACE SOIL SAMPLE LOCATION (2004 ADDITIONAL DATA COLLECTION)

ESTUARINE WETLAND SYSTEM

- SURFACE WATER/SEDIMENT SAMPLE LOCATION (2003 ADDITIONAL DATA COLLECTION)
- SEDIMENT SAMPLE LOCATION (2004 ADDITIONAL DATA COLLECTION)

OPEN WATER MARINE

- SURFACE WATER/SEDIMENT SAMPLE LOCATION (2003 ADDITIONAL DATA COLLECTION)
- SEDIMENT SAMPLE LOCATION (2004 ADDITIONAL DATA COLLECTION)

SOURCE: GEO-MARINE, INC., SEPTEMBER 6, 2000.

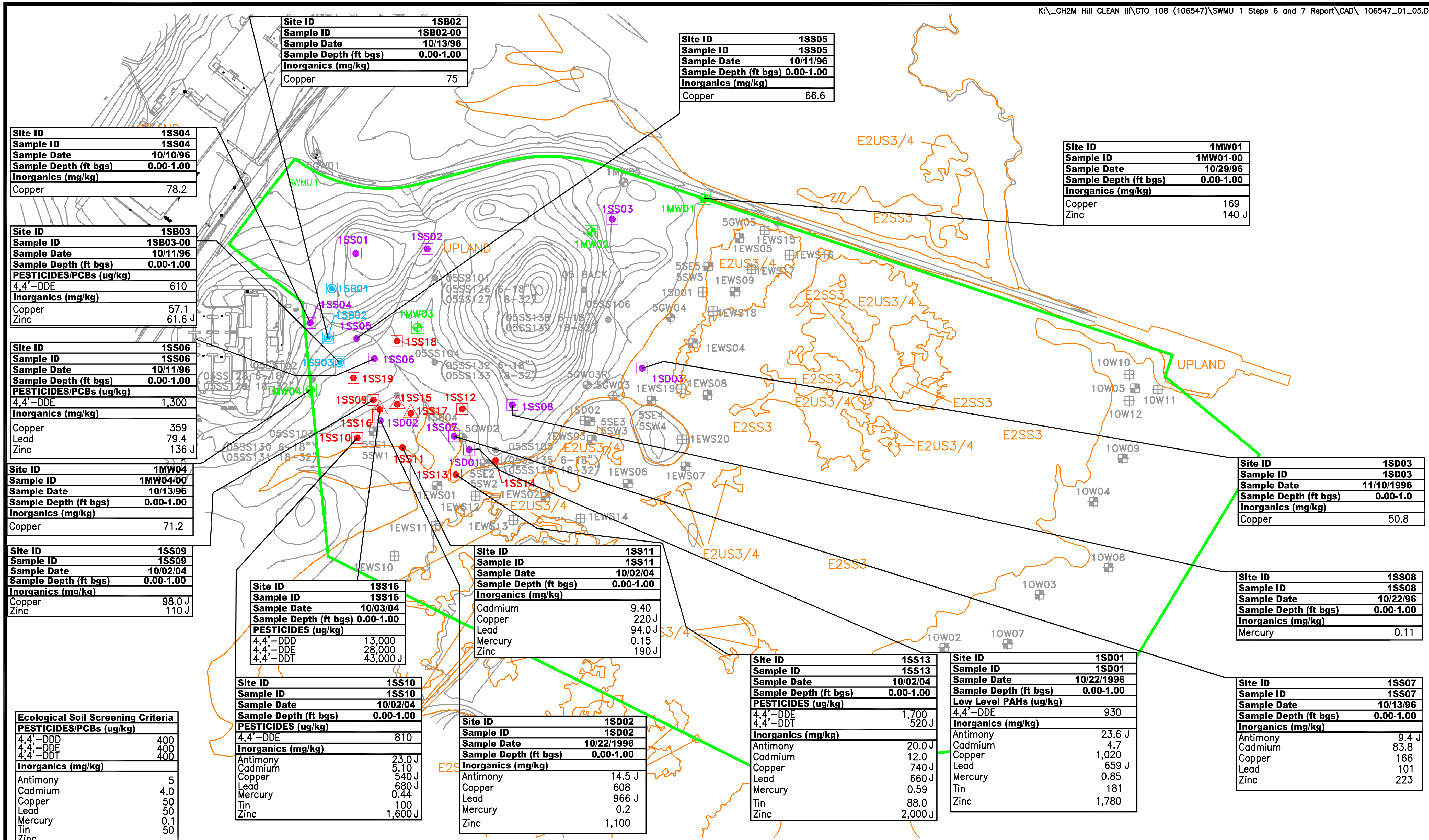
350 0 175 350

1 inch = 350 ft.

Baker

FIGURE 2-10
SOIL, SURFACE WATER, AND SEDIMENT SAMPLING LOCATIONS FOR ANALYTICAL DATA USED IN THE SERA AND STEP 3A OF THE BERA
SWMU 1-ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO

K:_CH2M Hill CLEAN III\CTO 108 (106547)\SWMU 1 Steps 6 and 7 Report\CAD\ 106547_01_05.DWG



Site ID	1SB02
Sample ID	1SB02-00
Sample Date	10/13/96
Sample Depth (ft bgs)	0.00-1.00
Inorganics (mg/kg)	
Copper	75

Site ID	1SS05
Sample ID	1SS05
Sample Date	10/11/96
Sample Depth (ft bgs)	0.00-1.00
Inorganics (mg/kg)	
Copper	66.6

Site ID	1SS04
Sample ID	1SS04
Sample Date	10/10/96
Sample Depth (ft bgs)	0.00-1.00
Inorganics (mg/kg)	
Copper	78.2

Site ID	1MW01
Sample ID	1MW01-00
Sample Date	10/29/96
Sample Depth (ft bgs)	0.00-1.00
Inorganics (mg/kg)	
Copper	169
Zinc	140 J

Site ID	1SB03
Sample ID	1SB03-00
Sample Date	10/11/96
Sample Depth (ft bgs)	0.00-1.00
PESTICIDES/PCBs (ug/kg)	
4,4'–DDE	610
Inorganics (mg/kg)	
Copper	57.1
Zinc	61.6 J

Site ID	1SS06
Sample ID	1SS06
Sample Date	10/11/96
Sample Depth (ft bgs)	0.00-1.00
PESTICIDES/PCBs (ug/kg)	
4,4'–DDE	1,300
Inorganics (mg/kg)	
Copper	359
Lead	79.4
Zinc	136 J

Site ID	1MW04
Sample ID	1MW04-00
Sample Date	10/13/96
Sample Depth (ft bgs)	0.00-1.00
Inorganics (mg/kg)	
Copper	71.2

Site ID	1SD03
Sample ID	1SD03
Sample Date	11/10/1996
Sample Depth (ft bgs)	0.00-1.0
Inorganics (mg/kg)	
Copper	50.8

Site ID	1SS09
Sample ID	1SS09
Sample Date	10/02/04
Sample Depth (ft bgs)	0.00-1.00
Inorganics (mg/kg)	
Copper	98.0 J
Zinc	110 J

Site ID	1SS11
Sample ID	1SS11
Sample Date	10/02/04
Sample Depth (ft bgs)	0.00-1.00
Inorganics (mg/kg)	
Cadmium	9.40
Copper	220 J
Lead	94.0 J
Mercury	0.15
Zinc	190 J

Site ID	1SS08
Sample ID	1SS08
Sample Date	10/22/96
Sample Depth (ft bgs)	0.00-1.00
Inorganics (mg/kg)	
Mercury	0.11

Site ID	1SS16
Sample ID	1SS16
Sample Date	10/03/04
Sample Depth (ft bgs)	0.00-1.00
PESTICIDES (ug/kg)	
4,4'–DDD	13,000
4,4'–DDE	28,000
4,4'–DDT	43,000 J

Site ID	1SS13
Sample ID	1SS13
Sample Date	10/02/04
Sample Depth (ft bgs)	0.00-1.00
PESTICIDES (ug/kg)	
4,4'–DDE	1,700
4,4'–DDT	520 J
Inorganics (mg/kg)	
Antimony	20.0 J
Cadmium	12.0
Copper	740 J
Lead	660 J
Mercury	0.59
Tin	88.0
Zinc	2,000 J

Site ID	1SD01
Sample ID	1SD01
Sample Date	10/22/1996
Sample Depth (ft bgs)	0.00-1.00
Low Level PAHs (ug/kg)	
4,4'–DDE	930
Inorganics (mg/kg)	
Antimony	23.6 J
Cadmium	4.7
Copper	1,020
Lead	659 J
Mercury	0.85
Tin	181
Zinc	1,780

Site ID	1SS07
Sample ID	1SS07
Sample Date	10/13/96
Sample Depth (ft bgs)	0.00-1.00
Inorganics (mg/kg)	
Antimony	9.4 J
Cadmium	83.8
Copper	166
Lead	101
Zinc	223

Site ID	1SS10
Sample ID	1SS10
Sample Date	10/02/04
Sample Depth (ft bgs)	0.00-1.00
PESTICIDES (ug/kg)	
4,4'–DDE	810
Inorganics (mg/kg)	
Antimony	23.0 J
Cadmium	5.10
Copper	540 J
Lead	680 J
Mercury	0.44
Tin	100
Zinc	1,600 J

Site ID	1SD02
Sample ID	1SD02
Sample Date	10/22/1996
Sample Depth (ft bgs)	0.00-1.00
Inorganics (mg/kg)	
Antimony	14.5 J
Copper	608
Lead	966 J
Mercury	0.2
Zinc	1,100

Ecological Soil Screening Criteria	
PESTICIDES/PCBs (ug/kg)	
4,4'–DDD	400
4,4'–DDE	400
4,4'–DDT	400
Inorganics (mg/kg)	
Antimony	5
Cadmium	4.0
Copper	50
Lead	50
Mercury	0.1
Tin	50
Zinc	

LEGEND

- SWMU
- E2SS3 WETLANDS BOUNDARIES (SEE FIGURE 2–6 FOR CLASSIFICATIONS)
- REPORTED LOCATION OF 5GW03 (NOT LOCATED DURING 1996 RFI FIELD INVESTIGATION)
- SEDIMENT SAMPLE LOCATION (RELATIVE RISK RANKING)
- SURFACE WATER/SEDIMENT SAMPLE LOCATION (CONFIRMATION STUDY)
- SOIL SAMPLE LOCATION (SUPPLEMENTAL INVESTIGATION)
- SOIL BORING LOCATION (1996 RFI)
- MONITORING WELL/SURFACE SOIL LOCATION (1996 RFI)
- EXISTING MONITORING WELL LOCATION (CONFIRMATION STUDY)
- SURFACE SOIL SAMPLE LOCATION (1996 RFI)
- SURFACE SOIL SAMPLE LOCATION (2004 ADDITIONAL DATA COLLECTION)
- SURFACE AND SUBSURFACE SOIL SAMPLE LOCATION (2004 ADDITIONAL DATA COLLECTION)

ESTUARINE WETLAND SYSTEM
- SURFACE WATER/SEDIMENT SAMPLE LOCATION (2003 ADDITIONAL DATA COLLECTION)
- SEDIMENT SAMPLE LOCATION (2004 ADDITIONAL DATA COLLECTION)

OPEN WATER MARINE
- SURFACE WATER/SEDIMENT SAMPLE LOCATION (2003 ADDITIONAL DATA COLLECTION)
- SEDIMENT SAMPLE LOCATION (2004 ADDITIONAL DATA COLLECTION)

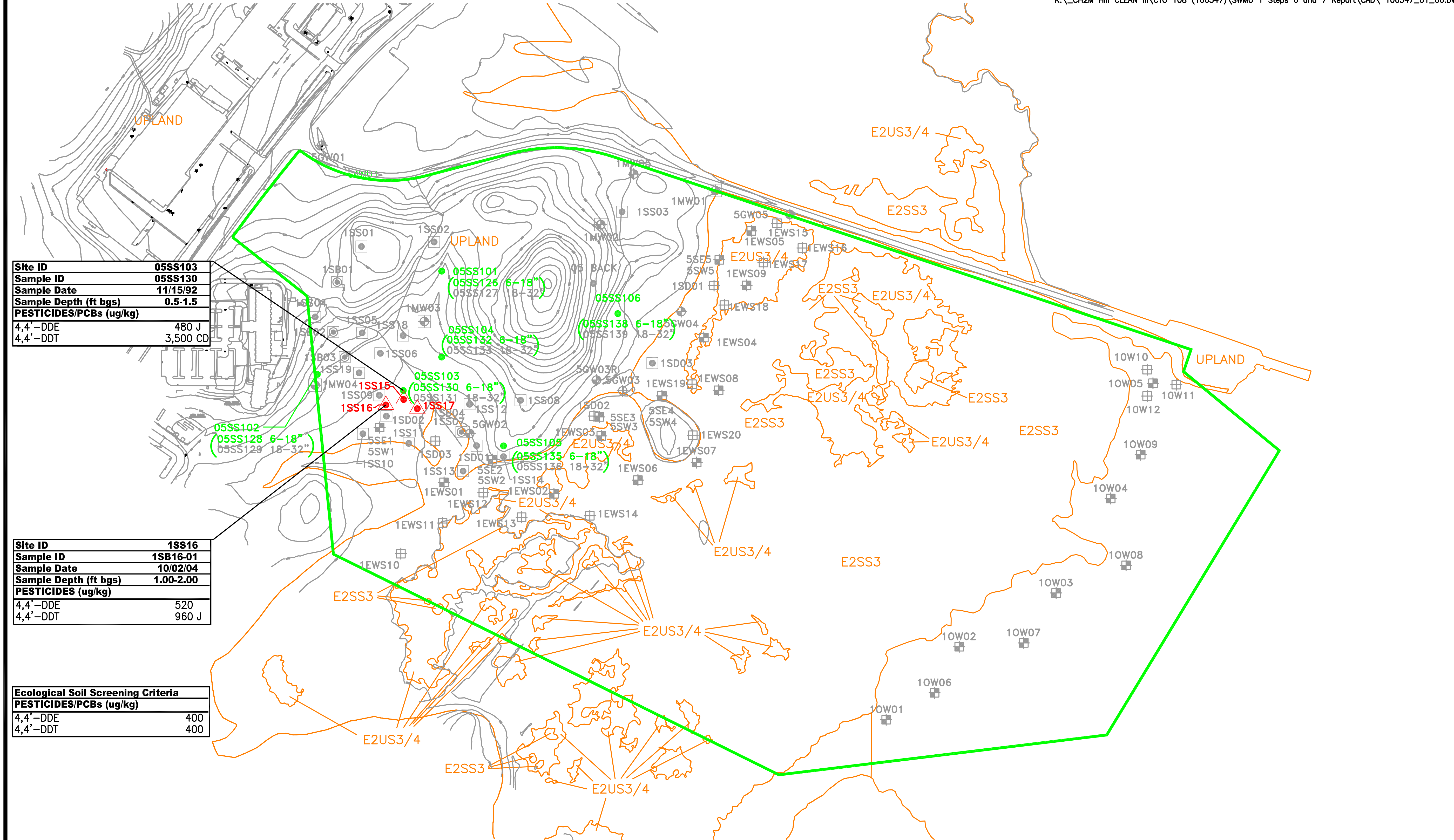
SOURCE: GEO–MARINE, INC., SEPTEMBER 6, 2000.

350 0 175 350
1 inch = 350 ft.

Baker

FIGURE 2–11
DETECTED CONCENTRATIONS OF ECOLOGICAL COCS IN SWMU 1 SURFACE SOIL EXCEEDING SOIL SCREENING VALUES:
1996 RFI AND 2004 ADDITIONAL DATA COLLECTION INVESTIGATION
SWMU 1–ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO

K:_CH2M Hill CLEAN III\CTO 108 (106547)\SWMU 1 Steps 6 and 7 Report\CAD\ 106547_01_06.DWG



Site ID	05SS103
Sample ID	05SS130
Sample Date	11/15/92
Sample Depth (ft bgs)	0.5-1.5
PESTICIDES/PCBs (ug/kg)	
4,4'-DDE	480 J
4,4'-DDT	3,500 CD

Site ID	1SS16
Sample ID	1SB16-01
Sample Date	10/02/04
Sample Depth (ft bgs)	1.00-2.00
PESTICIDES (ug/kg)	
4,4'-DDE	520
4,4'-DDT	960 J

Ecological Soil Screening Criteria	
PESTICIDES/PCBs (ug/kg)	
4,4'-DDE	400
4,4'-DDT	400

LEGEND

- SWMU
- E2SS3 WETLANDS BOUNDARIES (SEE FIGURE 2-6 FOR CLASSIFICATIONS)
- REPORTED LOCATION OF 5GW03 (NOT LOCATED DURING 1996 RFI FIELD INVESTIGATION)
- SEDIMENT SAMPLE LOCATION (RELATIVE RISK RANKING)
- SURFACE WATER/SEDIMENT SAMPLE
- SOIL SAMPLE LOCATION (SUPPLEMENTAL INVESTIGATION)
- SOIL BORING LOCATION (1996 RFI)
- MONITORING WELL/SURFACE SOIL LOCATION (1996 RFI)
- EXISTING MONITORING WELL LOCATION (CONFIRMATION STUDY)
- SURFACE SOIL SAMPLE LOCATION (1996 RFI)
- SURFACE SOIL SAMPLE LOCATION (2004 ADDITIONAL DATA COLLECTION)
- SURFACE AND SUBSURFACE SOIL SAMPLE LOCATION (2004 ADDITIONAL DATA COLLECTION)

ESTUARINE WETLAND SYSTEM
- SURFACE WATER/SEDIMENT SAMPLE LOCATION (2003 ADDITIONAL DATA COLLECTION)
- SEDIMENT SAMPLE LOCATION (2004 ADDITIONAL DATA COLLECTION)

OPEN WATER MARINE
- SURFACE WATER/SEDIMENT SAMPLE LOCATION (2003 ADDITIONAL DATA COLLECTION)
- SEDIMENT SAMPLE LOCATION (2004 ADDITIONAL DATA COLLECTION)

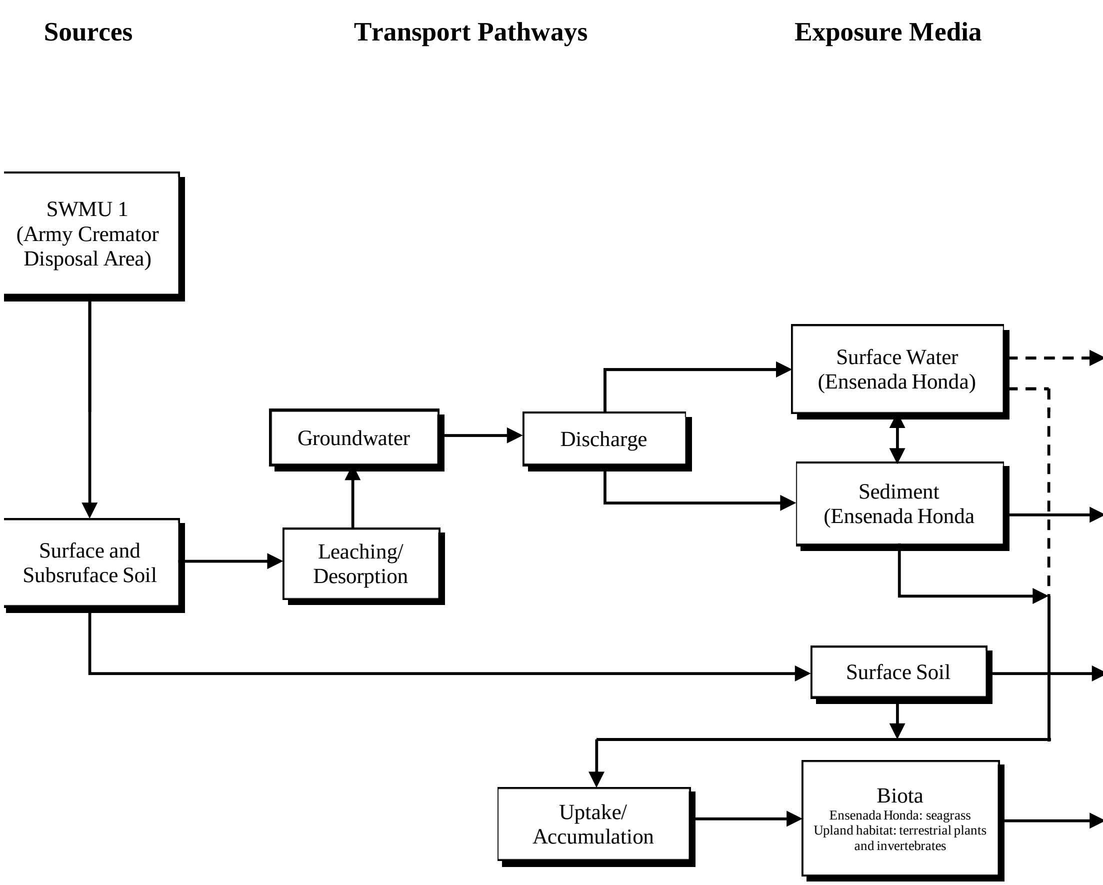
SOURCE: GEO-MARINE, INC., SEPTEMBER 6, 2000.

350 0 175 350
1 inch = 350 ft.

Baker

FIGURE 2-12
DETECTED CONCENTRATIONS OF ECOLOGICAL COCS IN SWMU 1
SUBSURFACE SOIL EXCEEDING SOIL SCREENING VALUES:
1993 SUPPLEMENTAL INVESTIGATION AND 2003 ADDITIONAL DATA COLLECTION INVESTIGATION
SWMU 1-ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO

FIGURE 2-13
REFINED CONCEPTUAL MODEL
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO



Exposure Routes / **Receptors**

Exposure Routes	Plants	Invertebrates	Fish	Reptiles	Mammals	Birds		Plants	Invertebrates	Amphibians	Reptiles	Birds
Ingestion		○	○	○	○	○						
Dermal	○	○	○	○	○	○						
Ingestion		○	○	●	●	○						
Dermal		○	○	○	○	○						
Root Uptake	○											
Ingestion									●	●	●	●
Dermal									●	○	○	○
Root Uptake								●				
Ingestion		○	○	●	●	○			●	●	●	●

→ Potentially complete and significant pathway

- - → Potentially complete but insignificant pathway

● Potential for unnacceptable risk identified; receptor/pathway quantitatively or qualitatively evaluated in the baseline ecological risk assessment

○ No potential for unnacceptable risk identified; no further evaluation required in the baseline ecological risk assessment

LEGEND

1 – SWMUs

AOC D – AOCs

– AREA TO WHICH THIS INVESTIGATION PERTAINS

SOURCE: GEO-MARINE, INC., SEPTEMBER 6, 2000.

2000 0 1000 2000

1 inch = 2000 ft.

FIGURE 3-1

UPLAND AND OPEN WATER REFERENCE AREAS

SWMU 1-ARMY CREMATOR DISPOSAL SITE

STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT

NAVAL ACTIVITY PUERTO RICO

LEGEND

- SWMU 1 BOUNDARY
E2SS3 - E2SS3 WETLANDS BOUNDARIES
- REFERENCE SOIL SAMPLE LOCATON (FEB 2007)

SOURCE: GEO-MARINE, INC., SEPTEMBER 6, 2000.

600 0 300 600
1 inch = 600 ft.

FIGURE 3-2
SWMU 1 AND UPLAND REFERENCE AREA SAMPLING LOCATIONS:
VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 1-ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO

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LEGEND

◎ – OPEN WATER REFERENCE AREA SEDIMENT SAMPLING LOCATION

SOURCE: GEO–MARINE, INC., SEPTEMBER 6, 2000.

100 0 50 100
1 inch = 100 ft.

FIGURE 3–3
OPEN WATER REFERENCE AREA NO. 1 SEDIMENT SAMPLING LOCATIONS:
VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 1–ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT

NAVAL ACTIVITY PUERTO RICO

Baker

LEGEND

◎ – OPEN WATER REFERENCE AREA SEDIMENT SAMPLING LOCATION

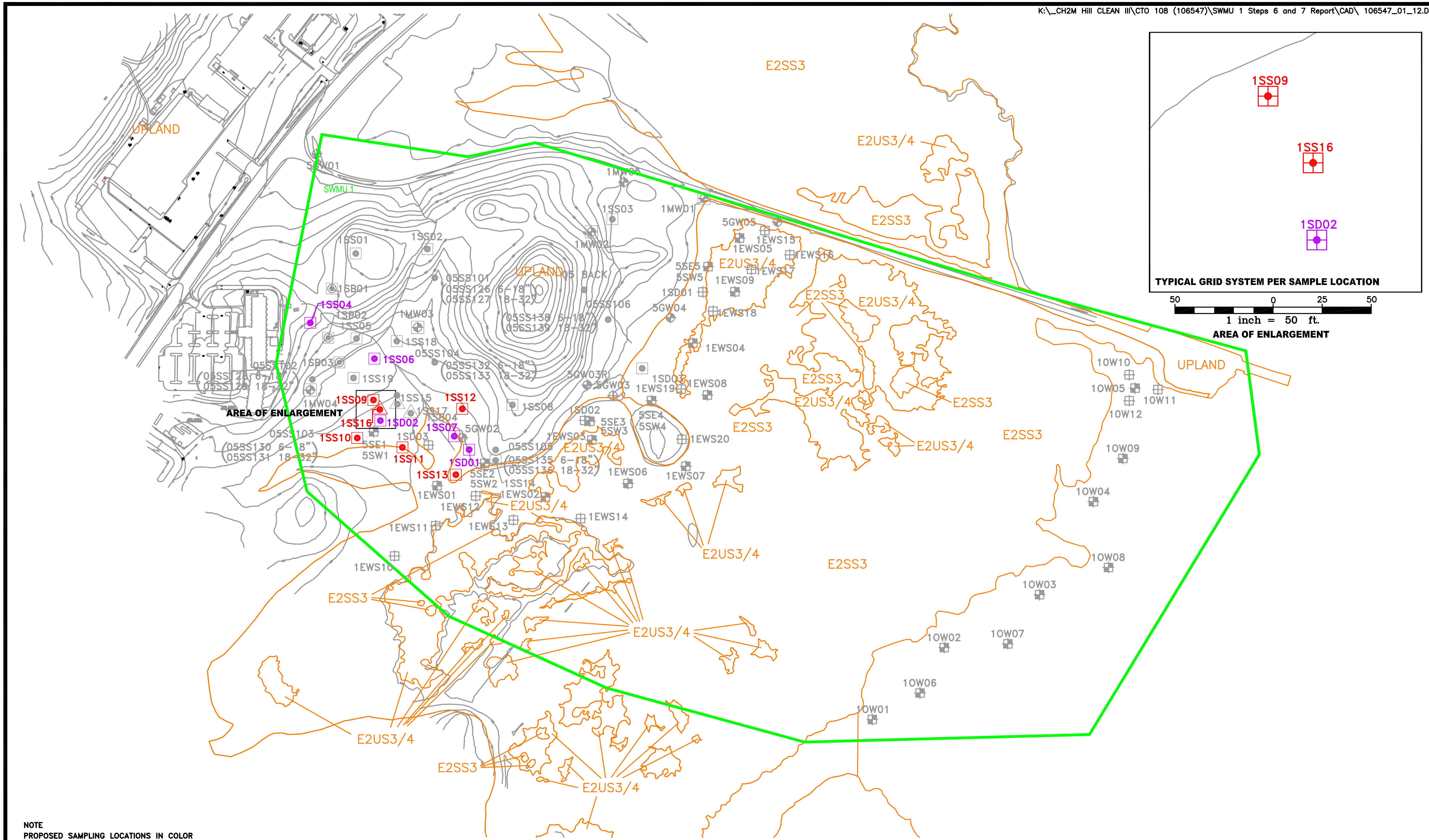
SOURCE: GEO-MARINE, INC., SEPTEMBER 6, 2000.

160 0 80 160

1 inch = 160 ft.

FIGURE 3-4
OPEN WATER REFERENCE AREA NOS. 2 AND 3 SEDIMENT SAMPLING LOCATIONS:
VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 1-ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT

NAVAL ACTIVITY PUERTO RICO



LEGEND

- SWMU 1
- E2SS3 WETLANDS BOUNDARIES (SEE FIGURE 2-6 FOR CLASSIFICATIONS)
- REPORTED LOCATION OF 5GW03 (NOT LOCATED DURING 1996 RFI FIELD INVESTIGATION)
- SEDIMENT SAMPLE LOCATION (RELATIVE RISK RANKING)
- SURFACE WATER/SEDIMENT SAMPLE LOCATION (CONFIRMATION STUDY)
- SOIL SAMPLE LOCATION (SUPPLEMENTAL INVESTIGATION)
- SOIL BORING LOCATION (1996 RFI)
- MONITORING WELL/SURFACE SOIL LOCATION (1996 RFI)
- EXISTING MONITORING WELL LOCATION (CONFIRMATION STUDY)
- SURFACE SOIL SAMPLE LOCATION (1996 RFI)
- SURFACE SOIL SAMPLE LOCATION (2004 ADDITIONAL DATA COLLECTION)
- SURFACE AND SUBSURFACE SOIL SAMPLE LOCATION (2004 ADDITIONAL DATA COLLECTION)

ESTUARINE WETLAND SYSTEM

- SURFACE WATER/SEDIMENT SAMPLE LOCATION (2003 ADDITIONAL DATA COLLECTION)
- SEDIMENT SAMPLE LOCATION (2004 ADDITIONAL DATA COLLECTION)

OPEN WATER MARINE

- SURFACE WATER/SEDIMENT SAMPLE LOCATION (2003 ADDITIONAL DATA COLLECTION)
- SEDIMENT SAMPLE LOCATION (2004 ADDITIONAL DATA COLLECTION)

SOURCE: GEO-MARINE, INC., SEPTEMBER 6, 2000.

350 0 175 350

1 inch = 350 ft.

Baker

FIGURE 3-5
SWMU 1 SURFACE SOIL SAMPLING LOCATIONS:
BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 1-ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO

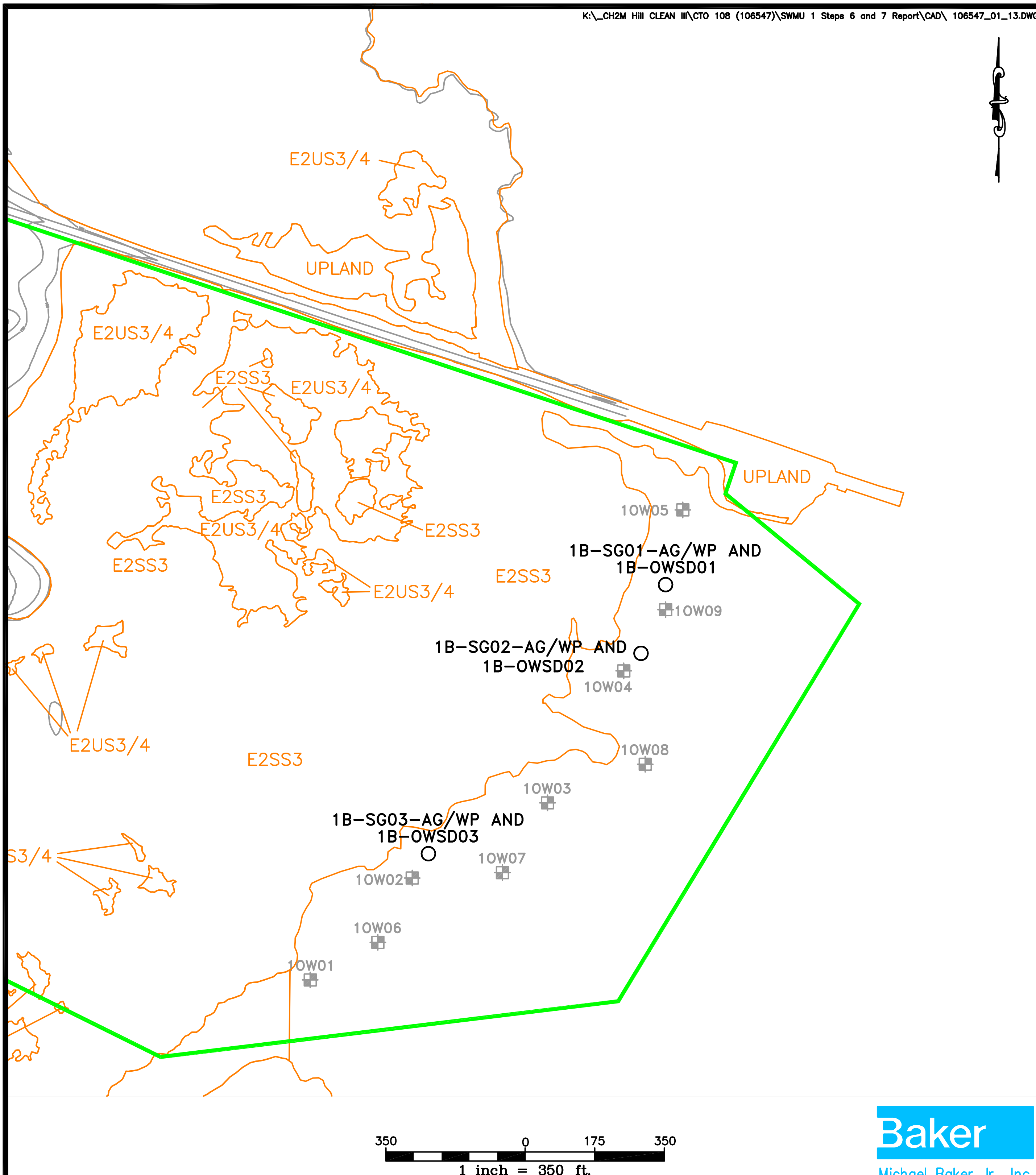
LEGEND

- SWMU 1 BOUNDARY
- E2SS3 — E2SS3 WETLANDS BOUNDARIES (SEE FIGURE 2-6 FOR CLASSIFICATIONS)
- REFERENCE AREA SOIL SAMPLE LOCATON (FEB 2007)

SOURCE: GEO-MARINE, INC., SEPTEMBER 6, 2000.

400 0 200 400
1 inch = 400 ft.

FIGURE 3-6
UPLAND REFERENCE AREA NO. 2 SURFACE SOIL SAMPLING LOCATIONS:
BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 1-ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO



Baker
Michael Baker Jr., Inc.

LEGEND

- SWMU 1
- E2SS3 WETLANDS BOUNDARIES (SEE FIGURE 2-6 FOR CLASSIFICATIONS)
- SURFACE WATER/SEDIMENT SAMPLE LOCATION (2003 ADDITIONAL DATA COLLECTION INVESTIGATION)
- SEDIMENT/TURTLE GRASS SAMPLE LOCATION (BERA FIELD INVESTIGATION)

SOURCE: GEO-MARINE, INC., SEPTEMBER 6, 2000.

FIGURE 3-7
SWMU 1 TURTLE GRASS TISSUE AND CO-LOCATED SEDIMENT SAMPLING LOCATIONS: BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 1-ARMY CREMATOR DISPOSAL SITE STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO

Baker

LEGEND

◎ – OPEN WATER REFERENCE AREA SEAGRASS TISSUE AND SEDIMENT SAMPLING LOCATION

SOURCE: GEO-MARINE, INC., SEPTEMBER 6, 2000.

160 0 80 160
1 inch = 160 ft.

FIGURE 3-8
OPEN WATER REFERENCE AREA NO. 2 TURTLE GRASS TISSUE AND CO-LOCATED SEDIMENT SAMPLING LOCATIONS:
BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 1-ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO

APPENDIX A
HABITAT CHARACTERIZATION OF SOLID WASTE MANAGEMENT UNITS (SWMU) 1, SWMU 2, AND SWMU 45

HABITAT CHARACTERIZATION OF SOLID WASTE MANAGEMENT UNITS (SWMU) 1, SWMU 2, AND SWMU 45, NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Prepared for:

CH2M Hill

Prepared by:

Dr. Dan L. Wilkinson, Rudi Reinecke, Melissa Lopez-Rodriguez, Manuel Figueroa-Pagan, and Donna DeYoung

Geo-Marine, Inc.
550 E. 15th Street
Plano, Texas 75074

October 11, 2000

TABLE OF CONTENTS

Page

LIST OF FIGURES

Page

LIST OF TABLES

Page

INTRODUCTION

As part of a Resource Conservation and Recovery Act (RCRA) facility investigation at Naval Station (NAVSTA) Roosevelt Roads, Puerto Rico, ecological risk assessments were conducted at 3 solid waste management unit (SWMU) sites. A habitat characterization was conducted at each SWMU in order to determine the presence of plant and animal species and to determine whether preferred habitat was present for any federally endangered or threatened plant and animal species.

SITE LOCATION

NAVSTA Roosevelt Roads (approximately 8,627 acres) is located in the municipality of Ceiba on the southeastern coast of Puerto Rico (Figure 1). This report covers three SWMU sites located at NAVSTA Roosevelt Roads (Figure 2). SWMU 1 and SWMU 2 were located near each other and both had been used as disposal sites and contained similar debris. SWMU 1, an abandoned Army Cremation Disposal Site, is located east of the Navy Lodge with Kearsage Road to the north. Ensenada Honda is to the east and south of SWMU 1, and the Bowling Alley is to the west. SWMU 2 (Langley Drive Disposal Site) is located along Langley Drive and is approximately 2,000 feet northwest of the Navy Exchange. SWMU 2 extends from Langley Drive towards a mangrove community and has an estimated length of 1,300 feet in a northeast-southeast direction. SWMU 45 includes areas outside of Building 38, ground above the cooling water tunnels, and a cove in Puerca Bay. Building 38 is located along a dirt access road south of Forrestal Drive. Associated with Building 38 is a cooling tower intake tunnel that runs from the north end of the building to a small cove in Puerca Bay.

METHODS

Vegetation communities were initially characterized into broad community types based on the color signatures from 1998 true-color and 1993 color infrared (CIR) aerial photographs. Vegetation communities were delineated based on species composition and structure by viewing magnified stereo pairs of aerial photography. The community types were marked on overlying acetate for use in the field (May 15 to 19, 2000). Personnel walked transects through each of these SWMU to:

1. verify that the community types were identified and delineated correctly from the true color and CIR aerial photography;
2. identify the species composition of the dominant vegetation;
3. identify the wildlife species present in the SWMU sites;
4. identify habitat that may potentially support federally designated threatened and endangered species within and contiguous to each SWMU; and
5. identify any obvious impacts potentially related to previous waste management activities.

Figure 1. General Location of NAVSTA Roosevelt Roads, Puerto Rico.

Figure 2. Location of SWMU 1,2 and 45, Roosevelt Roads, Puerto Rico.

The vegetation communities were verified by walking surveys through each community type previously identified with aerial photography. Most species were identified in the field; however, some specimens were collected for identification using reference books (Liogier 1985, 1988, 1994, 1995, 1997; Little and Wadsworth 1964; Little et al. 1964; and Acevedo-Rodriguez 1996) and herbarium specimens. Relative dominance and species structure were characterized from the visual observations within each community type and SWMU.

Wildlife species residing within or utilizing each SWMU habitat, and wildlife habitat were identified during the vegetation field surveys. A wildlife biologist characterized the habitats and determined the types of wildlife that could potentially inhabit the plant communities or SWMU sites. Any wildlife species that were observed were identified in the field with the use of 8 x 40 binoculars and reference guides (Raffaele 1989 and Raffaele et al 1998).

Eleven federally listed species are known to occur or have the potential to occur on NAVSTA Roosevelt Roads (Table 1). The entire NAVSTA Roosevelt Roads was designated as critical habitat in 1976 for the endangered yellow-shouldered blackbird (*Agelaius xanthomus*). However, a 1980 agreement with the USFWS exempted certain areas on the station from this categorization. SWMU 45 is outside this area, while SWMUs 1 and 2 are included within the critical habitat designation.

Prior to conducting the fieldwork, a literature search was conducted for each federally protected species. During the May 15 to 19, 2000 surveys, biologists walked transects through each site and identified any federally protected species seen and noted the presence or absence of preferred habitat for the species.

Table 1

Federally Listed Species Occurring or Potentially Occurring at NAVSTA Roosevelt Roads

Scientific Name **(Common Name)**	**Federal Status**
Plants	
Stahlia monosperma (Cobana negra)	Threatened
Reptiles and Amphibians	
Caretta caretta (Loggerhead sea turtle)	Threatened
Chelonia mydas (Green sea turtle)	Threatened
Dermochelys coriacea (Leatherback sea turtle)	Endangered
Eretmochelys imbricata (Hawksbill sea turtle)	Endangered
Epicrates inornatus (Puerto Rican Boa)	Endangered
Birds	
Agelaius xanthomus (Yellow-shouldered blackbird)	Endangered
*Falco peregrinus tundrius (*Arctic peregrine)	Threatened
*Pelecanus occidentalis occidentalis (*Brown pelican)	Endangered
Sterna dougalli dougalli (Roseate tern)	Endangered
Mammals	
*Trichechas manatus (*West Indian manatee)	Endangered

Source: U.S. Navy 1998b

Past management activities at the SWMU sites may have potentially impacted the current vegetation communities. During the field surveys the biologists made visual observations to characterize the health of the plants in the SWMU sites. Indications of altered plant communities include; chlorotic leaves, epinasty (deformities of leaves and stems), patches of altered plant growth, absence of plants (bare ground), and changes in species composition. To determine if the SWMU sites contained altered plant communities, a nearby representative site was selected as a control. When altered plant communities were identified, the biologists made an effort to determine and record the probable cause (i.e., chemical, soil compaction, natural causes, etc.).

In addition to identification of wildlife in the field, existing literature sources were used to identify any additional species that may have occurred on the SWMU sites but were not observed. Most of the wildlife occurring in the area is bird species and these are presented in Appendix A. Species information and field data was used to generate a simplified food web for the sites. A food web is an interlocking pattern of several to many food chains that is helpful in determining ecosystem processes including those that may occur when a contaminant is introduced to a system.

A reconnaissance survey of SWMU 45 was conducted June 19, 2000 by Dial Cordy and Associates, Inc. to define the marine habitat and associated flora and fauna of the outfall structure and surrounding embayment and shore. Results are presented in the SWMU 45 section.

RESULTS AND DISCUSSION

SWMU 1

Vegetation Community Description

SWMU 1 (an abandoned Army Cremation Disposal Site) is located east of the Navy Lodge (Figure 3). There were four plant communities identified at this site. Geology and human disturbances, to a lesser extent, have influenced the types of plants occurring at this site. The communities included red mangrove (*Rhizophora mangle*), black mangrove, (*Avicennia germinans*), coastal upland forest, and coastal scrub forest. These communities were identified in the NAVSTA Roosevelt Roads Integrated Natural Resources Management Plan (U.S. Navy 1998b) and brief descriptions follow.

The mangrove communities were located farthest east of the Navy lodge in SWMU 1 and had little evidence of human disturbance. Both red and black mangrove communities had sparse cover consisting of low growing shrubs. The red mangroves occurred adjacent to Ensenada Honda and the community was sparsely vegetated (approximately 25 percent cover) with large pools of water present. Nearly all vegetation included short shrubs of red mangrove and numerous red mangrove seedlings were observed.

The black mangroves were located inland between the red mangroves and the coastal upland forest community. Species composition consisted of saline tolerant plants as the result of periodic saturation with highly saline water. The site had sparse vegetation cover (approximately 25 percent) and plants were predominately short shrubs (8 to 15 feet). In addition, there was some herbaceous vegetation near the inland boundary. Black mangrove trees and shrubs dominated the shrub vegetation. The herbaceous vegetation was dominated by *Batis maritima*, with *Sporobolus virginicus* and *Sesuvium portulacastrum* also present.

An upland coastal forest community was located on the southern portion of the hill to the east of the Navy lodge. The upland coastal forest served as the upland boundary of the black mangrove community. Soil disturbance, debris, and an un-maintained road for access to several monitoring wells were observed. Tree cutting may have occurred in this area in the past; however, relatively large trees were observed. Shrubs with scattered large trees (8 to 14 inches in diameter breast height) and grassy areas dominated the community. There was approximately 80 to 90 percent vegetation cover with multiple layers of stratification. *Leucaena leucocephala*, *Bursera simaruba*, and *Randia aculeata* dominated the shrub layer. *Bucida buceras*, *Trichostigma octandrum*, and *Psidium guajava* were the only trees present, and these were confined to the ridges and steep hillsides. Patches of herbaceous areas were dominated by *Panicum maximum*.

The coastal scrub forest community also showed signs of soil disturbance and had vegetation similar to the upland forest community. However, the coastal scrub had less topographic relief, fewer trees, and larger grassy patches than the upland forest. Vegetation cover in the coastal scrub was approximately 80 to 95 percent and was limited to two stratums (shrub and herbaceous). The lack of tree cover had probably occurred due to slope exposure to hurricane force winds. *Leucaena leucocephala* and *Panicum maximum* dominated the shrub and herbaceous stratums, respectively. Vegetation photos for SWMU 1 are presented in Figures 4 and 5. The vegetation observed at SWMU 1 is presented in Table 2.

Plant Community Health

The control for SWMU 1 was carefully chosen in order to represent the different plant communities present. Factors needed for the control included a protected hillside community adjacent to mangroves and proximity to SWMU 1. The control that was chosen had upland coastal forest, coastal scrub forest, and mangroves similar to SWMU 1 and was located on the south side of Langley Drive between the elementary school and South Princeton Road.

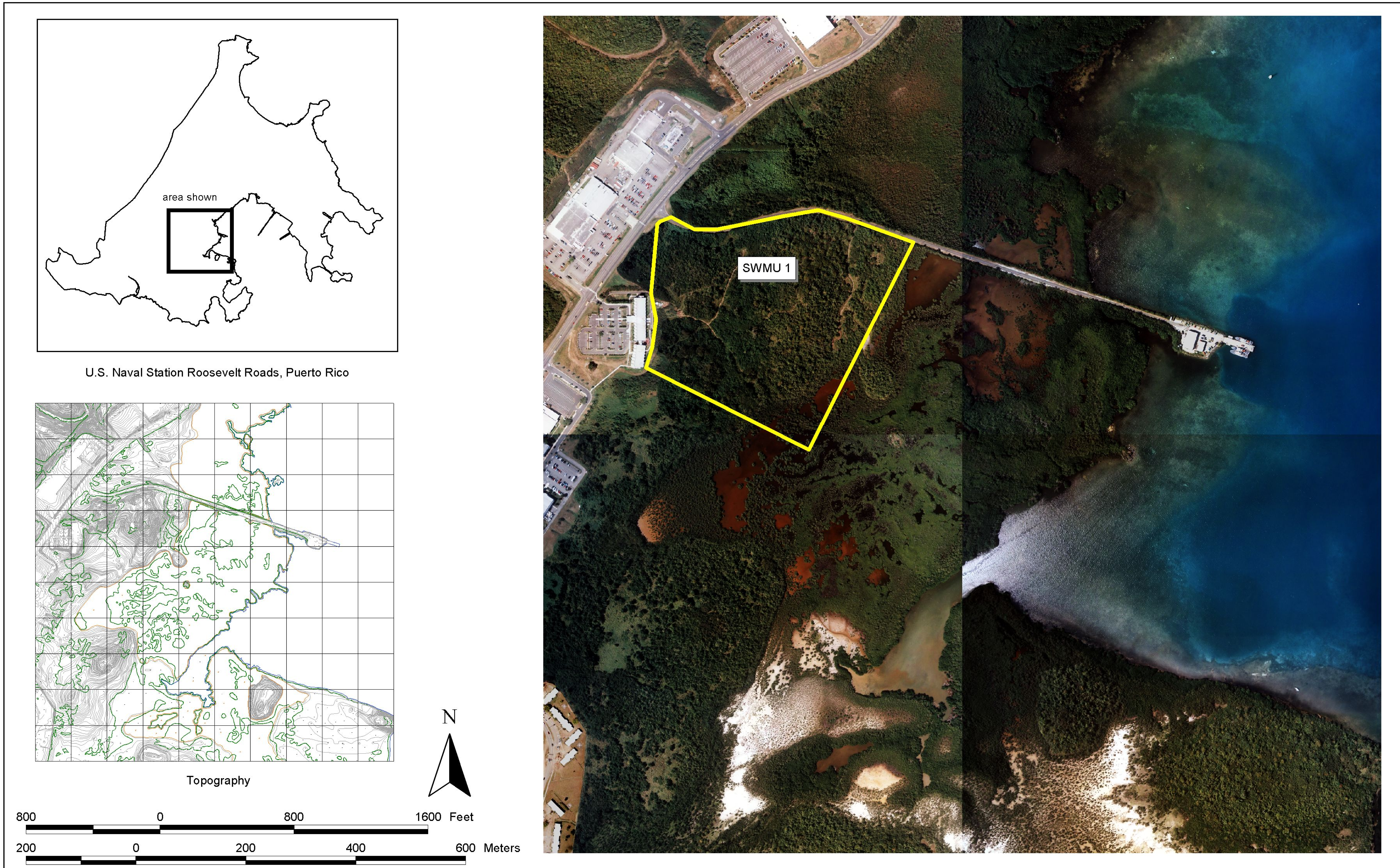


Figure 3. Location of SWMU 1, Roosevelt Roads, Puerto Rico

Figure 4. SWMU 1, Red Mangrove Community (*Rhizophora mangle*) with Upland Coastal Forest in Background.

Figure 5. SWMU 1, Coastal Scrub Forest Community

Table 2

Vegetation Observed at SWMU 1

Common Name	Scientific Name	Stratum
Black Mangrove		
black mangrove	*Avicenia germinans*	S
salt plant, saltwort	*Batis maritima*	H
white mangrove	*Laguncularia racemosa*	S
verdolaga rosada, pink purslane	*Sesuvium portulacastrum*	H
None	*Sporobolus virginicus*	H
Red Mangrove		
red mangrove	*Rhizophora mangle*	S
Upland Coastal Forest		
crab's eye, jumbie bead, rosary bead	*Abrus precatorius*	S
none	*Acacia westiana*	S
none	*Bothriochloa ichaemum*	H
Ucar, oxhorn bucida	*Bucida buceras*	T
almácigo	*Bursera simaruba*	S/T
bottle wiss	*Capparis flexusa*	S
French grass	*Commelina erect*	H
Bermuda grass	*Cynodon dactylon*	H
none	*Ipomea* spp.	V
none	*Lasiacis divaricata*	H
none	*Leptochloa ichaemum*	H
tan tan, tanty, wild tamarind, lead tree	*Leucaena leucocephala*	S
none	*Panicum maximum*	H
guayaba, common guayaba	*Psidium guajava*	T
Christmas tree, tintillo	*Randia aculeata*	S
none	*Sporobolus indicus*	H
none	*Tragia volubilis*	H
basket wiss	*Trichostigma octandrum*	S/T
marsh-mallow	*Waltheria indica*	H
Coastal scrub forest		
none	*Asystasia gangetica*	H
almácigo	*Bursera simaruba*	S
bottle wiss	*Capparis flexusa*	S
none	*Cissus obovata*	V
palma de coco	*Cocos nucifera*	S
rattle box, yellow lupine	*Crotalaria retusa*	H
flamboyant tree, Poinciana	*Delonix regia*	S
brazilette	*Erythroxylum brevipes*	S
none	*Forestiera eggersiana*	S
black mampoo, wild mampoo	*Guapira fragans*	S
none	*Ipomea* spp.	H
tan tan, tanty, wild tamarind, lead tree	*Leucaena leucocephala*	S
cat claw, cat paw, monkey earing	*Macfadyena unguis-cati*	S
none	*Panicum maximum*	H
none	*Pinzona coriacea*	H
Christmas tree, tintillo	*Randia aculeata*	S
royal palm	*Roystonea borinquena*	S
basket wiss, white root, black or white wist	*Serjania polyphylla*	V
basket wiss	*Trichostigma octandrum*	S/T

S = shrub
T = tree
H = herbaceous
V = vine

There were no noticeable differences in plant community species composition between the control and the SWMU 1 site. However, the structure of the plant communities was somewhat different. SWMU 1 had more grassy areas within the coastal scrub forest community than the control. The increase in grassy areas was probably the result of past dirt-moving activities at SWMU 1. There were also more large trees at SWMU 1 in the upland coastal forest community than the control. It appeared that the control hillside had been more exposed to hurricane force winds thus resulting in fewer large trees.

The SWMU 1 plant communities seemed to be growing healthy and vigorously. The mangrove communities had a low vegetation cover; however, depending upon their position in the landscape, this is not uncommon. Debris and evidence of dirt-moving activities were observed in the upland coastal forest and the coastal scrub forest communities, but ecological succession was occurring and the existing forest communities had no evidence of stress.

Wildlife Description

During the short duration of wildlife surveys conducted on this site, numerous wildlife species such as birds and lizards (*Anolis* species) were observed utilizing the habitat of this site. An active Wilson's plover (*Charadrius wilsonia*) nest was found in the black mangrove community. The mangrove communities also had significant crab activity. The red mangrove community, with more water present, had more crab holes than the black mangroves. There was no evidence that the SWMU site had an impact on the wildlife diversity or its habitat. Wildlife that was observed at SWMU 1 is presented in Table 3.

Protected Species

Stahlia monosperma (Cobana negra), a federally threatened tree, has been found between the boundary of black mangrove communities and coastal upland forest communities. This species is also known to occur in coastal forests of southeastern Puerto Rico (Little and Wadsworth 1964). However, this species has not been verified as occurring on NAVSTA Roosevelt Roads by past surveys (U.S. Navy 1998b) and was not observed during the surveys.

The Puerto Rican boa (*Epicrates inornatus*) utilizes a variety of habitats but is most commonly found in karst forest habitats. The coastal upland forest community habitat at SWMU 1 is similar to karst habitat due to the steep topography and presence of large stature trees (an indicator of minimal recent disturbance). Occurrence of the boa at NAVSTA Roosevelt Roads has not been verified and due to the disturbance at SWMU 1, there is a low probability of occurrence for the species at this site.

Table 3

Wildlife Observed at SWMU 1

English Name	Scientific Name	Local Name
Red and Black Mangrove Communities		
Birds		
Green Mango	*Anthracothorax viridis*	Zumbador Verde de P.R.
Red-tailed Hawk	*Buteo jamaicensis*	Guaraguao de Cola Roja
Wilson's Plover	*Charadrius wilsonia*	Playero Marítimo
Yellow Warbler	*Dendroica petechia*	Canario de Mangle
Common Moorhen	*Gallinula chloropus*	Gallareta Común
Ruddy Quail-Dove	*Geotrygon montana*	Perdiz Pequeña
Puerto Rico Woodpecker	*Melanerpes portoricensis*	Carpintero de Puerto Rico
Northern Mockingbird	*Mimus polyglottos*	Ruiseñor
Cave Swallow	*Pterochelidon fulva*	Golondrina de Cuevas
Greater Antillean Grackle	*Quiscalus niger*	Mozambique (Chango)
Louisiana Waterthrush	*Seiurus motacilla*	Pizpita de Rio
Loggerhead Kingbird	*Tyrannus caudifasciatus*	Clérigo
Gray Kingbird	*Tyrannus dominicensis*	Pitirre
Upland Coastal Forest		
Reptiles and Amphibians		
Crested Anole	*Anolis cristatellus*	not known
Birds		
Red-tailed Hawk	*Buteo jamaicensis*	Guaraguao de Cola Roja
Bananaquit	*Coereba flaveola*	Reinita Común
Yellow Warbler	*Dendroica petechia*	Canario de Mangle
Ruddy Quail-Dove	*Geotrygon montana*	Perdiz Pequeña
Pearly-eyed Thrasher	*Margarops fuscatus*	Zorzal Pardo
Northern Mockingbird	*Mimus polyglottos*	Ruiseñor
Greater Antillean Grackle	*Quiscalus niger*	Mozambique (Chango)
Coastal Scrub Forest		
Reptiles and Amphibians		
Brown Lizard	*Anolis cristatellus*	not known
Lizard	*Anolis stratulus*	not known
Birds		
Bananaquit	*Coereba flaveola*	Reinita Común
Ruddy Quail-Dove	*Geotrygon montana*	Perdiz Pequeña
Grackle	*Quiscalus niger*	Mozambique (Chango)
Loggerhead Kingbird	*Tyrannus caudifasciatus*	Clérigo
Gray Kingbird	*Tyrannus dominicensis*	Pitirre
Black-Whiskered Vireo	*Vireo altiloquus*	Bien-te-veo
Zenaida Dove	*Zenaida aurita*	Tórtola cardosantera

Federally threatened and endangered sea turtles such as the Green (*Chelonia mydas*), Hawksbill (*Eretmochelys imbricata*), Loggerhead (*Caretta caretta*) and Leatherback sea turtles (*Dermochelys coriacea*) and the endangered West Indian Manatee (*Trichechas manatus*) would not occur at this site because they require marine habitats. There is potential for some of the species to occur in nearby Ensenada Honda, however most of the site considered here contained terrestrial habitat.

Federally endangered marine birds such as the Brown pelican (*Pelecanus occidentalis occidentalis*) and the Roseate tern (*Sterna dougalli dougallii*) would most likely not occur at this terrestrial site due to the absence of preferred habitat. The Roseate tern has not been observed on or adjacent to the NAVSTA Roosevelt Roads (U.S. Navy 1998b), although it has been observed recently at Vieques Island. Brown pelicans prefer more coastal areas.

Potential upland feeding habitat (shrubland) was present for the yellow-shouldered blackbird (*Agelaius xanthomus*). However, nesting habitat for the species (mature mangroves and Royal Palm [*Roystonea borinquena*]) was not present. Some nesting habitat may have been located adjacent to the site (U.S. Navy 1998a). A pair of yellow-shouldered blackbirds was observed near the site, although only seven sightings in all have been reported at NAVSTA Roosevelt Roads from 1986 to 1996.

The Arctic peregrine falcon (*Falco peregrinus tundrius*) has been observed at NAVSTA Roosevelt Roads (U.S. Navy 1998b). This species utilizes open grassland areas for potential feeding areas. This type of habitat was not present at or near this site.

Food Web

The information in a food web is very important when considering the potential for contaminants existing in the ecosystem. Many contaminants are passed from one trophic level to the next. A contaminant at the soil surface goes through a different process than a contaminant that has leached into the soil. The surface contaminant may be ingested by a decomposer such as a hermit crab and then passed on to the secondary consumer (i.e., a carnivorous bird). Leached contaminates are picked up by the primary producers and are then passed upwards in the food chain.

Figure 6 presents a generalized food web for the upland coastal forest and the coastal scrub forest communities. Figure 7 presents a food web for the mangrove communities. The abundance within each of the food groups is represented by the size of their polygon in the figure. Dominant species are listed in each of the food groups except for plants, which were provided previously in this section.

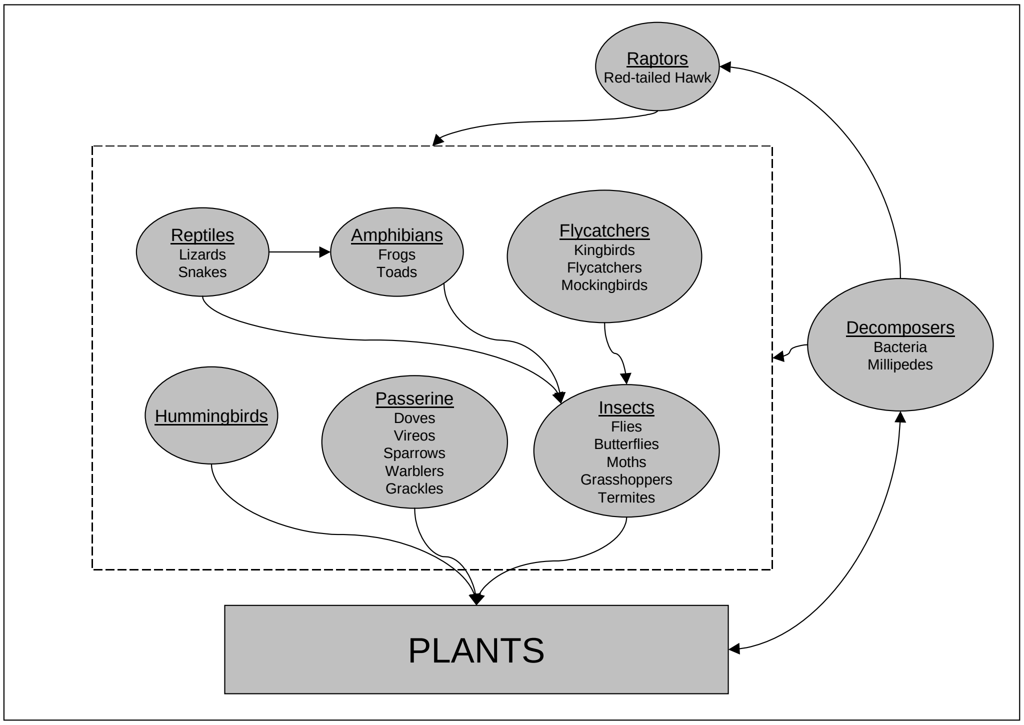


Figure 6. Generalized Food Web for the Upland Coastal Forest and Coastal Scrub Forest Communities at NAVSTA Roosevelt Roads.

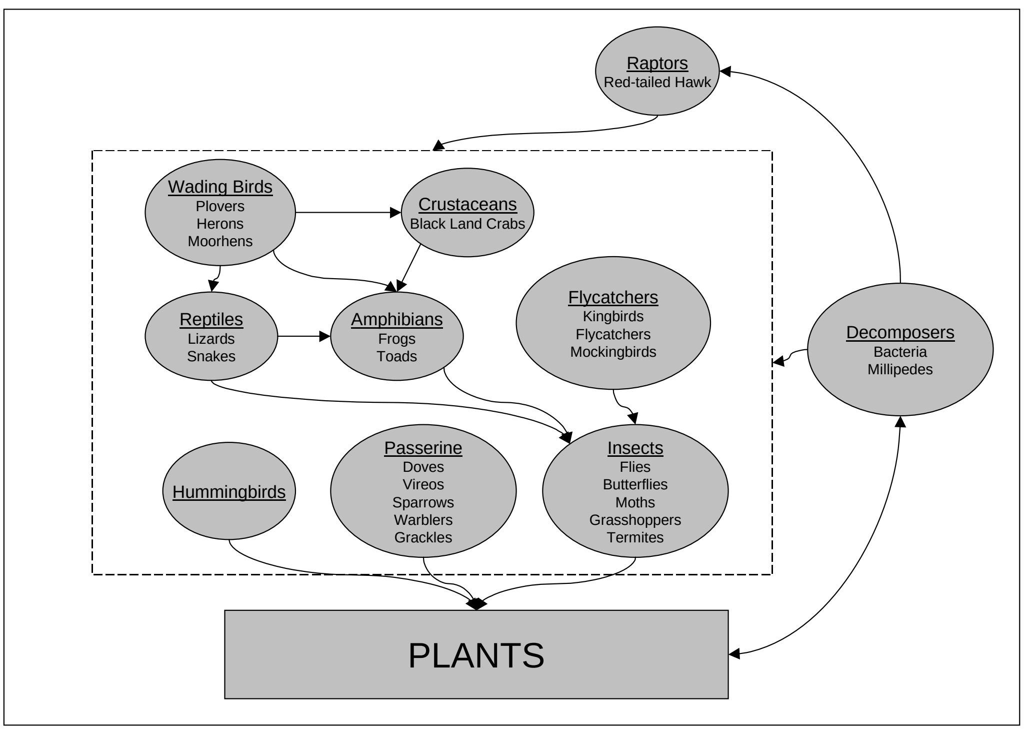


Figure 7. Generalized Food Web for Mangrove Communities at NAVSTA Roosevelt Roads.

SWMU 2

Vegetation Community Description

SWMU 2, Langley Drive Disposal Site, is located along Langley Drive and is approximately 2,000 feet northwest of the Navy Exchange. SWMU 2 extends from Langley Drive in a gentle slope towards a mangrove community and has an estimated length of 1,300 feet in a northeast-southeast direction. Disturbances consisted of an un-maintained road that led to a monitoring well. There was a small earthen berm running parallel to the mangrove boundary. The dominant vegetation was upland coastal forest; however, the adjacent black mangrove community was also described.

Various stages of ecological succession were observed throughout the upland coastal forest community and canopy cover approached 100 percent. The dominant plant community along the monitoring well road was herbaceous vegetation with *Leucaena leucocephala* shrubs, *Panicum maximum*, *Sporobolus indicus*, and *Waltheria indi*ca. Road edges were a nearly monotypic stand of *Leucaena leucocephala* shrubs. Further from the monitoring well road, there were fewer individuals of Leucaena *leucocephala* and more upland coastal forest plant community species such as *Bursera simaruba*, *Erthroxylum brevipes,* and *Capparis flexusa*.

Although the mangrove community was limited within SWMU 2, it is described here and included in Table 4. The mangrove community formed the boundary for SWMU 2 and contained a number of additional species that are not typically found in mangrove communities. Because the area described was in the upland/wetland boundary (ecotone) of the community and there was adjacent road disturbance, higher species richness would be expected. Dominant plants included black mangrove, *Leucaena leucocephala*, and *Randia aculeata*. Vegetation photos are presented in Figures 9 and 10. The vegetation observed at SWMU 2 is presented in Table 4.

Plant Community Health

The control for SWMU was a similar plant community found on the eastern boundary of SWMU 2 along Langley Road. The control had similar topography, soils, position in landscape, and it was located between a paved road and a mangrove community. The only difference between the control and SWMU 2 was that SWMU 2 contained a road that had created an opening in the plant community. This opening had allowed an herbaceous stratum to establish and *Leucaena leucocephala* dominated the road edges. No other vegetation stresses were observed throughout the SWMU 2 community when compared to the control.

Table 4

Vegetation Observed at SWMU 2

Common Name	Scientific Name	Stratum
Upland Coastal Forest		
aroma, sweet acacia	*Acacia farnensiana*	S
none	*Bothriochloa ichaemum*	H
bottle wiss	*Capparis flexusa*	S
none	*Cissus obovata*	V
none	*Ipomea spp.*	V
tan tan, tanty, wild tamarind, zarcilla	*Leucaena leucocephala*	S
none	*Macfadyena unguis-cati*	S
none	*Panicum maximum*	H
cattle tongue, sweet scent	*Pluchea carolinensis*	H
none	*Sporobolus indicus*	H
yerba socialista, socialist herb	*Vernonia cinerea*	H
marsh mallow	*Waltheria indica*	H
Black mangrove		
black mangrove	*Avicenia germinans*	S/T
almácigo, turpentine-tree	*Bursera simaruba*	S/T
bottle wiss	*Capparis flexuosa*	S
Black willie, Jamaican caper	*Capparis cynophallophora*	S/T
brazilette	*Erythroxylum brevipes*	S
none	*Foresteria eggersiana*	S
black mampoo, wild mampoo	*Guapira fragans*	S
none	*Lasiacis divaricata*	H
tan tan, tanty, wild tamarind, lead tree	*Leucaena leucocephala*	S
none	*Panicum maximum*	H
Christmas tree, tintillo	*Randia aculeata*	S
none	*Sporobolus indicus*	H

S = shrub
T = tree
H = herbaceous
V = vine

Wildlife Description

During the short duration of wildlife surveys conducted on this site, numerous wildlife species including birds, lizards, frogs, and crabs were observed utilizing the habitat of this site (Table 5). A large land crab (*Ucar* species) was observed in the mangrove community. There was no evidence that the SWMU site had an impact on the wildlife or its habitat.

Protected Species

SWMU 2 was in close proximity and had similar habitat as SWMU 1. There were no federally protected species or preferred habitat observed at SWMU 2. See the discussion on protected species for SWMU 1 for information on potentially occurring species and their habitat.

Food Web

Figures 6 and 7 present generalized food webs for the upland coastal forest and mangrove communities, respectively.

Table 5

Wildlife Observed at SWMU 2

English Name	Scientific Name	Local Name
Upland Coastal Forest		
Reptiles and Amphibians		
Lizard	*Anolis cristatellus*	not known
Lizard	*Anolis pulchellus*	not known
Frog	*Eleutherodactylus sp.*	not known
Frog	*Leptodactylus albilabris*	not known
Birds		
Red-tailed Hawk	*Buteo jamaicensis*	Guaraguao de Cola Roja
Yellow Warbler	*Dendroica petechia*	Canario de Mangle
Pearly-eyed Thrasher	*Margarops fuscatus*	Zorzal Pardo
Puerto Rico Woodpecker	*Melanerpes portoricensis*	Carpintero de Puerto Rico
Northern Mockingbird	*Mimus polyglottos*	Ruiseñor
Greater Antillean Grackle	*Quiscalus niger*	Mozambique (Chango)
Gray Kingbird	*Tyrannus dominicensis*	Pitirre
Black-Whiskered Vireo	*Vireo altiloquus*	Bien-te-veo
Zenaida Dove	*Zenaida aurita*	Tórtola Cardosantera
Mangrove		
Crustacean		
Land Crab	*Ucar sp.*	Ucar
Birds		
Bananaquit	*Coereba flaveola*	Reinita Común
Loggerhead Kingbird	*Tyrannus caudifasciatus*	Clérigo
Black-Whiskered Vireo	*Vireo altiloquus*	Bien-te-veo
Zenaida Dove	*Zenaida aurita*	Tórtola Cardosantera

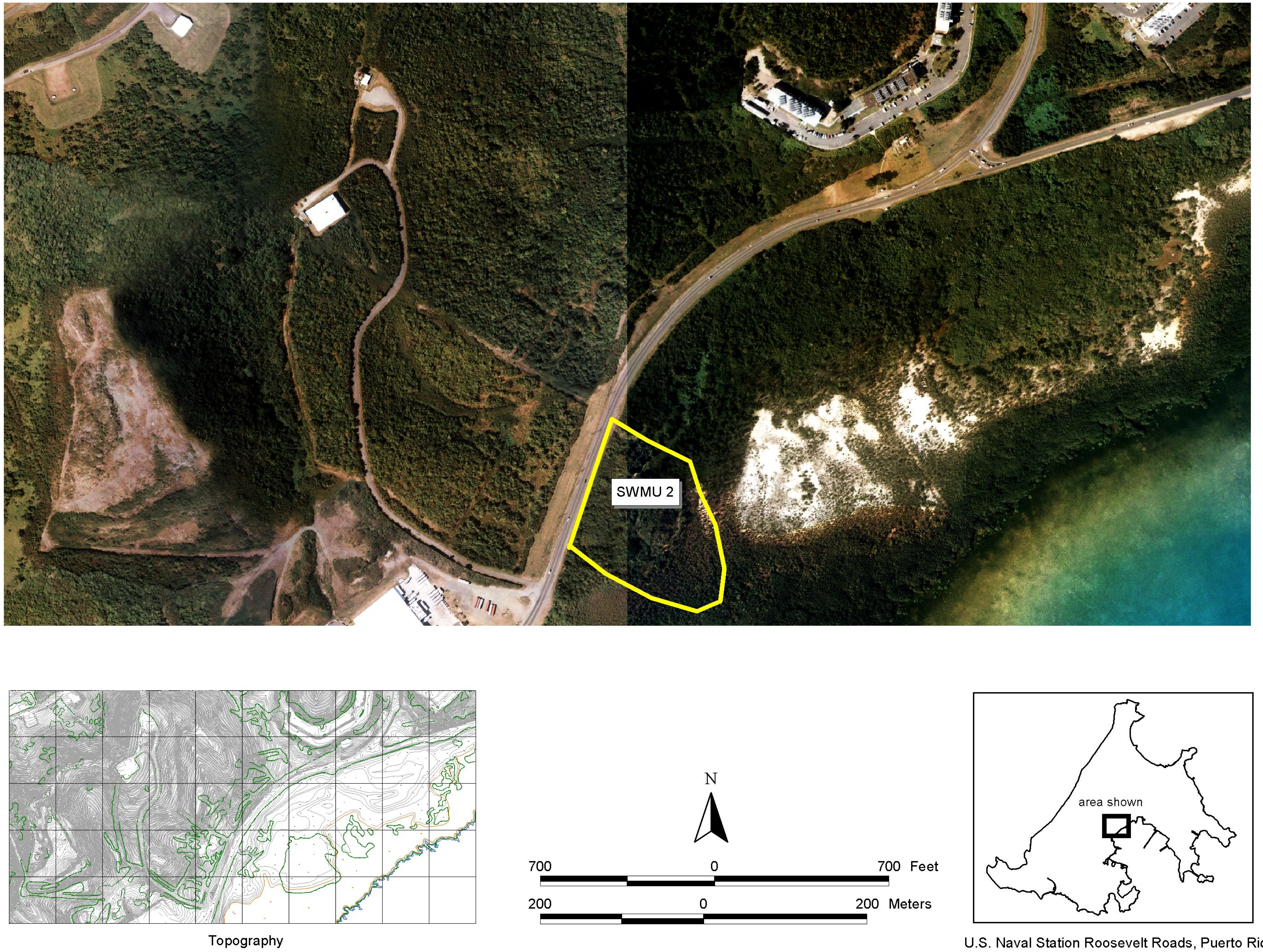


Figure 8. Location of SWMU 2, Roosevelt Roads, Puerto Rico

Figure 9. SWMU 2, Un-maintained Road in Center of Photograph within the Upland Coastal Forest Community.

Figure 10. SWMU 2, Typical Vegetation Showing Upland Coastal Forest Species

SWMU 45

Terrestrial Area

Vegetation Community Description

SWMU 45 included areas outside of Building 38, the right-of-way for the cooling water tunnels, and a small cove in Puerca Bay (Figure 11). Building 38 is located along a dirt access road south of Forrestal Drive. Grounds maintenance and building maintenance activity appeared to have been abandoned a few years ago. NAVSTA Roosevelt Roads INRMP indicated that the general cover type for the terrestrial portion of SWMU is urban/developed (U.S. Navy, 1998b). However, observations of the present species composition indicated that the site was in the early ecological succession stages of an upland coastal forest community. In addition to the vegetation around the building and the cooling water tunnel right-of-way, there was a fringe of mangroves along the cove of Puerca Bay. The marine environment at the small cove within Puerca Bay is discussed later.

The majority of the site was located on nearly level upland terrain with almost 100 percent vegetation cover. Shrubs dominated the site, except where road corridors occurred. Maintained grasses such as *Bothriochloa ischaemum*, *Chloris barbata*, and *Digitaria* sp. dominated the road corridors while 10 to 15-foot tall *Leucaena leucocephala* shrubs dominated the un-maintained areas.

The small cove at Puerca Bay was shallow and had been excavated for the water cooling tunnels. The fringe of the bay had near 100 percent shrub cover and little to no herbaceous vegetation. *Thespesia populnea* shrubs dominated the community. There were also sparse black mangroves, *Stachytarpeta jamaicensis*, and *Heliotropium curassavicum* present. A wildlife photo along the cove shoreline is presented in Figure 12. The vegetation observed at SWMU 45 is presented in Table 6.

Plant Community Health

Because SWMU 45 was very similar to SWMU 2 in species composition, community structure, and topography, the same control plot was used for both sites. The control was located along Langley Road adjacent to the eastern boundary of SWMU 2. There were minimal differences between the control and SWMU 45. Most of SWMU 45 had been well maintained, but it appeared that recent lack of maintenance had allowed *Leucaena leucocephala*, an invasive species, to increase. Besides mowing and other grounds maintenance practices at SWMU 45, there were no other plant community stresses observed.

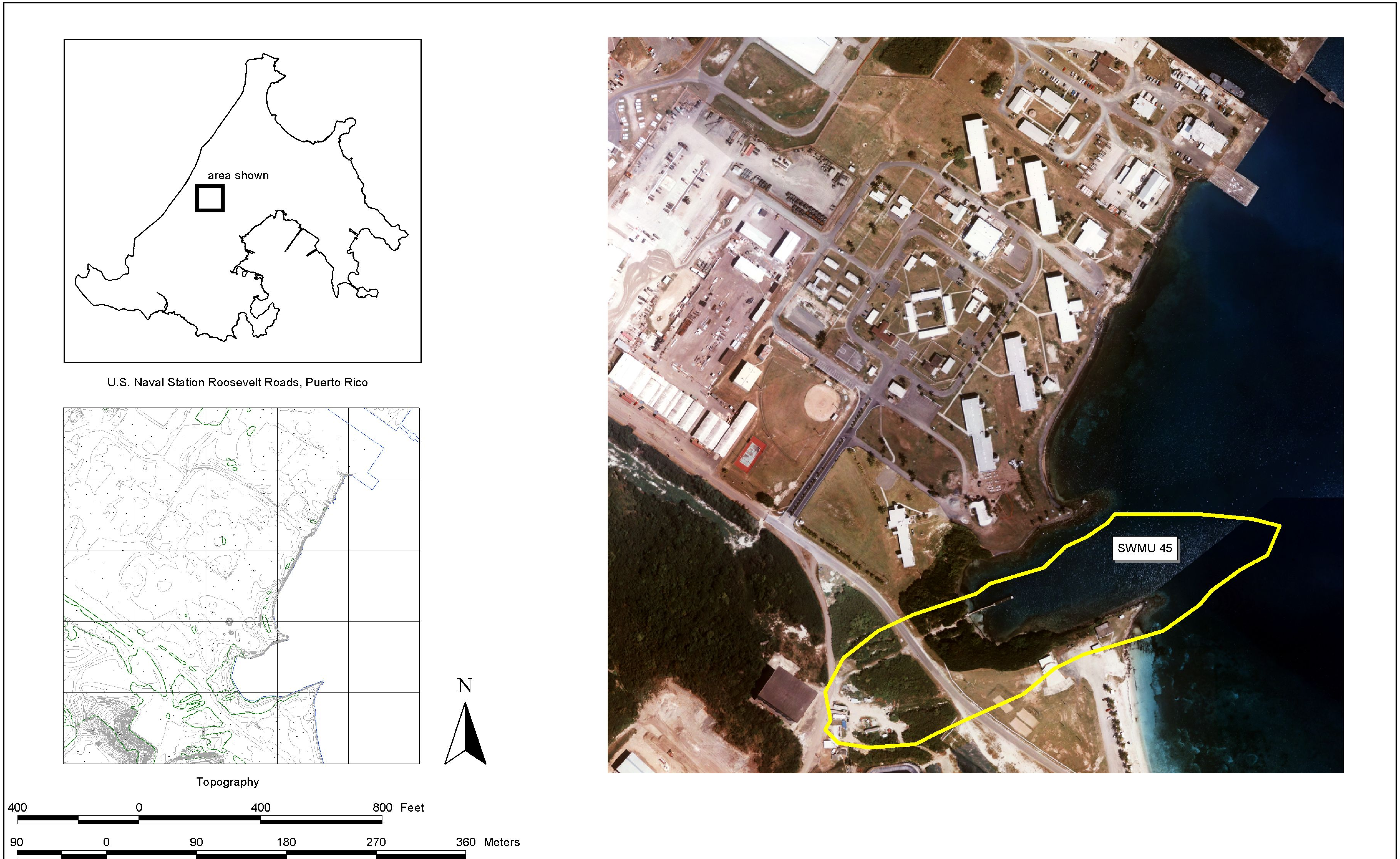


Figure 11. Location of SWMU 45, Roosevelt Roads, Puerto Rico

Figure 12. SWMU 45, Along the Shoreline of the Cove, Killdeer (*Charadrius vociferous*) Foraging Among Washed-up Seagrass.

Table 6

Vegetation Observed at SWMU 45

Common Name	Scientific Name	Stratum
Upland Coastal Forest		
bay flower	*Blutaparon vermiculare*	H
almácigo, turpentine-tree	*Bursera simaruba*	S/T
Barbados pride, dwarf poinciana	*Caesalpinia pulcherrima*	S
bottle wiss	*Capparis flexusa*	S
conchita de Virginia	*Centrosema virginianum*	V
none	*Chloris barbata*	H
péndula de sierra, fiddlewood	*Citharexylum caudafum*	S/T
copper	*Cordia alliodora*	S
none	*Dalbergia ecastaphyllum*	S
cotton	*Gossypium barbadense*	H
bay vine	*Ipomea pes-caprae*	V
willy vine	*Ipomea tiliacea*	V
tan tan, tanty, wild tamarind	*Leucaena leucocephala*	S
batatilla blanca	*Merremia quinquefolia*	V
Bellyache balsam, bitter bushplant	*Oncimum campechianum*	S
Prickly mampoo	*Pisonia aculeata*	S
guamá americano, guamuchil	*Pithcellobium dulce*	S
Christmas tree, tintillo	*Randia aculeata*	S
royal palm	*Roystonea borinquena*	S
bay flower, sea purslane, sea pusley	*Sesuvium portulacastrum*	H
None	*Sida rhombifolia*	S
Mangrove		
sea pusley	*Heliotropium curassavicum*	H
black mangrove	*Laguncularia racemosa*	S/T
None	*Stachytarpeta jamaicensis*	H/S
seaside mahoe, emajaguilla, portiatree	*Thespesia populnea*	S

S = shrub T = tree
H = herbaceous V = vine

Wildlife Description

During the short duration of wildlife surveys conducted on this site, numerous wildlife species such as birds and lizards were observed utilizing the habitat of this site (Table 7). Bird species were typical of coastal forest and shore species due to the proximity of the site to the open waters of Puerca Bay. There was no evidence that the SWMU site had an impact on the wildlife or habitat.

Protected Species

There were no federally protected species or preferred habitat observed at this site. The federally threatened plant *Stahlia monosperma* and the endangered Puerto Rican boa (*Epicrates inornatus*) would not be expected to inhabit the area since the site has been disturbed. Intact coastal forest habitat is not present (preferred habitat for the Puerto Rican boa) and only sparse black mangroves were present along the fringe of the Puerca Bay cove, so *Stahlia monosperma* would probably not occur. SWMU 45 is outside the area of critical habitat designation, although potential feeding habitat (shrubland) for the Yellow-shouldered blackbird was present at the site.

Table 7

Wildlife Observed at SWMU 45

English Name	Scientific Name	Local Name
Reptiles and Amphibians		
Lizard	*Anolis cristatellus*	Not known
Birds		
Killdeer	*Charadrius vociferous*	Playero Sabanero
Common-ground Dove	*Columbina passerina*	Rolita
Yellow Warbler	*Dendroica petechia*	Canario de Mangle
Magnificent Frigatebird	*Fregata magnificens*	Tijerilla (Rabijunco)
Pearly-eyed Thrasher	*Margarops fuscatus*	Zorzal Pardo
Northern Mockingbird	*Mimus polyglottos*	Ruiseñor
Cave Swallow	*Pterochelidon fulva*	Golondrina de Cuevas
Greater Antillean Grackle	*Quiscalus niger*	Mozambique (Chango)
Gray Kingbird	*Tyrannus dominicensis*	Pitirre
White-winged Dove	*Zenaida asiatica*	Tórtola Aliblanca
Zenaida Dove	*Zenaida aurita*	Tórtola Cardosantera

Food Web

A generalized food web for the upland coastal forest community is provided in Figure 6.

Marine Area

A reconnaissance survey of SWMU 45 was conducted June 19, 2000 (Dial Cordy and Associates Inc., 2000) to define the marine habitat and associated flora and fauna of the outfall structure and surrounding embayment and shore. Marine habitats observed in the study area included: rocky rubble subtidal zone, shallow subtidal sandy shelf, shelf slope, deep level bottom of embayment, and the outfall structure. A complete list of the marine flora and fauna observed at SWMU 45 is given in the Dial Cordy report (Dial Cordy and Associates Inc., 2000), which is included in Appendix B.

The rocky subtidal zone was located along the shoreline of the embayment and served as a means of shore protection. The rocky habitat was occupied by marine algal species (*Halimeda tuna*, *H. opuntia*, *Penicilllus pyriformis*, and *Udotea* species), invertebrates such as sea urchins (*Echinometra lucunter* and *E. viridis*), encrusting fire coral (*Millipora alcicornus*), common sea fan (*Gorgonia ventalina*), and starlet coral (*Siderastrea radians*). Sixteen fish species were seen and common species included sergeant major (*Abudefduf saxatillis*), dusky damselfish (*Stegastes fuscus*), tomtate (*Haemulon aurolineatum*), gray snapper (*Lutjanus griseus*), and squirrelfish (*Holocentrus* species). Most of the fish species were using the rocky zone for food and refuge from predators.

The shallow subtidal sandy shelf was characterized as a seagrass/algal bed dominated by turtle grass (*Thalassia testudinum*). Seagrass cover ranged from approximately 50 to 75 percent. Marine invertebrates included pincushion starfish (*Oreaster reticulatus*), several species of sea cucumbers, and the corkscrew anemone (*Bartholomea annulatta*). Common fish included the tomtate and gray snappers.

The shelf slope was devoid of seagrass and was characterized by marine algae. Fish observed included the yellowfin mojarra (*Gerres cinereus*) and silver jenny (*Eucinostomus gula*). The level sand bottom around the mouth of the outfall structure was un-vegetated and due to low visibility and depth, no large invertebrates or fish were observed.

The outfall structure itself supported a hardbottom community dominated by soft corals (*Leptogorgia* species, *Muricea elongata*, *Gorgonia ventalina*), marine algae (*Caulerpa racemosa* and *Cladophora* species), sponges (*Cliona* species), and fire coral.

CONCLUSION

The past activities at all to the SWMU sites presented in this report have some degree of impacts on their ecosystems. However, these impacts appear to be limited to changes in species composition based on physical disturbances. The construction of roads, rounds maintenance, and the addition of an outfall structure to the cove at Puerca Bay were only disturbances that have caused noticeable differences. Wildlife at these sites seems to be healthy and utilizing the habitats to their fullest extent. Through these surveys, no federally protected species were identified at these sites.

LITERATURE CITED

Acevedo-Rodriguez, P. 1996. Flora of St. John; U.S. Virgin Islands. The New York Botanical Garden. Bronx, NY.

Dial Cordy and Associates, Inc. 2000. Marine Resource Survey of SWMU Site NAS Roosevelt Roads, Puerto Rico. Prepared by Dial Cordy and Associates, Inc. for Geo-Marine, Inc., Fajardo, Puerto Rico.

Liogier, H.A. 1985. Descriptive Flora of Puerto Rico and Adjacent Islands; Spermatophyta Vol. 1 Casuarinacae to Connaraceae. Editorial de la Universidad de Puerto Rico, Rio Piedras, Puerto Rico.

Liogier, H.A. 1988. Descriptive Flora of Puerto Rico and Adjacent Islands; Spermatophyta. Vol. 2. Leguminosae to Anacardiaceae. Editorial de la Universidad de Puerto Rico, Rio Piedras, Puerto Rico.

Liogier, H.A. 1994. Descriptive Flora of Puerto Rico and Adjacent Islands; Spermatophyta. Vol. 3. Cyrillaceae to Myrtaceae. Editorial de la Universidad de Puerto Rico, Rio Piedras, Puerto Rico.

Liogier, H.A. 1995. Descriptive Flora of Puerto Rico and Adjacent Islands; Spermatophyta. Vol. 4. Melastomataceae to Lentibulariaceae. Editorial de la Universidad de Puerto Rico, Rio Piedras, Puerto Rico.

Liogier, H.A. 1997. Descriptive Flora of Puerto Rico and Adjacent Islands; Spermatophyta. Vol. 5. Acanthaceae to Compositae. Editorial de la Universidad de Puerto Rico, Rio Piedras, Puerto Rico.

Little, E.L., and F.H. Wadsworth. 1964. Common Trees of Puerto Rico and the Virgin Islands. Agriculture Handbook No. 249. U.S. Department of Agriculture, Forest Service, Washington, D.C.

Little, E.L., R. Woodbury, and F.H. Wadsworth. 1964. Trees of Puerto Rico and the Virgin Islands. Vol. 2. Agriculture Handbook No. 449. U.S. Department of Agriculture, Forest Service, Washington, D.C.

Raffaele, H. A. 1989. A Guide to the Birds of Puerto Rico and the Virgin Islands. Princeton University Press. Princeton, New Jersey.

Raffaele, H., J. Wiley, O. Garrido, A. Keith, and J. Raffaele. 1998. A Guide to the Birds of the West Indies. Princeton University Press. Princeton, New Jersey.

U.S. Navy. 1998a. Draft Pre-Consultation Plan for the Puerto Rican Boa. Prepared by Geo-Marine, Inc. for Atlantic Division, Naval Facilities Engineering Command, Norfolk, Virginia, and U.S. Naval Security Group Activity, Ceiba, Puerto Rico.

U.S. Navy. 1998b. Final Integrated Natural Resource Management Plan. Atlantic Division, Naval Facilities Engineering Command, Norfolk, Virginia, and U.S. Naval Station Roosevelt Roads, Ceiba, Puerto Rico. 15 p.

APPENDIX A

Birds Potentially Occurring at NAVSTA Roosevelt Roads

Pied-billed grebe (*Podilymbus podiceps*)
Red-billed tropicbird (*Phaethon aethereus*)
Brown pelican (*Pelecanus occidentalis*)
Brown booby (*Sula leucogaster*)
Magnificent frigatebird (*Fregata magnificens*)
Great blue heron (*Ardea herodias*)
Louisiana heron (*Hydranassa tricolor*)
Snowy egret (*Egretta thula*)
Great egret (*Egretta alba*)
Striated heron (*Butorides striatus*)
Little blue heron (*Florida caerulea*)
Cattle egret (*Bubulcus ibis*)
Least bittern (*Ixobrychus exilis*)
Yellow-crowned night heron (*Nyctanassa violacea*)
Black-crowned night heron (*Nycticorax nycticorax*)
White-cheeked pintail (*Anas bahamensis*)
Blue-winged teal (*Anas discors*)
American widgeon (*Anas americana*)
Red-tailed hawk (*Buteo jamaicensis*)
Osprey (*Pandion haliaetus*)
Merlin (*Falcon columbarius*)
Clapper rail (*Rallus longirostris*)
American coot (*Fulica americana*)
Caribbean coot (*Fulica caribaea*)
Common gallinule (*Gallinula chloropus*)
Piping plover (Charadrius melodus)
Semipalmated plover (*Charadrius semipalmatus*)
Black-bellied plover (*Squatarola squatarola*)
Wilson's plover (*Charadrius wilsonia*)
Killdeer (*Charadrius vocifera*)
Ruddy turnstone (*Arenaria interpres*)
Black-necked stilt (*Himantopus himantopus*)
Whimbrel (*Numenius phaeopus*)
Spotted sandpiper (*Actitis macularia*)
Semipalmated sandpiper (*Calidris pusilla*)
Short-billed dowitcher (*Limnodromus griseus*)
Greater yellowlegs (*Tringa melanoleauca*)
Lesser yellowlegs (*Tringa flavipes*)
Willet (*Catoptrophorus semipalmatus*)
Stilt sandpiper (*Micropalama himantopus*)
Pectoral sandpiper (*Calidris melanotos*)
Laughing gull (*Larus atricilla*)
Royal tern (*Thalasseus maximus*)
Sandwich tern (*Thalasseus sandvicensis*)
Bridled tern (*Sterna anaethetus*)
Least tern (*Sterna albifrons*)
Brown noddy (*Anous stolidus*)
White-winged dove (*Zenaida asiatica*)
Zenaida dove (*Zenaida aurita*)
White-crowned pigeon (*Columba leucocephala*)
Mourning dove (*Zenaida macroura*)
Red-necked pigeon (*Columba squamosa*)
Common ground dove (*Columba passerina*)
Bridled quail dove (*Geotrygon mystacea*)

Birds Potentially Occurring at NAVSTA Roosevelt Roads (Continued)

Ruddy quail dove (*Geotrygon montana*)
Caribbean parakeet (*Aratinga pertinax*)
Smooth-billed ani (*Crotophaga ani*)
Yellow-billed cuckoo (*Coccyzus americanus*)
Mangrove cuckoo (*Coccyzus minor*)
Short-eared owl (*Asio flammeus*)
Chuck-will's-widow (*Caprimulgus carolinensis*)
Common nighthawk (*Chordeiles minor*)
Antillean crested hummingbird (*Orthorynchus cristatus*)
Green-throated carib (*Sericotes holosericeus*)
Antillean mango (*Anthracothorax dominicus*)
Belted kingfisher (*Ceryle alcyon*)
Gray kingbird (*Tyrannus dominicensis*)
Loggerhead kingbird (*Tyrannus caudifasciatus*)
Stolid flycatcher (*Myiarchus stolidus*)
Caribbean elaenia (*Elaenia martinica*)
Purple martin (*Progne subis*)
Cave swallow (*Petrochelidon fulva*)
Barn swallow (*Hirundo rustica*)
Northern mockingbird (*Mimus polyglottos*)
Pearly-eyed thrasher (*Maragarops fuscatus*)
Red-legged thrush (*Mimocichla plumbea*)
Black-whiskered vireo (*Vireo altiloquus*)
American redstart (*Setaophaga ruticilla*)
Parula warbler (*Parula americana*)
Prairie warbler (*Dendroica discolor*)
Yellow warbler (*Dendroica petechia*)
Magnolia warbler (*Dendroica magnolia*)
Cape May warbler (*Dendroica tigrina*)
Black-throated blue warbler (*Dendroica caerulescens*)
Adelaide's warbler (*Dendroica adelaidae*)
Palm warbler (*Dendroica palmarum*)
Black and white warbler (*Mniotilta varia*)
Ovenbird (*Seiurus aurocapillus*)
Northern water thrush (*Seiurus noveboracensis*)
Bananaquit (*Coerba flaveola*)
Striped-headed tanager (*Spindalis zena*)
Shiny cowbird (*Molothrus bonariensis*)
Black-cowled oriole (*Icterus dominicensis*)
Greater Antillean grackle (*Quiscalis niger*)
Yellow-shouldered blackbird (*Agelaius xanthomus*)
Hooded mannikin (*Lonchura cucullata*)
Yellow-faced grassquit (*Tiaris olivacea*)
Black-faced grassquit (*Tiaris bicolor*)
Least sandpiper (*Calidris minutilla*)
Western sandpiper (*Calidris mauri*)
Puerto Rican woodpecker (*Melanerpes portoricensis*)
Rock dove (*Columba livia*)
Puerto Rican emerald (*Chlorostilbon maugeus*)
Puerto Rican flycatcher (*Myiarchus antillarum*)
Pin-tailed whydah (*Vidua macroura*)
Spice finch (*Lonchura punctulata*)
Ruddy duck (*Oxyura jamaicensis*)
Peregrine falcon (*Falco peregrinus*)

Birds Potentially Occurring at NAVSTA Roosevelt Roads (Continued)

Marbled godwit (*Limosa fedoa*)
Puerto Rican lizard cuckoo (*Saurothera vieilloti*)
Prothonotary warbler (*Protonotaria citrea*)
Green-winged teal (*Anas carolinensis*)
Orange-cheeked waxbill (*Estrilda melpoda*)
Least grebe (*Tachybaptus dominicus*)
West Indian whistling duck (*Dendrocygna arborea*)
Puerto Rican screech owl (*Otus nudipes*)
Puerto Rican tody (*Todus mexicanus*)

Source: U.S. Navy 1998b.

APPENDIX B

Marine Resource Survey of SWMU Site
NAS Roosevelt Roads, Puerto Rico

July 18, 2000

Prepared for:
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TABLE OF CONTENTS

LIST OF TABLES

1.0 INTRODUCTION

Dial Cordy and Associates Inc. conducted a reconnaissance survey of the SWMU 45 Site at NAS Roosevelt Roads on June 19, 2000. The marine biological survey was conducted for Geo-Marine, Inc. in support of their Ecological Risk Assessment for the installation. Objectives of the brief survey included defining the marine habitats and associated flora and fauna and identifying species observed which may be indicators of present conditions. Representative still photographs and video documentation of the site were also completed.

2.0 HABITAT DESCRIPTION

Marine habitats observed in the study area included a rocky-rubble subtidal zone located around most of the embayment, a shallow subtidal sandy shelf located seaward of the rocky shore, a shelf slope extending to the base of the slope, a deeper level bottom, and the outfall structure. A brief description of the biological communities observed within these habitat types is provided below.

2.1 Rocky Subtidal Zone

Rock rip-rap is located along the shoreline on both sides of the embayment, principally to serve as means of shore protection. The riprap extends from above MHW to approximately 3 feet below MLW. This rock habitat is occupied by a myriad of marine algal species attached to the rocks, as well as numerous sessile and motile epibiota and marine fish (Table 1, Photographs 1-4). Dominant algal species include *Halimeda tuna*, *H. opuntia*, *Penicillus pyriformis,* and *Udotea sp*. Common marine invertebrates observed included sea urchins (*Echinometra lucunter* and *E. viridis*), encrusting fire coral *(Millipora alcicornus*), common sea fan (*Gorgonia ventalina*), and starlet coral (*Siderastrea radians*). Sixteen species of marine fish were observed within the rocky zone. Many of these are species are more common to seagrass beds, but move to this zone for food and refugia from predators. Common species observed include sergeant major (*Abudefduf saxatillis*), dusky damselfish (Stegastes fuscus), tomtate (*Haemulon aurolineatum*), gray snapper *(Lutjanus griseus),* and squirrelfish (*Holocentrus sp*.). As shown in Table 1, 11 species of fish are classified as rarely observed. Of the 16 species observed, five were juveniles, which often reside in shallow interior seagrass beds or reefs during their earlier life stages, prior to moving to offshore reef environments upon reaching maturity.

Table 1 Marine Flora and Fauna Observed at SWMU Site on June 19, 2000

			Rocky Subtidal	Sandy Shelf	Shelf Slope	Outfall Structure
MARINE FLOWERING PLANTS						
	Thalassia testudinum		x	x	x	
	Syringodium filiforme			x		
ALGAE						
Green Algae						
	Acetabularia calyculus		x			
	Penicillus pyriformis		x			
	Cladophora sp.		x			x
	Caulerpa sertularioides		x			
	Caulerpa racemosa		x			x
	Dictyosphaeria ocellata		x			
	Udotea sp.		x	x	x	
	Avrainvillea nigricans		x			
	Halimeda tuna		x			
	Halimeda opuntia		x	x	x	
	Penicillus capitatus			x		
	Halimeda incrassata			x	x	
Brown Algae						
	Dictyota cervicornis		x			
	Dictyopteris sp.		x			
	Padina sp.		x	x	x	
Red Algae						
	Wrangelia argus		x			x
	Laurencia papillosa		x	x		
INVERTEBRATES						
c	*Cliona sp.*	red boring sponge	x			x
r	*Holopsamma sp.*	lumpy overgrowing sponge	x	x		
r	*Bartholomea annulata*	corkscrew anemone	x	x		
r	*Condylactis gigantea*	giant anemone	x			
c	*Millepora alcicornis*	branching fire coral	x			x
r	*Muricea elongata*	orange spiney sea rod				x
c	*Gorgonia ventalina*	common sea fan	x			x
c	*Leptogorgia sp.*	sea whip				x
c	*Siderastrea radians*	lesser starlet coral	x			x
c	*Sabellastarte magnifica*	feather duster	x			
r	*Cyphoma macgintyi*	spotted cyphoma	x			
r	*Oreaster reticulatus*	cushon sea star		x	x	
ab	*Echinometra lucunter*	rock boring urchin	x			
ab	*Echinometra viridis*	reef urchin	x			
r	*Actinopyga agassizii*	five-toothed sea cucumber		x	x	
c	*Holothuria mexicana*	donkey dung sea cucumber		x		
FISH						
r	*Chaetodon ocellatus*	spotfin butterflyfish	x			

			Rocky Subtidal	Sandy Shelf	Shelf Slope	Outfall Structure
r	*Pomacantus paru*	French angelfish (juv)	x			
r	*Acanthurus coeruleus*	blue tang (juv)	x			
r	*Sphyraena barracuda*	great baracuda		x		
c	*Gerres cinereus*	yellowfin mojarra (juv)		x	x	
r	*Archosargus rhomboidalis*	sea bream				x
c	*Calamus penna*	sheepshead porgy (adult)		x		
c	*Eucinostomus gula*	silver jenny (juv)		x	x	
c	*Haemulon aurolineatum*	tomtate (juv)	x	x		
c	*Lutjanus griseus*	gray snapper (juv)	x			x
r	*Lutjanus aoidus*	schoolmaster snapper	x	x		
c	*Stegastes fuscus*	dusky damselfish (adult)	x			x
r	*Stegastes leucostictus*	Beaugregory	x			
ab	*Abudefduf saxatillis*	sergeant major	x			x
r	*Serranus tigrinus*	harlequin bass	x			
r	*Sparisoma aurofrenatum*	redband parrotfish (juv)	x	x		
r	*Halichoeres bivittatus*	slippery dick	x	x		
c	*Holocentrus sp.*	squirrelfish	x			
r	*Coryphopterus glaucofraenum*	bridled goby	x			
r	*Aulostomus maculatus*	trumpetfish	x			
r	*Sphoeroides spengleri*	bandtail puffer	x			

r = rare
ab = abundant
c = commom

2.2 Shallow Subtidal Shelf

This zone occurs between the rocky subtidal zone and the deeper shelf slope, from 3-10 feet below MSL. The shelf is characterized as a seagrass/ algal bed dominated by turtle grass (*Thalassia testudinum*) and marine algae including *Halimeda incrassata, H. opuntia, Udotea sp., Padina sp*., and *Penicillus capitatus*. (Photographs 5 & 8). Seagrass cover values based on the Braun Blanquet Method (Braun-Blanquet, 1965) ranged from 50% to greater than 75% for the turtle grass beds. Marine invertebrates observed included the pin cushion star fish (*Oreaster reticulatus*), sea cucumbers (*Actinopyga agassizii, Holothuria mexicana*), and the corkscrew anemone (*Bartholomea annulatta*) (Table 1). Fish common to the seagrass habitat included tomtate (*Haemulon aurolineatum*, gray snapper (*Lutjanus griseus*), and several species of mojarras.

The shelf area at the back end of the basin is a sandy bottom habitat with little to no seagrass or algae present. The bottom is covered with active mounds created by callianassid burrowing shrimp. Mojarras were the only family of fish observed in this area. An abundance of drift algae was observed covering the bottom.

2.3 Shelf Slope

The shelf slope ranged from 10-15 feet below MSL around the perimeter of the basin. This area was void of seagrass and characterized by marine algae including *Padina* s*p*, *Udotea* sp*., and Halimeda spp* (Photographs 7 & 8). No conspicuous motile epibenthic species were observed in this habitat. Fish observed included yellowfin mojarrra (*Gerres cinereus*) and silver jenny (*Eucinostomus gula*).

2.4 Level Sandy Bottom

The interior of the basin from the mouth to and around the outfall structure is unvegetated sand to silty-sand bottom. Due to low visibility and depth (15-20 feet), no large invertebrates or fish were observed.

2.5 Outfall Structure

The concrete side walls of the outfall structure support a hardbottom community dominated by soft corals (*Leptogorgia* sp., *Muricea elongata*, *Gorgonia ventalina*,), marine algae (*Caulerpa racemosa*, *Cladophora* sp.), sponges (*Cliona* sp.), and fire coral (*Millipora alcicornus*). A list of species observed is provided in Table 1. Representative species are illustrated in Photographs 9 and 10.

3.0 INDICATOR SPECIES

Species which may serve as indicators of the present environmental quality of the site are listed below. The absence of seagrass and selected invertebrate species in the future would serve to indicate a change in the quality of the habitat and associated water quality in the embayment. Fish species selected are mobile and their absence may not reflect a significant change. The absence of many of the common species observed in association with the rocky shoreline would indicate a significant change had occurred.

Indicator Species	
Thalassia testudinum	turtle grass
Condylactis gigantea	giant anemone
Echinometra viridis	reef urchin
Siderastrea radians	lesser starlet coral
Chaetodon ocellatus	spotfin butterflyfish
Stegastes fuscus	dusky damselfish

4.0 REFERENCES

Braun-Blanquet, J. 1965. Plant sociology: the study of plant communities. Hafner Publications, London. 439p.

APPENDIX A

Photographs

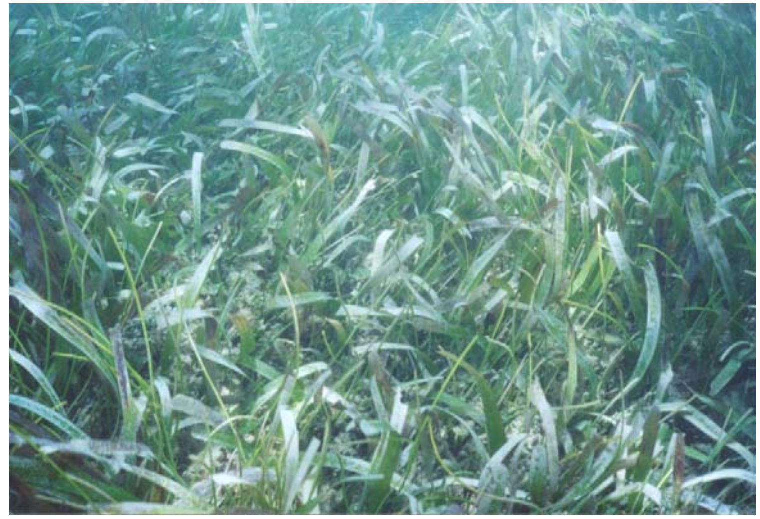
Photogragh 1. Rocky subtidal habitat with squirrelfish (*Holocentrus adcensionis*).

Photogragh 2. Rocky subtidal habitat and seagrass bed interface with calcareous green algae (*Halimeda incrassata)*, turtle grass (Thalassia testudinum) and porous sea rods (*Pseudoplexaura sp*.).

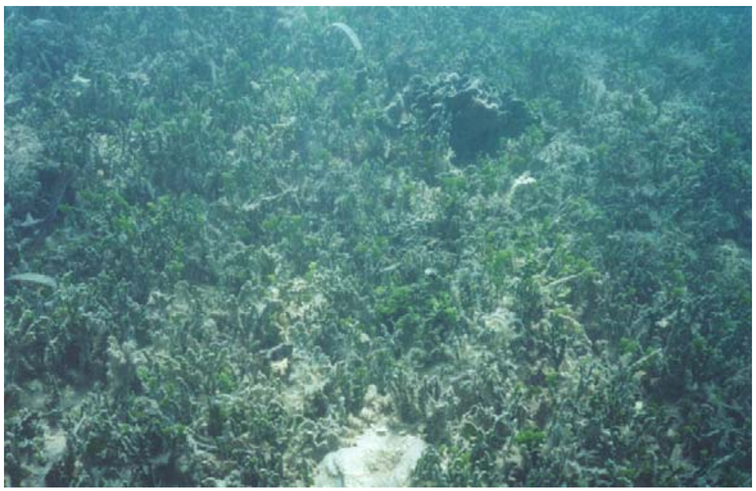
Photograph 3. Rocky subtidal habitat with calcareous green algae (*Halimeda incrassata*), turtle grass (*Thalassia testudinum*) and giant sea anemone (*Condylactis gigantea*).

Photograph 4. Rocky subtidal habitat with red-boring sponge (*Cliona sp*.), porous sea rod (*Pseudoplexaura sp*.) and knobby brain coral (*Diploria clivosa*).

Photograph 5. Seagrass habitat on shallow shelf dominated by turtle grass (*Thalassia testudinum*) and manatee grass (*Syringodium filiforme*).



Photograph 6. Seagrass habitat with turtle grass (*Thalassia testudinum*), manatee grass (*Syringodium filiforme*) and green algae (*Halimeda incrassata*).



Photograph 7. Shelf slope habitat characterized by green algae (*Halimeda incrassata* and *H. opuntia*).

Photograph 8. Shelf slope habitat characterized by green algae (H*alimeda incrassata* and *H. opuntia*) and scattered turtle grass (*Thalassia testudinum*).

Photograph 9. Hard substrate community on outfall structure with red boring sponge (Cliona sp.) and feather duster worm.

Photograph 10. Gorgonian soft corals located on outfall structure.

APPENDIX B
SCOPE OF WORK: 28-DAY *EISENIA FETIDA* SURVIVAL, GROWTH, AND REPRODUCTION TEST

Scope of Work (SOW)

Site 1 (Army Cremator Disposal - SWMU 1) and Site 2 (Langley Drive Disposal Site SWMU - 2) Naval Activity Puerto Rico, Ceiba, Puerto Rico NAVY CLEAN III Contract Task Order (CTO) 0108

Eisenia fetida Chronic Toxicity Assay

INTRODUCTION

The *Eisenia fetida* (Red Worm / Manure Worm) Chronic Assay will be used in a 28-d chronic assay to evaluate the effect of contaminants found in soil samples collected from Sites 1 and 2 of the Naval Activity, Ceiba, Puerto Rico. Common toxicity data endpoints of the bioassay are mortality, growth, reproduction, and bioaccumulation. The soil toxicity tests will be performed in accordance with ASTM Standard E-1676-04 (*Standard Guide for Conducting Laboratory Soil Toxicity or Bioaccumulation Tests with the Lumbricid Earthworm Eisenia fetida and the Enchytraeid Potworm Enchytraeus albidus*). Methodology particular to Fort Environmental Laboratories (FEL) and CTO 0108 are described in the following paragraphs.

MATERIALS AND METHODS

APPARATUS

- Temperature controlled (22°C, ± 3°C) chemical free room,
- Test vessels (500-1000 mL glass jars with ventilated lids, and
- Dissecting scope (10X or 15X power).

TEST MATERIAL

A maximum of 17 soil samples from each of two sites, including reference soils, will be collected from Sites 1 (SWMU – 1) and 2 (SWMU – 2) of the Naval Activity, Ceiba, Puerto Rico.

Sample Handling and Tracking

Samples will be shipped next day delivery to FEL via commercial carrier. Upon arrival, samples will be inventoried using the chain of custody. Temperatures will be recorded, along with signature and date, on the chain of custody. Samples will then be assigned appropriate tracking numbers and recorded in the sample check-in logbook. Tracking numbers will also be recorded on the individual sample bottles. Samples will be stored at 4°C throughout the testing and holding periods.

Laboratory Control

Laboratory prepared water, referred to as dechlorinated ($DeCl_2$) water, will be used with laboratory reference soil as the laboratory negative control and as the hydration water (if needed) if % moisture in any sample is below 25%. $DeCl_2$ water will be prepared by passing tap water through 3 filters; a 10" pre-treatment filter (5 μm) to remove solids, a 3.6 cf activated virgin carbon treatment filter to remove chlorine, ammonia, and higher molecular weight organics, and a 5 μm post-filter to remove any carbon particles from the carbon treatment phase.

Test System

Test species *E. fetida*, commonly known as red or manure worm, is readily available in nature and is easily cultured in the laboratory. The red worm has a short life-cycle consisting of 3 developmental phases: 1) cocoon phase, consisting of 1 to 10 eggs per cocoon; 2) immature phase, in which worms grow but can not reproduce; and 3) mature (adult) phase. The sensitivity of the red worm makes it a good indicator of toxicity in several types test media including soil, sediment, and sludge. Sexually mature, fully clitellate adults will be used at test initiation (d 0). *E. fetida* will be purchased from Aquatic Research Organisms (Hampton, NH) and shipped next day delivery to FEL.

Animal Handling and Feeding

Upon arrival at FEL, worms will be sorted and chosen for testing. Worms will not be fed during the 28-d assay. The red worm should be handled as little as possible to reduce stress to the organisms. Any worms injured or dropped while handling should be discarded.

Study Design

Each treatment (site and reference soil samples) plus laboratory control will consist of 4 replicate 1 L glass jars containing 500 g of soil. Each soil sample will be homogenized prior to test setup by screening soils to remove foreign (non-soil) materials, i.e. glass, rocks, paper, wood, etc.), and then mixing each soil sample. The assay will be conducted in a temperature controlled room (22°C ± 3°) for 28 days. The study will receive continuous light over the 28 days with a light intensity ranging from 400-1,000 lux. Test jars will be examined at test termination (d 28) for survival, growth, and reproduction endpoints. Lids will be perforated for ventilation. Surviving worms will then be depurated for 24 h, reweighed, and frozen for bioaccumulation testing. An additional 4 replicates of each soil with 10 worms per jar will be setup on d 0 and maintained for 28 d along side the original test replicates to provide extra biomass for the bioaccumulation test. No data collection will be required on the additional replicates beyond d 28 and d 29 weights per replicate. Test specifications are outlined in Table 1.

FEL

Prior to Test Setup

Each treatment and control will be measured for pH, % moisture, and total organic carbon (TOC). Ideally, % moisture should range from 35% to 45% of the dry weight. If % moisture is below 25%, hydration of the sample may be necessary, with client approval. Use $DeCl_2$ water to hydrate samples, if required.

Study Day Minus 1

For each treatment, place 500 g of homogenized soil into each of 4 replicate test jars, plus an additional 4 biomass jars. Place test jars in the testing room with temperature controlled at 22°C, ± 3°C for overnight equilibration. Test containers must be randomly distributed. Worms to be tested will be purged (no feeding) for 24 h prior to testing.

Study Day 0

Groups of 10 healthy, mature adult red worms with clitella will be rinsed in dechlorinated laboratory water, weighed as one biomass, and placed on top of the test material in each test jar located in the testing room. **An additional 20-30 adult worm background sample will be randomly chosen, weighed, and frozen for later tissue residue analysis to establish baseline data**. Measure room temperature and light intensity (lux).

Study Days 1 – 27

Test jars will be exposed to continuous light (400 – 1000 lux) throughout the assay. Room temperatures will be maintained at 22°C ± 3°. Temperature and light intensity will be measured and recorded daily.

Study Day 28

At test conclusion, the adult worms in each test jar will be counted to determine percent survival, and rinsed and weighed to determine mean growth. Mean reproduction will be determined by dividing the number of juveniles/cocoons by the number of surviving adults. Measure one replicate from each treatment and control for pH, % moisture, and TOC. Also, measure the room temperature and light intensity. Prepare worms (depurate for 24 h) for shipment to analytical laboratory for tissue residue analysis. Reweigh worms after depuration and freeze. Before and after depuration weights will also be required for the additional biomass replicates.

DATA COLLECTION

- Room temperature and light intensity – daily;
- % moisture, pH, and TOC – prior to day 0 and on day 28;
- Adult survival counts – day 28;
- Adult weights – days 0, 28, and 29 (after depuration); and
- Reproduction counts (juveniles plus cocoons) – day 28.

FEL

Data Analysis

Statistical calculations, including hypothesis testing, will be performed using SigmaStat® 2.03 statistical software (SPSS® Inc., Chicago, IL). All statistical evaluations will include comparison of site soil data for each endpoint to each individual reference and laboratory control.

Amendments and Deviations

A permanent change to the study will require that a written amendment be prepared and approved by the Study Director prior to incorporation. The amendment will then be reviewed to determine the potential impact on the study. If accepted, the amendment will be attached to the SOW and become an active component of the study. Any deviations from the SOW (temporary changes due to unforeseen problems) will be recorded, dated, and initialed by the Study Director.

QA/QC Requirements

Acceptable limits of mortality for the laboratory control (laboratory reference soil) will not exceed 20% for the assay. If acceptable limits are exceeded, the toxicity test will be repeated.

FINAL REPORTS

A separate report will be prepared for each SWMU and will be submitted within 21 calendar days from completion of the tests. Hardcopies of the final reports and electronic copies of the final reports (PDF) and raw data (PDF and excel) will be submitted to:

John Malinowski
Airside Business Park
100 Airside Drive
Moon Township, PA 15108
jmaliowski@mbakercorp.com

The report, summarizing the results of the study will include but not limited to:

- Information on test organisms, to include age, source, and culturing conditions;
- Description of test conditions, to include temperature, photoperiod, test chamber size, surface soil/sediment volume, replicate number per treatment, number of organisms per vessel, and feeding regime;

- Results of soil measurements (pH, TOC, and percent moisture) and/or sediment pore water and overlying water measurements (ammonia and sulfide) for each SWMU and reference area sample and each laboratory control;
- Test organism survival, growth, and/or reproduction per sample and test replicate;
- Description and results of statistical evaluations comparing site surface soil to the laboratory control and reference surface soil samples; and
- Description of any amendments or deviations from approved methodology and any impacts this may have had to the data endpoints in this study.

STUDY LOGISTICS

RECORDS MAINTENANCE

Raw data, derived data, QA reports, correspondence, and final reports will be electronically maintained in computer files. Printed copies of this material will also be kept in designated file cabinets located in a secured file room at the study facility.

TEST SUBSTANCE DISPOSAL

Spent test materials will be disposed of in accordance with proper disposal requirements as outlined in FEL SOP 6.2.0.

MATERIALS ARCHIVAL

Data files, correspondence, QA records, and reports will be archived indefinitely. Storage of archived files will be maintained in a two-tier manner. Archived files will first be kept in file cabinets located in a secured file room at the laboratory facility for a period of 1 year or until final report has been reviewed and accepted by the client. After which time the files may be transferred to storage file boxes and archived off premises at a secured commercial storage facility. The preserved animal specimens will be labeled and archived in the laboratory until such time as the specimens are no longer needed or degradation over time renders the specimens useless.

GOOD LABORATORY PRACTICES (GLP)

Although this study will be conducted in the essence of the principles set forth in the Good Laboratory Practice (GLP) regulations (21 CFR 58, 1987), it is not intended to meet all the requirements of the GLP.

Table 1
Test Specifications

Test type	Fixed exposure system
Test species	*Eisenia fetida* (red worm)
Test initiation	Within 14 days from sample receipt
Species age (test setup)	Sexually mature adult with clitella
Feeding regime	Do not feed
Test duration	28 days
Test treatments	17 soils (including 3 reference sites)
Laboratory control	Laboratory reference soil
Replicates	4 per treatment; extra 4 for added biomass
Number of test animals	10 per replicate (80 per treatment)
Soil volume	500 g per test jar (4 Kg per treatment)
Test vessel	1 L glass jar with perforated lid
Light quality	Ambient laboratory
Light intensity	400 to 1000 lux
Photoperiod	Continuous light
Room temperature	22 $\pm$ 3°C
% moisture, pH, TOC	Days 0 and 28
Room temperature and light intensity	Daily
Survival counts	Day 28
Organism weights	Days 0 and 28; Day 29 after depuration
Reproduction counts (juveniles + cocoons)	Day 28
Test validation	$\leq$ 20% mortality in control animals

APPENDIX C
FIELD NOTES

Joseph Burawa – Environmental Geologist

JOE Burawa
SWMY 1

4/28/07
Saturday

6:00 on-site
6-730 check in, unload, prep.

SS01 0-1' [0730]

Clay Loam
Dark Brown, damp
mod soft, rocky, root frags

SS02 0-1' [0740]

Clay Loam
DARK Brown, damp
Mod soft to hard, Rocky
root frags.

SS03 0-1' [0750]

Clay Loam
Dark Brown
Mod soft, rocky, root frags

JHB

4/28/07

SS04 0-1' [0800]
Clay Loam
Dark Brown
mod soft, rocky
root frags

SS05 0-1' [0810]
Clay Loam
Dark Brown
mod soft, rocky
root frags
ONE WORM found

JHB

4/28/07

830 Start

SS06 0-1' [0830]
Sandy Loam mod soft
rocky, root frags, damp
med dark brown

SS07 0-1' [0840]
Sandy Loam
very rocky dark brown
debris ... glass, metal
mod hard, damp

SS08 0-1' [0850]
Sandy Loam
dark brown, very rocky
damp, glass, metal
mod hard, one worm

SS09 [0900]
Clay Loam
dark brown, shells
very rocky, damp
no debris

JHB

 4/28/07

SS10 0-1' [0910]
Sandy loam
DARK Brown damp
glass, very rocky

Begin (925)
SS21 0-1' [0925]
Clayey silt
DARK brown, very soft
damp to moist, some
debris (aluminum)
peat at surface)

SS23 0-1' [0935]
clayey SILT
DARK Brown, very soft
damp to moist
peat @ surface
metal debris

JHB

 4/28/07

SS22 0-1' (0945)
Clayey silt, some sand
peat @ SURFACE
DARK Brown, soft very
damp to moist
glass, no metal

SS24 0-1' (0955)

clay, trace silt, sand
1/2" layer peat @ surface
~~medium~~ dark brown, soft
metal debris (nails)
damp.

SS-25 0-1' (1005)
clay, medium brown
very soft, damp
no ~~■~~ debris
mod. stiff

JHB

⑥ 4/28/07

Begin 10:15 end 10:45

SS-20 (1015)

Clayey silt
dark brown, very soft
area of surface debris
glass in sample

SS-19 (1025)
Clayey silt
dark brown,
ceramics, very soft
damp,
area of surface debris

SS16 1035
clayey silt
dark brown
very soft damp
area of surface debris

JHB

4/28/07 ⑦

SS17 (1040)
Clayey silt
med brownish red
area of surface
debris, damp, very
soft

SS18 (1045)
Clayey silt
med dark brown
area of surface debris
damp very soft

Start 1240

SS-12 0-1' (1240)
Clay loam
mod soft & damp
many roots, metal
debris

JHB

⑧ 4/28/07

SS13 0-1'
Silty loam
med dark brown
gloss, mod soft damp

SS 14 0-1'
clay Loam
dark brown, gloss
rocky, mod soft, damp
many roots

SS 15 0-1'
clay Loam
dark brown, gloss
rocky, mod soft
many roots

JHB

4/28/07 ⑨

SS-11 0-1'
Silty Loam
dark brown, mod soft
glass, rocky, many roots
damp.

1305 Begin

SS32 0-1'
Clay Loam med brown
rocky @ top
damp ~~mod~~ hard
roots

SS35 0-1'
silty loam med brown
rocky, worm, damp

JHB

SS 31 0-1'
Silty loam
med dark brown, damp
ceramics, glass, mod soft
rocky

SS-33 0-1'
Silty loam
dark brown, worm, damp
rocky, glass, mod hard

SS 34 0-1'
Silty loam
dark brown, worms
rocky, roots, damp

JHB

1320

SS26 0-1'
Silty Clay
dark brown, mod soft
roots no debris
rocky, burned chunk, ash

SS 28 0-1'
Silty clay
dark brown, roots, damp
rocky, shells, grub

SS 27 0-1'
Silty clay
dark brown, shells, damp
mod soft, roots, ash

JHB

(12) 4/28/07

SS 29 0-1'
Sandy Loam
Dark Brown, med soft
damp, ash, roots, rocky

SS 30 0-1'

Clayey Silt
Dark Brown, med soft
roots, rocky, ash
damp

JHB

(13) 4/28/07

1440 Begin

SS36 0-1'

Sandy Clay
med brown, iron staining
med soft, damp
glass, roots
melted

SS 40 0-1'

Sandy clay glass
med. brown
damp, soft roots

SS 37 0-1'
Sandy clay
med brown, soft
glass, rocky, damp roots

JHB

(14) 4/28/07

SS38 0-1'

Sandy clay, glass
iron staining, damp
roots, med soft
iron staining

SS39 0-1'

Sandy clay
med brown, glass
damp, med soft,
roots, iron staining,
shells

JHB

(15) 4/28/07

1540 Begin

SS41 0-1'

Clay some sand & silt
med brown, very soft
damp to moist, roots

SS42 0-1'

clay, some sand & silt
med brown, very soft
damp to moist, roots

SS43 0-1'

clay, some sand & silt
med brown, very soft
damp to moist, roots

JHB

SS44 0-1'

Clay with some sand & silt, mod soft, damp to moist, roots

SS45 0-1'

Clay with some sand & silt, mod soft, damp to moist, roots

JHB

Begin 1500

SS46 0-1'
Silty sand, glass roots, damp, soft dark brown

SS47 0-1'
Silt & organic material damp, soft, glass dark brown

SS48 0-1'

Silty sand, glass, soft damp, organic material dark brown

SS49 0-1'

Silty sand, glass, soft damp, rags, plastic dark brown

JHB

SS 50 0-1'

Silty sand, dark brown soft, damp, organic material, metal glass

Begin 1540

SS 51 0-1'

Silt Loam dark brown, roots few rocks, soft damp

JHB

SS 52 0-1'
Silt Loam, dark brown, soft, damp worm

SS 53 0-1'
Silt Loam, dark brown, soft, damp

SS 54 0-1'

Silt Loam, dark brown soft, damp

SS 55 0-1'

Silt Loam, dark brown soft, damp.

JHB

(20)

JHB

(21)

4/29/07

6 am On-site

6:30 to 7:30 Collect Dups, MS/MSD samples for SWMU 1.

1B-REF-SS01
Clay Loam, med to Dark Brown
soft, damp, roots
[Reference Area ~~3~~ 2] JHB

1B-REF-SS02
Clay with some sand
med brown, sticky, moist
soft [Reference Area ~~3~~ 2] JHB

1B-REF-SS03
Silty Loam, med. brown
damp, soft, roots
[Reference Area 2]

1B-REF-SS04
Clay Loam, med dark Brown
damp to moist, soft, roots
[Reference Area 2]

JHB

1B - REF - SS05

Clay Loam, dark brown
warm, soft, roots, damp
to moist.

[Reference Area 2]

1B - REF - SS06

Sandy Clay, med gray brown
mod soft to soft, damp to moist

[Reference Area 2]

JHB

5/3/07 ; 0850 - 0902

Open Water Quality Readings w/YSI - 556

~~Point~~

Temp °C	Cond	Sal.	D.O.	pH	ORP
27.92	56.58	37.63	5.65	8.30	81 - pt 3
28.53	56.73	37.62	6.67	8.30	72 - pt. 2
28.60	56.28	37.64	6.67	8.33	71 - pt 1

JHB

ship sea grass samples off 5/1/07 to STL - Savannah.

Clear paths in SWMU 2 and locate surface soil sample locations for upcoming field investigation.

JHB

photo	52	Ref Area 2
photo	50	Ref Area 3
photo	49	SS01 - SS05
photo	48	SS06 - SS10
photo	47	SS11 - SS15
photo	46	SS31 - SS35
photo	45	SS36 - SS40
photo	44	SS41 - SS45
photo	43	SS46 - SS50
photo	42	SS51 - SS55
photo	41	SS16 - SS20
photo	40	SS26 - SS30
photo	39	SS21 - SS25

JHB

JHB

obtain lab results and decision making from MKimes & JMalinoski

Will collect the following samples for a 28-Day Earthworm Test.

SS09 → former SS06
SS13
SS15 → former SS10
SS18
SS19 → former SS16
SS29 → former SD02
SS33 → former SS11
SS37
SS39 → former SS07
SS46
SS48
SS49
SS50 → former SS13
SS51 → former SS12

In addition REF 03
REF 05
REF 06

JHB

28

1 Gallon ↓
Retrieve sample containers from the field area of SWMU 1.

Pull sample from each container to analyze for TOC, grain size, and pH. Ship to STL Burlington

Large one gallon containers shipped to Fort Environmental in Stillwater OK.

JHB

APPENDIX D
CHAIN-OF-CUSTODY FORMS

Serial Number 42349

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

SEVERN TRENT **STL**

Fed Ex Airbill No.: 8471 8519 9537

STL Savannah
5102 LaRoche Avenue
Savannah, GA 31404
Website: www.stl-inc.com
Phone: (912) 354-7858
Fax: (912) 352-0165

SWMUs 1 & 2 SITE VERIFICATION

Alternate Laboratory Name/Location
Phone:
Fax:

PROJECT REFERENCE	SWMUs 1 and 2 SV
PROJECT NO.	CTO-108
PROJECT LOCATION (STATE)	PR
STL (LAB) PROJECT MANAGER	Kathy Smith
P.O. NUMBER	
CONTRACT NO.	
CLIENT (SITE) PM	Mark Kimes
CLIENT PHONE	412-337-7465
CLIENT FAX	
CLIENT NAME	Baker Environmental, Inc.
CLIENT E-MAIL	mkimes@mbakercorp.com
CLIENT ADDRESS	100 Airside Drive, Moon Township, PA 15108
COMPANY CONTRACTING THIS WORK (if applicable)	CH2M Hill

PAGE 1 OF 8

STANDARD REPORT DELIVERY (selected) — DATE DUE 28 day TAT

EXPEDITED REPORT DELIVERY (SURCHARGE) — DATE DUE

NUMBER OF COOLERS SUBMITTED PER SHIPMENT:

MATRIX TYPE: COMPOSITE (C) OR GRAB (G) INDICATE; AQUEOUS (WATER); SOLID OR SEMISOLID; AIR; NONAQUEOUS LIQUID (OIL, SOLVENT,...)

REQUIRED ANALYSIS / NUMBER OF CONTAINERS SUBMITTED

SAMPLE DATE	SAMPLE TIME	SAMPLE IDENTIFICATION	C/G	Aqueous	Solid	Air	Nonaqueous	LL-PAHs	App IX Organochlorine Pesticides	AppIX Metals	Sb, Cd, Cu, Pb, Hg, Sn, Zn	4,4'-DDD, 4,4'-DDE, & 4,4'-DDT	Cu, Pb, Hg, Zn	Ammonia and Sulfide	TOC	Grain Size	pH	REMARKS
2/27/07	0902	1V-SS01	G		S										1	1	1	
↓	0917	1V-SS02	G		S										1	1	1	
↓	0924	1V-SS03	G		S										1	1	1	
↓	0937	1V-SS04	G		S										1	1	1	
↓	0959	1V-SS05	G		S										1	1	1	
↓	1014	1V-SS06	G		S										1	1	1	

TEMP.: 1/0.4/0.4/0.9
0.4/1/0.9/0.4

RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME
			Mark E. Kimes	3/1/07	1500			
RECEIVED BY: (SIGNATURE)	**DATE**	**TIME**	**RECEIVED BY: (SIGNATURE)**	**DATE**	**TIME**	**RECEIVED BY: (SIGNATURE)**	**DATE**	**TIME**
Mark E. Kimes	2/27/07	0615						

LABORATORY USE ONLY

RECEIVED FOR LABORATORY BY: (SIGNATURE)	DATE	TIME	CUSTODY INTACT	CUSTODY SEAL NO.	STL SAVANNAH LOG NO.	LABORATORY REMARKS
KL	3/2/07	0927	YES ◯ NO ◯		680-24740	

Page 143 of 150

Serial Number 94894

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

SEVERN TRENT **STL**

FED EX AIRBILL No.: 8471 8519 9537

STL Savannah
5102 LaRoche Avenue
Savannah, GA 31404

Website: www.stl-inc.com
Phone: (912) 354-7858
Fax: (912) 352-0165

Alternate Laboratory Name/Location
Phone:
Fax:

PROJECT REFERENCE: SWMUs 1 and 2 SV
PROJECT NO.: CTO-108
PROJECT LOCATION (STATE): PR
STL (LAB) PROJECT MANAGER: Kathy Smith
P.O. NUMBER:
CONTRACT NO.:
CLIENT (SITE) PM: Mark Kimes
CLIENT PHONE: 412-337-7465
CLIENT FAX:
CLIENT NAME: Baker
CLIENT E-MAIL: mkimes@mbakercorp.com
CLIENT ADDRESS: 100 Airside Drive, Moon Township, PA 15108
COMPANY CONTRACTING THIS WORK (if applicable): CH2M Hill

PAGE 4 OF 8

STANDARD REPORT DELIVERY: x
DATE DUE: ~~28 day TAT~~
EXPEDITED REPORT DELIVERY (SURCHARGE):
DATE DUE:
NUMBER OF COOLERS SUBMITTED PER SHIPMENT:

MATRIX TYPE: COMPOSITE (C) OR GRAB (G) INDICATE; AQUEOUS (WATER); SOLID OR SEMISOLID; AIR; NONAQUEOUS LIQUID (OIL, SOLVENT,...)

REQUIRED ANALYSIS / PRESERVATIVE / NUMBER OF CONTAINERS SUBMITTED

Date	Time	Sample Identification	C/G	Matrix	LL-PAHs	App IX Organochlorine Pesticides	AppIX Metals	Sb, Cd, Cu, Pb, Hg, Sn, Zn	4,4'-DDD, 4,4'-DDE, & 4,4'-DDT	Cu, Pb, Hg, Zn	Ammonia and Sulfide	TOC	Grain Size	pH	Remarks
2/28/07	0752	REF-SS01	G	S	✓	✓	✓					✓	✓	✓	
	0752	REF-SS01D	G	S	✓	✓	✓								
	0752	REF-SS01MS/MSD	G	S	✓	✓	✓								
	0801	REF-SS02	G	S	✓	✓	✓					✓	✓	✓	
	0815	REF-SS03	G	S				✓	✓			✓	✓	✓	
	0815	REF-SS03D	G	S				✓	✓						
	0823	REF-SS04	G	S				✓	✓			✓	✓	✓	
	0930	REF-SS05	G	S	✓	✓	✓					✓	✓	✓	
	0940	REF-SS06	G	S	✓	✓	✓					✓	✓	✓	
	1002	REF-SS07	G	S				✓	✓			✓	✓	✓	
	1016	REF-SS08	G	S				✓	✓			✓	✓	✓	
↓	1141	REF-SS09	G	S	✓	✓	✓					✓	✓	✓	

RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME
			[signature]	3/1/07	1500			
RECEIVED BY: (SIGNATURE)	**DATE**	**TIME**	**RECEIVED BY: (SIGNATURE)**	**DATE**	**TIME**	**RECEIVED BY: (SIGNATURE)**	**DATE**	**TIME**
[signature]	2/27/07	0615						

LABORATORY USE ONLY

RECEIVED FOR LABORATORY BY: (SIGNATURE)	DATE	TIME	CUSTODY INTACT	CUSTODY SEAL NO.	STL SAVANNAH LOG NO.	LABORATORY REMARKS
KL	3/2/07	0927	YES ○ NO ○		680-24740	

Serial Number 42345

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

SEVERN TRENT **STL**

FEDEX AIRBILL No: 8471 8519 9537

STL Savannah
5102 LaRoche Avenue
Savannah, GA 31404
Website: www.stl-inc.com
Phone: (912) 354-7858
Fax: (912) 352-0165

Alternate Laboratory Name/Location

Phone:
Fax:

PROJECT REFERENCE: SWMUs 1 and 2 SV	PROJECT NO.: CTO-108	PROJECT LOCATION (STATE): PR
STL (LAB) PROJECT MANAGER: Kathy Smith	P.O. NUMBER:	CONTRACT NO.:
CLIENT (SITE) PM: Mark Kimes	CLIENT PHONE: 412-337-7465	CLIENT FAX:
CLIENT NAME: Baker	CLIENT E-MAIL: mkimes@mbakercorp.com	
CLIENT ADDRESS: 100 Airside Drive, Moon Township, PA 15108		
COMPANY CONTRACTING THIS WORK (if applicable): CH2M Hill		

PAGE 5 OF 8

STANDARD REPORT DELIVERY (selected) — DATE DUE 28 day TAT

EXPEDITED REPORT DELIVERY (SURCHARGE) — DATE DUE ______

NUMBER OF COOLERS SUBMITTED PER SHIPMENT:

MATRIX TYPE: COMPOSITE (C) OR GRAB (G) INDICATE; AQUEOUS (WATER); SOLID OR SEMISOLID; AIR; NONAQUEOUS LIQUID (OIL, SOLVENT, ...)

REQUIRED ANALYSIS / NUMBER OF CONTAINERS SUBMITTED

SAMPLE DATE	SAMPLE TIME	SAMPLE IDENTIFICATION	COMPOSITE (C) OR GRAB (G) INDICATE	AQUEOUS (WATER)	SOLID OR SEMISOLID	AIR	NONAQUEOUS LIQUID (OIL, SOLVENT, ...)	LL-PAHs	App IX Organo-chlorine Pesticides	AppIX Metals	Sb, Cd, Cu, Pb, Hg, Sn, Zn	4,4'-DDD, 4,4'-DDE, & 4,4'-DDT	Cu, Pb, Hg, Zn	Ammonia and Sulfide	TOC	Grain Size	pH	REMARKS
2/28/07	1202	REF-SS010	G		S			✓	✓	✓					✓	✓	✓	
↓	1217	REF-SS011	G		S						✓	✓			✓	✓	✓	
	1233	REF-SS012	G		S						✓	✓			✓	✓	✓	
	0845	REF-SB01	G		S			✓	✓	✓					✓	✓	✓	
	0845	REF-SB01D	G		S			✓	✓	✓								
	0845	REF-SB01MS/MSD	G		S			✓	✓	✓								
	0855	REF-SB02	G		S			✓	✓	✓					✓	✓	✓	
	0900	REF-SB03	G		S						✓	✓			✓	✓	✓	
	0904	REF-SB04	G		S						✓	✓			✓	✓	✓	
		~~REF-SB05~~ MEK																
	0944	REF-SB06	G		S			✓	✓	✓					✓	✓	✓	
↓	1006	REF-SB07	S		S						✓	✓			✓	✓	✓	

RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME
			[signature]	3/1/07	1500			
RECEIVED BY: (SIGNATURE)	**DATE**	**TIME**	**RECEIVED BY: (SIGNATURE)**	**DATE**	**TIME**	**RECEIVED BY: (SIGNATURE)**	**DATE**	**TIME**
[signature]	2/27/07	0615						

LABORATORY USE ONLY

RECEIVED FOR LABORATORY BY: (SIGNATURE)	DATE	TIME	CUSTODY INTACT	CUSTODY SEAL NO.	STL SAVANNAH LOG NO.	LABORATORY REMARKS
[signature]	3/2/07	0927	YES ◯ NO ◯		680-24740	

Serial Number 42346

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

SEVERN TRENT **STL**

FedEx Airbill No.: 8471 8519 9537

STL Savannah
5102 LaRoche Avenue
Savannah, GA 31404

Website: www.stl-inc.com
Phone: (912) 354-7858
Fax: (912) 352-0165

Alternate Laboratory Name/Location
Phone:
Fax:

PROJECT REFERENCE	PROJECT NO.	PROJECT LOCATION (STATE)
SWMUs 1 and 2 SV	CTO-108	PR
STL (LAB) PROJECT MANAGER: Kathy Smith	P.O. NUMBER	CONTRACT NO.
CLIENT (SITE) PM: Mark Kimes	CLIENT PHONE: 412-337-7465	CLIENT FAX
CLIENT NAME: Baker	CLIENT E-MAIL: mkimes@mbakercorp.com	
CLIENT ADDRESS: 100 Airside Drive, Moon Township, PA 15108		
COMPANY CONTRACTING THIS WORK (if applicable): CH2M Hill		

PAGE 6 OF 8

STANDARD REPORT DELIVERY (selected) — DATE DUE 28 day TAT
EXPEDITED REPORT DELIVERY (SURCHARGE) — DATE DUE
NUMBER OF COOLERS SUBMITTED PER SHIPMENT:

MATRIX TYPE: COMPOSITE (C) OR GRAB (G) INDICATE; AQUEOUS (WATER); SOLID OR SEMISOLID; AIR; NONAQUEOUS LIQUID (OIL, SOLVENT,...)

REQUIRED ANALYSIS / NUMBER OF CONTAINERS SUBMITTED

DATE	TIME	SAMPLE IDENTIFICATION	C/G	AQUEOUS	SOLID	AIR	NONAQ.	LL-PAHs	App IX Organochlorine Pesticides	AppIX Metals	Sb, Cd, Cu, Pb, Hg, Sn, Zn	4,4'-DDD, 4,4'-DDE, & 4,4'-DDT	Cu, Pb, Hg, Zn	Ammonia and Sulfide	TOC	Grain Size	pH	REMARKS
2/28/07	1020	REF-SB08	G		S						✓	✓			✓	✓	✓	
↓	1145	REF-SB09	G		S			✓	✓	✓					✓	✓	✓	
↓	1206	REF-SB010	G		S			✓	✓	✓					✓	✓	✓	
↓	1221	REF-SB011	G		S						✓	✓			✓	✓	✓	
↓	1237	REF-SB012	G		S						✓	✓			✓	✓	✓	

RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME
			Mark E. Kimes	3/1/07	1500			
RECEIVED BY: (SIGNATURE)	DATE	TIME	RECEIVED BY: (SIGNATURE)	DATE	TIME	RECEIVED BY: (SIGNATURE)	DATE	TIME
Mark E. Kimes	2/27/07	0615						

LABORATORY USE ONLY

RECEIVED FOR LABORATORY BY: (SIGNATURE)	DATE	TIME	CUSTODY INTACT	CUSTODY SEAL NO.	STL SAVANNAH LOG NO.	LABORATORY REMARKS
KL	3/2/07	0927	YES ○ NO ○		680-24740	

Serial Number 42347

SEVERN TRENT **STL**

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

FEDEX AIRBILL No. 8471 8519 9537

STL Savannah
5102 LaRoche Avenue
Savannah, GA 31404

Website: www.stl-inc.com
Phone: (912) 354-7858
Fax: (912) 352-0165

SWMU 1&2 SITE VER.

Alternate Laboratory Name/Location
Phone:
Fax:

PROJECT REFERENCE: SWMUs 1 and 2 SV	PROJECT NO.: CTO-108	PROJECT LOCATION (STATE): PR
STL (LAB) PROJECT MANAGER: Kathy Smith	P.O. NUMBER:	CONTRACT NO.:
CLIENT (SITE) PM: Mark Kimes	CLIENT PHONE: 412-337-7465	CLIENT FAX:
CLIENT NAME: Baker	CLIENT E-MAIL: mkimes@mbakercorp.com	
CLIENT ADDRESS: 100 Airside Drive, Moon Township, PA 15108		
COMPANY CONTRACTING THIS WORK (if applicable): CH2M Hill		

PAGE 8 OF 8

STANDARD REPORT DELIVERY: [filled]
DATE DUE: 28 day TAT
EXPEDITED REPORT DELIVERY (SURCHARGE): ○
DATE DUE:
NUMBER OF COOLERS SUBMITTED PER SHIPMENT:

MATRIX TYPE / REQUIRED ANALYSIS — NUMBER OF CONTAINERS SUBMITTED

SAMPLE DATE	SAMPLE TIME	SAMPLE IDENTIFICATION	COMPOSITE (C) OR GRAB (G) INDICATE	AQUEOUS (WATER)	SOLID OR SEMISOLID	AIR	NONAQUEOUS LIQUID (OIL, SOLVENT, ...)	LL-PAHs	App IX Organo-chlorine Pesticides	App IX Metals	Sb, Cd, Cu, Pb, Hg, Sn, Zn	4,4'-DDD, 4,4'-DDE, & 4,4'-DDT	Cu, Pb, Hg, Zn	Ammonia and Sulfide	TOC	Grain Size	pH	REMARKS
2/27/07	1610	1V-ER01	G	✓				2	2	1								
2/28/07	1630	2V-ER01	G	✓				2	2	1								
3/1/07	1605	REF-ER01	G	✓									1					
2/27/07	1620	1V-FB01	G	✓				2	2	1								

RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME
			[signature]	3/1/07	1500			
RECEIVED BY: (SIGNATURE)	DATE	TIME	RECEIVED BY: (SIGNATURE)	DATE	TIME	RECEIVED BY: (SIGNATURE)	DATE	TIME
[signature]	2/27/07	0615						

LABORATORY USE ONLY

RECEIVED FOR LABORATORY BY: (SIGNATURE)	DATE	TIME	CUSTODY INTACT	CUSTODY SEAL NO.	STL SAVANNAH LOG NO.	LABORATORY REMARKS
[signature]	3/2/07	0927	YES ○ NO ○		680-24740	

Serial Number 71192

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

SEVERN TRENT **STL**

FED EX AIRBILL NO.: 8480 3122 5244

STL Savannah
5102 LaRoche Avenue
Savannah, GA 31404

Website: www.stl-inc.com
Phone: (912) 354-7858
Fax: (912) 352-0165

Alternate Laboratory Name/Location — SWMU 45 SITE VERIFICATION
Phone:
Fax:

Field	Value
PROJECT REFERENCE	SWMU 45 Field Verification FI.SV.45
PROJECT NO.	CTO-108
PROJECT LOCATION (STATE)	PR
STL (LAB) PROJECT MANAGER	Kathy Smith
P.O. NUMBER	
CONTRACT NO.	
CLIENT (SITE) PM	Mark Kimes
CLIENT PHONE	412-337-7465
CLIENT FAX	412-375-3995
CLIENT NAME	Baker Environmental, Inc.
CLIENT E-MAIL	mkimes@mbakercorp.com
CLIENT ADDRESS	100 Airside Drive, Moon Township, PA 15108
COMPANY CONTRACTING THIS WORK (if applicable)	CH2M Hill
PAGE	1 OF 3
STANDARD REPORT DELIVERY	●
DATE DUE	28 Day TAT
EXPEDITED REPORT DELIVERY (SURCHARGE)	○
DATE DUE	
NUMBER OF COOLERS SUBMITTED PER SHIPMENT:	

REQUIRED ANALYSIS: Aroclor 1260 (8082); As,Cd,Cu,Pb,Se,Zn(6020), Hg (7471A); TOC (9060); Grain Size (ASTM D422)

PRESERVATIVE: — | — | — |

SAMPLE DATE	SAMPLE TIME	SAMPLE IDENTIFICATION	COMPOSITE (C) OR GRAB (G) INDICATE	AQUEOUS (WATER)	SOLID OR SEMISOLID	AIR	NONAQUEOUS LIQUID (OIL, SOLVENT,...)	Aroclor 1260 (8082)	As,Cd,Cu,Pb,Se, Zn(6020), Hg (7471A)	TOC (9060)	Grain Size (ASTM D422)	REMARKS
9/20/06	0746	45B-SD01V			X			1	1	1	1	
↓	0809	45B-SD02V			X			1	1	1	1	
	0818	45B-SD03V			X			1	1	1	1	
	0827	45B-SD04V			X			1	1	1	1	
	0834	45B-SD05V			X			1	1	1	1	
	0838	45B-SD06V			X			1	1	1	1	
	0909	REF1-SD01V			X			1	1	1	1	
	0921	REF1-SD02V			X			1	1	1	1	
	0929	REF1-SD03V			X			1	1	1	1	
	0936	REF1-SD04V			X			1	1	1	1	TEMP. 1.0 2.0 2.0
	0946	REF1-SD05V			X			1	1	1	1	
↓	0953	REF1-SD06V			X			1	1	1	1	

RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME
			[signature]	9/21/06	1500			
RECEIVED BY: (SIGNATURE)	**DATE**	**TIME**	**RECEIVED BY: (SIGNATURE)**	**DATE**	**TIME**	**RECEIVED BY: (SIGNATURE)**	**DATE**	**TIME**
[signature]	9/19/06	0700						

LABORATORY USE ONLY

RECEIVED FOR LABORATORY BY: (SIGNATURE)	DATE	TIME	CUSTODY INTACT	CUSTODY SEAL NO.	STL SAVANNAH LOG NO.	LABORATORY REMARKS
[signature]	9/22/06	0848	YES ○ NO ○		680-20478	

Page 77 of 79

STL8240-680 (12/02)

Serial Number 71194

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

SEVERN TRENT **STL**

FedEx Airbill No: 8480 3122 5244

STL Savannah
5102 LaRoche Avenue
Savannah, GA 31404
Website: www.stl-inc.com
Phone: (912) 354-7858
Fax: (912) 352-0165

Alternate Laboratory Name/Location: SWMU 45 Site Verification
Phone:
Fax:

PROJECT REFERENCE	SWMU 45 Field Verification FI.SV.45
PROJECT NO.	CTO-108
PROJECT LOCATION (STATE)	PR
STL (LAB) PROJECT MANAGER	Kathy Smith
P.O. NUMBER	
CONTRACT NO.	
CLIENT (SITE) PM	Mark Kimes
CLIENT PHONE	412-337-7465
CLIENT FAX	412-375-3995
CLIENT NAME	Baker Environmental, Inc.
CLIENT E-MAIL	mkimes@mbakercorp.com
CLIENT ADDRESS	100 Airside Drive, Moon Township, PA 15108
COMPANY CONTRACTING THIS WORK (if applicable)	CH2M Hill
PAGE	2 OF 3
STANDARD REPORT DELIVERY	● DATE DUE 28 DAY TAT
EXPEDITED REPORT DELIVERY (SURCHARGE)	○ DATE DUE
NUMBER OF COOLERS SUBMITTED PER SHIPMENT:	

REQUIRED ANALYSIS — PRESERVATIVE: Aroclor 1260 (8082) —; As,Cd,Cu,Pb,Se,Zn (6020), Hg (7471A) —

NUMBER OF CONTAINERS SUBMITTED

SAMPLE DATE	SAMPLE TIME	SAMPLE IDENTIFICATION	COMPOSITE (C) OR GRAB (G) INDICATE	AQUEOUS (WATER)	SOLID OR SEMISOLID	AIR	NONAQUEOUS LIQUID (OIL, SOLVENT,...)	Aroclor 1260 (8082)	As,Cd,Cu,Pb,Se,Zn (6020), Hg (7471A)	TOC (9060)	Grain Size (ASTM D422)	REMARKS
9/20/06	1638	REF2-SD01V			X			1	1	1	1	
↓	1647	REF2-SD02V			X			1	1	1	1	
	1700	REF2-SD03V			X			1	1	1	1	
	1709	REF2-SD04V			X			1	1	1	1	
	1709	REF2-SD04VD			X			1	1			
	1709	REF2-SD04VMS/MSD			X			1	1			
	1727	REF2-SD05V			X			1	1	1	1	
↓	1734	REF2-SD06V			X			1	1	1	1	
9/21/06	0838	REF3-SD01V			X			1	1	1	1	
↓	0852	REF3-SD02V			X			1	1	1	1	
↓	0838	REF3-SD01VD			X			1	1			
		~~REF3-SD04V~~ MEK 9/21/06										

RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME
			[signature]	9/21/06	1500			
RECEIVED BY: (SIGNATURE)	**DATE**	**TIME**	**RECEIVED BY: (SIGNATURE)**	**DATE**	**TIME**	**RECEIVED BY: (SIGNATURE)**	**DATE**	**TIME**
[signature]	9/19/06	0700						

RECEIVED FOR LABORATORY BY (SIGNATURE)	DATE	TIME	CUSTODY INTACT	CUSTODY SEAL NO.	SAVANNAH LOG NO.	LABORATORY REMARKS
[signature]	9/22/06	0848	YES ○ NO ○	[illegible]	[illegible] 478	

Serial Number 76892

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

SEVERN TRENT **STL**® FEDEX AIRBILL NO.: 8480 3122 5244

STL Savannah
5102 LaRoche Avenue
Savannah, GA 31404

Website: www.stl-inc.com
Phone: (912) 354-7858
Fax: (912) 352-0165

Alternate Laboratory Name/Location SWMU 45 SITE VERIFICATION
Phone:
Fax:

Field	Value
PROJECT REFERENCE	SWMU 45 Field Verification
PROJECT NO.	CTO-108 FI.SV.45
PROJECT LOCATION (STATE)	PR
STL (LAB) PROJECT MANAGER	Kathy Smith
P.O. NUMBER	
CONTRACT NO.	
CLIENT (SITE) PM	Mark Kimes
CLIENT PHONE	412-337-7465
CLIENT FAX	412-375-3995
CLIENT NAME	Baker Environmental, Inc.
CLIENT E-MAIL	mkimes@mbakercorp.com
CLIENT ADDRESS	100 Airside Drive, Moon Township, PA 15108
COMPANY CONTRACTING THIS WORK (if applicable)	CH2M Hill
PAGE	3 OF 3
STANDARD REPORT DELIVERY	● DATE DUE 28 DAY TAT
EXPEDITED REPORT DELIVERY (SURCHARGE)	○ DATE DUE
NUMBER OF COOLERS SUBMITTED PER SHIPMENT:	

MATRIX TYPE: COMPOSITE (C) OR GRAB (G) INDICATE; AQUEOUS (WATER); SOLID OR SEMISOLID; AIR; NONAQUEOUS LIQUID (OIL, SOLVENT,...)

REQUIRED ANALYSIS: Aroclor 1260 (8082); As, Cd, Cu, Pb, Se, Zn (6020), Hg (7471A); TOC (9060); Grain Size (ASTM D422)

PRESERVATIVE: — | —

SAMPLE DATE	SAMPLE TIME	SAMPLE IDENTIFICATION	C/G	AQUEOUS (WATER)	SOLID OR SEMISOLID	AIR	NONAQUEOUS LIQUID	Aroclor 1260 (8082)	As, Cd, Cu, Pb, Se, Zn (6020), Hg (7471A)	TOC (9060)	Grain Size (ASTM D422)	REMARKS
		~~REF3-SD05V~~ e										
		~~REF3-SD06V~~ e MEK 9/21/06										
		~~REF3-SD06VD~~ e										
9/20/06	1630	45B-ER01V		X				2	1			
9/20/06	1408	45B-FB01V		X				2	1			

RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME
			[signature]	9/21/06	1500			

RECEIVED BY: (SIGNATURE)	DATE	TIME	RECEIVED BY: (SIGNATURE)	DATE	TIME	RECEIVED BY: (SIGNATURE)	DATE	TIME
[signature]	9/19/06	0700						

LABORATORY USE ONLY

RECEIVED FOR LABORATORY BY: (SIGNATURE)	DATE	TIME	CUSTODY INTACT	CUSTODY SEAL NO.	STL SAVANNAH LOG NO.	LABORATORY REMARKS
[signature] NC	092206	0848	YES ○ NO ○		680-20477	

STL8240-680 (12/02)

C7E010111

Serial Number 42551

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

SEVERN TRENT **STL**

FedEx Airbill No. 8480 3122 4204

STL Savannah
5102 LaRoche Avenue
Savannah, GA 31404

Website: www.stl-inc.com
Phone: (912) 354-7858
Fax: (912) 352-0165

1B-001

Alternate Laboratory Name/Location
STL PITTSBURGH
301 Alpha Drive, RIDC Park, Pgh, PA
Phone: (412) 963-7058
Fax:

PROJECT REFERENCE: SWMU 1 STEP 6	PROJECT NO.: CTO-108	PROJECT LOCATION (STATE): PR
STL (LAB) PROJECT MANAGER: Kathy Smith	P.O. NUMBER:	CONTRACT NO.:
CLIENT (SITE) PM: Mark Kimes	CLIENT PHONE: 412-337-7465	CLIENT FAX:
CLIENT NAME: Baker Environmental, Inc.	CLIENT E-MAIL: mkimes@mbakercorp.com	
CLIENT ADDRESS: 100 Airside Drive, Moon Township, PA 15108		
COMPANY CONTRACTING THIS WORK (if applicable): CH2M Hill		

PAGE 1 OF 2

STANDARD REPORT DELIVERY ○ DATE DUE ______
EXPEDITED REPORT DELIVERY (SURCHARGE) ● DATE DUE ______
NUMBER OF COOLERS SUBMITTED PER SHIPMENT:

REQUIRED ANALYSIS: Total Sb, Cd, Cu, Pb, Hg, Sn, Zn (1); 4,4'-DDD, 4,4'-DDE, 4,4'-DDT (1); Total Ni

SAMPLE DATE	SAMPLE TIME	SAMPLE IDENTIFICATION	COMPOSITE (C) OR GRAB (G) INDICATE	AQUEOUS (WATER)	SOLID OR SEMISOLID	AIR	NONAQUEOUS LIQUID (OIL, SOLVENT,...)	Total Sb, Cd, Cu, Pb, Hg, Sn, Zn	4,4'-DDD, 4,4'-DDE, 4,4'-DDT	Total Ni	REMARKS
4/29/07	0800	1B-REF-SS01	G		X			1	1		
↓	0825	1B-REF-SS02	G		X			1	1		
	0914	1B-REF-SS03	G		X			1	1	X	
	0920	1B-REF-SS04	G		X			1	1	X	
	0920	1B-REF-SS04D	G		X			1	1	X	
	0920	1B-REF-SS04MS/MSD	G		X			1	1	X	
	1016	1B-REF-SS05	G		X			1	1	X	
↓	1026	1B-REF-SS06	G		X			1	1	X	
4/28/07	0730	1B-SS01	G		X			1	1		
↓	0740	1B-SS02	G		X			1	1		
	0750	1B-SS03	G		X			1	1		
↓	0800	1B-SS04	G		X			1	1		

RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE) Mark E. Kimes	DATE 4/30/07	TIME 1500
RECEIVED BY: (SIGNATURE) Mark E. Kimes	DATE 4/28/07	TIME 0630	RECEIVED BY: (SIGNATURE)	DATE	TIME

RELINQUISHED BY: (SIGNATURE) ______ DATE ______ TIME ______
RECEIVED BY: (SIGNATURE) ______ DATE ______ TIME ______

LABORATORY USE ONLY

RECEIVED FOR LABORATORY BY: (SIGNATURE)	DATE	TIME	CUSTODY INTACT	CUSTODY SEAL NO.	STL SAVANNAH LOG NO.	LABORATORY REMARKS
Patricia R. [signature]	5/1/07	1000	YES ○ NO ○			

STL8240-680 (12/02)

7

(1 - 75)

C7E010111

Serial Number 42358

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

SEVERN TRENT **STL**

FedEx Airbill No. 8480 3122 4204

STL Savannah
5102 LaRoche Avenue
Savannah, GA 31404

Website: www.stl-inc.com
Phone: (912) 354-7858
Fax: (912) 352-0165

1B-001

Alternate Laboratory Name/Location (selected): STL Pittsburgh, 301 Alpha Dr., RIDC Park, Pittsburgh, PA 15238
Phone: (412)963-7058
Fax:

Field	Value
PROJECT REFERENCE	SWMU 1 STEP 6
PROJECT NO.	CTO-108
PROJECT LOCATION (STATE)	PR
STL (LAB) PROJECT MANAGER	Kathy Smith
P.O. NUMBER	
CONTRACT NO.	
CLIENT (SITE) PM	Mark Kimes
CLIENT PHONE	412-337-7465
CLIENT FAX	
CLIENT NAME	Baker Environmental, Inc.
CLIENT E-MAIL	mkimes@mbakercorp.com
CLIENT ADDRESS	100 Airside Drive, Moon Township, PA 15108
COMPANY CONTRACTING THIS WORK (if applicable)	CH2M Hill

PAGE 2 OF 2

REQUIRED ANALYSIS: (A) Total Sb, Cd, Cu, Pb, Hg, Sn, Zn — (B) 4,4'-DDD, 4,4'-DDE, 4,4'-DDT

STANDARD REPORT DELIVERY ○ DATE DUE ____
EXPEDITED REPORT DELIVERY (SURCHARGE) ● DATE DUE ____
NUMBER OF COOLERS SUBMITTED PER SHIPMENT:

Sample Date	Time	Sample Identification	Composite (C) or Grab (G)	Aqueous (Water)	Solid or Semisolid	Air	Nonaqueous Liquid (Oil, Solvent,...)	(A) Metals – No. of Containers	(B) Pesticides – No. of Containers	Remarks
4/28/07	0800	1B-SS04D	G		X			1	1	
		~~1B-SS04MS/MSD~~ MEK 4/29/07								
4/28/07	0810	1B-SS05	G		X			1	1	
↓	0830	1B-SS06	G		X			1	1	
	0840	1B-SS07	G		X			1	1	
	0850	1B-SS08	G		X			1	1	
	0900	1B-SS09	G		X			1	1	
	0910	1B-SS10	G		X			1	1	
	1240	1B-SS11	G		X			1	1	
	1242	1B-SS12	G		X			1	1	
		~~1B-SS13~~ MEK 4/29/07								
		~~1B-SS14~~ MEK 4/29/07								

RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME
			[signature]	4/30/07	1500			
RECEIVED BY: (SIGNATURE)	**DATE**	**TIME**	**RECEIVED BY: (SIGNATURE)**	**DATE**	**TIME**	**RECEIVED BY: (SIGNATURE)**	**DATE**	**TIME**
[signature]	4/28/07	0630						

LABORATORY USE ONLY

RECEIVED FOR LABORATORY BY: (SIGNATURE)	DATE	TIME	CUSTODY INTACT	CUSTODY SEAL NO.	STL SAVANNAH LOG NO.	LABORATORY REMARKS
[signature]	5/1/07	1000	YES ○ NO ○			

STL8240-680 (12/02)

8

(1 - 75)

Serial Number

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

SEVERN TRENT **STL**

Fedex Airbill No.: 8462 4707 7031

STL Burlington, 30 Community Dr., South Burlington VT 05403

STL Savannah, 5102 LaRoche Avenue, Savannah, GA 31404 — Website: www.stl-inc.com — Phone: (912) 354-7858 — Fax: (912) 352-0165 — 1B-002

Alternate Laboratory Name/Location (filled in): ~~STL Pittsburgh, 301 Alpha Dr., RIDC Park, Pittsburgh, PA 15238~~ MCK — Phone: ~~(412) 963-7058~~ MCK — Fax: (802) 660-1990

PROJECT REFERENCE: SWMU 1 STEP 6	PROJECT NO.: CTO-108	PROJECT LOCATION (STATE): PR
STL (LAB) PROJECT MANAGER: KATHY SMITH	P.O. NUMBER:	CONTRACT NO.:
CLIENT (SITE) PM: MARK KIMES	CLIENT PHONE: 412-337-7465	CLIENT FAX:
CLIENT NAME: BAKER ENVIRONMENTAL, INC.	CLIENT E-MAIL: mkimes@mbakercorp.com	
CLIENT ADDRESS: 100 AIRSIDE DR., MOON TWP., PA 15108		
COMPANY CONTRACTING THIS WORK (if applicable): CH2M HILL		

PAGE 1 OF 3

STANDARD REPORT DELIVERY ○ DATE DUE ____

EXPEDITED REPORT DELIVERY (SURCHARGE) ● DATE DUE 5/3 1000

NUMBER OF COOLERS SUBMITTED PER SHIPMENT:

REQUIRED ANALYSIS: (1) Total Sb, Cd, Cu, Pb, Hg, Sn, Zn — (2) 4,4'-DDD, 4,4'-DDE, 4,4'-DDT

SAMPLE DATE	SAMPLE TIME	SAMPLE IDENTIFICATION	COMPOSITE (C) OR GRAB (G) INDICATE	AQUEOUS (WATER)	SOLID OR SEMISOLID	AIR	NONAQUEOUS LIQUID (OIL, SOLVENT,...)	Total Sb, Cd, Cu, Pb, Hg, Sn, Zn	4,4'-DDD, 4,4'-DDE, 4,4'-DDT	REMARKS
4/28/07	1244	1B-SS13	G		X			1	1	
4/28/07	1246	1B-SS14	G		X			1	1	

(Number of containers submitted)

RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME
			Mark E. Kimes (signature)	4/30/07	1500	(signature) 5/1/07		
RECEIVED BY: (SIGNATURE)	**DATE**	**TIME**	**RECEIVED BY: (SIGNATURE)**	**DATE**	**TIME**	**RECEIVED BY: (SIGNATURE)**	**DATE**	**TIME**
Mark E. Kimes (signature)	4/28/07	0630				(signature)	5/1/07	0915

LABORATORY USE ONLY

RECEIVED FOR LABORATORY BY: (SIGNATURE)	DATE	TIME	CUSTODY INTACT	CUSTODY SEAL NO.	STL SAVANNAH LOG NO.	LABORATORY REMARKS
			YES ○ NO ○			

Serial Number 42359

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

SEVERN TRENT STL

FedEx Airbill No. 8462 4707 7031

STL Savannah
5102 LaRoche Avenue
Savannah, GA 31404
Website: www.stl-inc.com
Phone: (912) 354-7858
Fax: (912) 352-0165

1B-002

● Alternate Laboratory Name/Location
STL Burlington
30 Community Dr.
South Burlington, VT 05403
Phone: (802) 660-1990
Fax:

PROJECT REFERENCE	SWMU 1 STEP 6
PROJECT NO.	CTO-108
PROJECT LOCATION (STATE)	PR
STL (LAB) PROJECT MANAGER	Kathy Smith
P.O. NUMBER	
CONTRACT NO.	
CLIENT (SITE) PM	Mark Kimes
CLIENT PHONE	412-337-7465
CLIENT FAX	
CLIENT NAME	Baker Environmental, Inc.
CLIENT E-MAIL	mkimes@mbakercorp.com
CLIENT ADDRESS	100 Airside Drive, Moon Township, PA 15108
COMPANY CONTRACTING THIS WORK (if applicable)	CH2M Hill
PAGE	2 OF 3
STANDARD REPORT DELIVERY	○ DATE DUE
EXPEDITED REPORT DELIVERY (SURCHARGE)	● DATE DUE 5/3 1000
NUMBER OF COOLERS SUBMITTED PER SHIPMENT:	

REQUIRED ANALYSIS / NUMBER OF CONTAINERS SUBMITTED

SAMPLE DATE	SAMPLE TIME	SAMPLE IDENTIFICATION	COMPOSITE (C) OR GRAB (G) INDICATE	AQUEOUS (WATER)	SOLID OR SEMISOLID	AIR	NONAQUEOUS LIQUID (OIL, SOLVENT,...)	Total Sb, Cd, Cu, Pb, Hg, Sn, Zn	4,4'-DDD, 4,4'-DDE, 4,4'-DDT	REMARKS
4/28/07	1246	1B-SS14D	G		X			1	1	
4/28/07	1246	1B-SS14MS/MSD	G		X			1	1	
↓	1248	1B-SS15	G		X			1	1	
	1035	1B-SS16	G		X			1	1	
	1040	1B-SS17	G		X			1	1	
	1045	1B-SS18	G		X			1	1	
	1025	1B-SS19	G		X			1	1	
	1015	1B-SS20	G		X			1	1	
	0925	1B-SS21	G		X			1	1	
	0945	1B-SS22	G		X			1	1	
	0935	1B-SS23	G		X			1	1	
↓	0955	1B-SS24	G		X			1	1	

RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME
			Mark Kimes	4/30/07	1500			
RECEIVED BY: (SIGNATURE)	**DATE**	**TIME**	**RECEIVED BY: (SIGNATURE)**	**DATE**	**TIME**	**RECEIVED BY: (SIGNATURE)**	**DATE**	**TIME**
Mark Kimes	4/28/07	0630				[signature]	5/1/07	0915

LABORATORY USE ONLY

RECEIVED FOR LABORATORY BY: (SIGNATURE)	DATE	TIME	CUSTODY INTACT	CUSTODY SEAL NO.	STL SAVANNAH LOG NO.	LABORATORY REMARKS
			YES ○ NO ○			

Serial Number 42300

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

SEVERN TRENT STL

FedEx Airbill No. 8462 4707 7031

STL Savannah
5102 LaRoche Avenue
Savannah, GA 31404

Website: www.stl-inc.com
Phone: (912) 354-7858
Fax: (912) 352-0165

1B-002

Alternate Laboratory Name/Location (marked)

Phone:
Fax:

PROJECT REFERENCE: SWMU 1 STEP 6
PROJECT NO.: CTO-108
PROJECT LOCATION (STATE): PR
STL (LAB) PROJECT MANAGER: Kathy Smith
P.O. NUMBER:
CONTRACT NO.:
CLIENT (SITE) PM: Mark Kimes
CLIENT PHONE: 412-337-7465
CLIENT FAX:
CLIENT NAME: Baker Environmental, Inc.
CLIENT E-MAIL: mkimes@mbakercorp.com
CLIENT ADDRESS: 100 Airside Drive, Moon Township, PA 15108
COMPANY CONTRACTING THIS WORK (if applicable): CH2M Hill

PAGE 3 OF 3

STANDARD REPORT DELIVERY ○ DATE DUE ________
EXPEDITED REPORT DELIVERY (SURCHARGE) ● DATE DUE 5/3 1000
NUMBER OF COOLERS SUBMITTED PER SHIPMENT:

REQUIRED ANALYSIS: Total Sb, Cd, Cu, Pb, Hg, Sn, Zn (1); 4,4'-DDD, 4,4'-DDE, 4,4'-DDT (1)

SAMPLE DATE	SAMPLE TIME	SAMPLE IDENTIFICATION	COMPOSITE (C) OR GRAB (G) INDICATE	AQUEOUS (WATER)	SOLID OR SEMISOLID	AIR	NONAQUEOUS LIQUID (OIL, SOLVENT,...)	Total Sb, Cd, Cu, Pb, Hg, Sn, Zn	4,4'-DDD, 4,4'-DDE, 4,4'-DDT	REMARKS
4/28/07	0955	1B-SS24D	G		X			1	1	
		~~1B-SS24MS/MSD~~ e MEK 4/29/07								
4/28/07	1005	1B-SS25	G		X			1	1	
↓	1320	1B-SS26	G		X			1	1	
	1322	1B-SS27	G		X			1	1	
	1324	1B-SS28	G		X			1	1	
	1326	1B-SS29	G		X			1	1	
↓	1328	1B-SS30	G		X			1	1	
		~~1B-SS31~~ MEK 4/29/07								
		~~1B-SS32~~ MEK 4/29/07								
		~~1B-SS33~~ MEK 4/29/07								
		~~1B-SS34~~ MEK 4/29/07								

NUMBER OF CONTAINERS SUBMITTED

RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME
			Mark E. Kimes (signature)	4/30/07	1500	(signature) AL 5/1/07		
RECEIVED BY: (SIGNATURE)	**DATE**	**TIME**	**RECEIVED BY: (SIGNATURE)**	**DATE**	**TIME**	**RECEIVED BY: (SIGNATURE)**	**DATE**	**TIME**
Mark E. Kimes (signature)	4/28/07	0630				(signature)	5/1/07	0915

LABORATORY USE ONLY

RECEIVED FOR LABORATORY BY: (SIGNATURE)	DATE	TIME	CUSTODY INTACT	CUSTODY SEAL NO.	STL SAVANNAH LOG NO.	LABORATORY REMARKS
			YES ○ NO ○			

SEVERN TRENT **STL**

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

FedEx Airbill No.: 8480 3122 4395

STL Savannah
5102 LaRoche Avenue
Savannah, GA 31404

Website: www.stl-inc.com
Phone: (912) 354-7858
Fax: (912) 352-0165

1B-003

Alternate Laboratory Name/Location
Phone:
Fax:

PROJECT REFERENCE: SWMU 1 STEP 6	PROJECT NO.: CTO-108	PROJECT LOCATION (STATE): PR
STL (LAB) PROJECT MANAGER: Kathy Smith	P.O. NUMBER:	CONTRACT NO.:
CLIENT (SITE) PM: Mark Kimes	CLIENT PHONE: 412-337-7465	CLIENT FAX:
CLIENT NAME: Baker Environmental, Inc.	CLIENT E-MAIL: mkimes@mbakercorp.com	
CLIENT ADDRESS: 100 Airside Dr., Moon Twp., PA, 15108		
COMPANY CONTRACTING THIS WORK (if applicable): CH2M Hill		

PAGE 1 OF 3

STANDARD REPORT DELIVERY ○ DATE DUE ______
EXPEDITED REPORT DELIVERY (SURCHARGE) ● DATE DUE 5/3 1000
NUMBER OF COOLERS SUBMITTED PER SHIPMENT:

MATRIX TYPE: COMPOSITE (C) OR GRAB (G) INDICATE; AQUEOUS (WATER); SOLID OR SEMISOLID; AIR; NONAQUEOUS LIQUID (OIL, SOLVENT,...)

REQUIRED ANALYSIS: Total Sb, Cd, Cu, Pb, Hg, Sn, Zn; 4,4'-DDD, 4,4'-DDE, 4,4'-DDT

SAMPLE DATE	SAMPLE TIME	SAMPLE IDENTIFICATION	C/G	AQUEOUS	SOLID OR SEMISOLID	AIR	NONAQUEOUS LIQUID	Total Sb, Cd, Cu, Pb, Hg, Sn, Zn	4,4'-DDD, 4,4'-DDE, 4,4'-DDT	REMARKS
								—	—	
4/28/07	1305	1B-SS31	G		X			1	1	
↓	1307	1B-SS32	G		X			1	1	
	1309	1B-SS33	G		X			1	1	
↓	1311	1B-SS34	G		X			1	1	Includes MS/MSD

(Number of containers submitted)

Page 60 of 62

TEMP: 3.2, 1.6, 2.0

RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME
			Mark E. Kimes	4/30/07	1500			
RECEIVED BY: (SIGNATURE)	**DATE**	**TIME**	**RECEIVED BY: (SIGNATURE)**	**DATE**	**TIME**	**RECEIVED BY: (SIGNATURE)**	**DATE**	**TIME**
Mark E. Kimes	4/28/07	0630						

LABORATORY USE ONLY

RECEIVED FOR LABORATORY BY: (SIGNATURE)	DATE	TIME	CUSTODY INTACT	CUSTODY SEAL NO.	STL SAVANNAH LOG NO.	LABORATORY REMARKS
T. Allen	5-1-07	922	YES ○ NO ○		680-26275	

Serial Number 52900

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

SEVERN TRENT **STL**

FedEx Airbill No. 8480 3122 4395

(●) STL Savannah
5102 LaRoche Avenue
Savannah, GA 31404

Website: www.stl-inc.com
Phone: (912) 354-7858
Fax: (912) 352-0165 13-003

( ) Alternate Laboratory Name/Location
Phone:
Fax:

PROJECT REFERENCE	PROJECT NO.	PROJECT LOCATION (STATE)
SWMU 1 STEP 6	CTO-108	PR

STL (LAB) PROJECT MANAGER	P.O. NUMBER	CONTRACT NO.
Kathy Smith		

CLIENT (SITE) PM	CLIENT PHONE	CLIENT FAX
Mark Kimes	412-337-7465	

CLIENT NAME	CLIENT E-MAIL
Baker Environmental, Inc.	mkimes@mbakercorp.com

CLIENT ADDRESS: 100 Airside Drive, Moon Township, PA 15108

COMPANY CONTRACTING THIS WORK (if applicable): CH2M Hill

PAGE 2 OF 3

STANDARD REPORT DELIVERY ( ) DATE DUE ______

EXPEDITED REPORT DELIVERY (SURCHARGE) (●) DATE DUE 5/3 1000

NUMBER OF COOLERS SUBMITTED PER SHIPMENT:

REQUIRED ANALYSIS: (1) Total Sb, Cd, Cu, Pb, Hg, Sn, Zn; (2) 4,4'-DDD, 4,4'-DDE, 4,4'-DDT

PRESERVATIVE: — | —

SAMPLE DATE	SAMPLE TIME	SAMPLE IDENTIFICATION	COMPOSITE (C) OR GRAB (G) INDICATE	AQUEOUS (WATER)	SOLID OR SEMISOLID	AIR	NONAQUEOUS LIQUID (OIL, SOLVENT,...)	Total Sb, Cd, Cu, Pb, Hg, Sn, Zn	4,4'-DDD, 4,4'-DDE, 4,4'-DDT	REMARKS
4/28/07	1311	1B-SS34D	G		X			1	1	
↓	1313	1B-SS35	G		X			1	1	
	1440	1B-SS36	G		X			1	1	
	1442	1B-SS37	G		X			1	1	
	1444	1B-SS38	G		X			1	1	
	1446	1B-SS39	G		X			1	1	
	1448	1B-SS40	G		X			1	1	
	1540	1B-SS41	G		X			1	1	
	1542	1B-SS42	G		X			1	1	TEMP: 3.2, 1.6, 2.0
	1544	1B-SS43	G		X			1	1	
	1546	1B-SS44	G		X			1	1	
	1546	1B-SS44D	G		X			1	1	

RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME
			Mark E. Kimes	4/30/07	1500			
RECEIVED BY: (SIGNATURE)	**DATE**	**TIME**	**RECEIVED BY: (SIGNATURE)**	**DATE**	**TIME**	**RECEIVED BY: (SIGNATURE)**	**DATE**	**TIME**
Mark E. Kimes	4/28/07	0630						

LABORATORY USE ONLY

RECEIVED FOR LABORATORY BY: (SIGNATURE)	DATE	TIME	CUSTODY INTACT	CUSTODY SEAL NO.	STL SAVANNAH LOG NO.	LABORATORY REMARKS
[signature]	5-1-07	922	YES ( ) NO ( )		680-26275	

Page 61 of 62

STL8240-680 (12/02)

Serial Number 32033

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

SEVERN TRENT **STL**

FedEx Airbill No. 8480 3122 4395

STL Savannah
5102 LaRoche Avenue
Savannah, GA 31404

Website: www.stl-inc.com
Phone: (912) 354-7858
Fax: (912) 352-0165

1B-003

Alternate Laboratory Name/Location
Phone:
Fax:

PROJECT REFERENCE: SWMU 1 STEP 6	PROJECT NO.: CTO-108	PROJECT LOCATION (STATE): PR
STL (LAB) PROJECT MANAGER: Kathy Smith	P.O. NUMBER:	CONTRACT NO.:
CLIENT (SITE) PM: Mark Kimes	CLIENT PHONE: 412-337-7465	CLIENT FAX:
CLIENT NAME: Baker Environmental, Inc.	CLIENT E-MAIL: mkimes@mbakercorp.com	
CLIENT ADDRESS: 100 Airside Drive, Moon Township, PA 15108		
COMPANY CONTRACTING THIS WORK (if applicable): CH2M Hill		

PAGE 3 OF 3

STANDARD REPORT DELIVERY ○ DATE DUE ______
EXPEDITED REPORT DELIVERY (SURCHARGE) ● DATE DUE 5/3 1000
NUMBER OF COOLERS SUBMITTED PER SHIPMENT:

MATRIX TYPE: COMPOSITE (C) OR GRAB (G) INDICATE; AQUEOUS (WATER); SOLID OR SEMISOLID; AIR; NONAQUEOUS LIQUID (OIL, SOLVENT,...)

REQUIRED ANALYSIS: (A) Total Sb, Cd, Cu, Pb, Hg, Sn, Zn; (B) 4,4'-DDD, 4,4'-DDE, 4,4'-DDT

PRESERVATIVE: (A) — ; (B) —

NUMBER OF CONTAINERS SUBMITTED

SAMPLE DATE	SAMPLE TIME	SAMPLE IDENTIFICATION	C/G	AQUEOUS	SOLID	AIR	NONAQUEOUS	Total Sb, Cd, Cu, Pb, Hg, Sn, Zn	4,4'-DDD, 4,4'-DDE, 4,4'-DDT	REMARKS
4/28/07	1548	1B-SS45	G		X			1	1	
↓	1600	1B-SS46	G		X			1	1	
	1602	1B-SS47	G		X			1	1	
	1604	1B-SS48	G		X			1	1	
	1606	1B-SS49	G		X			1	1	
	1608	1B-SS50	G		X			1	1	
	1640	1B-SS51	G		X			1	1	
	1642	1B-SS52	G		X			1	1	
	1644	1B-SS53	G		X			1	1	TEMP: 3.2, 1.6, 2.0
	1646	1B-SS54	G		X			1	1	Includes MS/MSD [initials] 5/1
	1646	1B-SS54D	G		X			1	1	
↓	1648	1B-SS55	G		X			1	1	

RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME
			[signature]	4/30/07	1500			
RECEIVED BY: (SIGNATURE)	**DATE**	**TIME**	**RECEIVED BY: (SIGNATURE)**	**DATE**	**TIME**	**RECEIVED BY: (SIGNATURE)**	**DATE**	**TIME**
[signature]	4/28/07	0630						

LABORATORY USE ONLY

RECEIVED FOR LABORATORY BY: (SIGNATURE)	DATE	TIME	CUSTODY INTACT	CUSTODY SEAL NO.	STL SAVANNAH LOG NO.	LABORATORY REMARKS
[signature]	5-1-07	922	YES ○ NO ○		680-26275	

Page 62 of 62

Serial Number 93022

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

SEVERN TRENT **STL**

FEDEX AIRBILL 8462 4707 7042

STL Savannah
5102 LaRoche Avenue
Savannah, GA 31404

Website: www.stl-inc.com
Phone: (912) 354-7858
Fax: (912) 352-0165

1B-007

Alternate Laboratory Name/Location: STL BURLINGTON, VT
30 Community Drive, Suite 11, South Burlington VT 05403
Phone: 802 660 1990
Fax:

PROJECT REFERENCE: SWMU 1 STEP 6	PROJECT NO.: CTO-108	PROJECT LOCATION (STATE): PR
STL (LAB) PROJECT MANAGER: KATHY SMITH	P.O. NUMBER:	CONTRACT NO.:
CLIENT (SITE) PM: Mark Kimes	CLIENT PHONE: 412 337 7465	CLIENT FAX:
CLIENT NAME: Baker	CLIENT E-MAIL: mkimes@mbakercorp.com	
CLIENT ADDRESS: 100 Airside Drive Moon Twp, PA 15108		
COMPANY CONTRACTING THIS WORK (if applicable): CH2M HILL		

PAGE 1 OF 2

STANDARD REPORT DELIVERY: ● DATE DUE: ____
EXPEDITED REPORT DELIVERY (SURCHARGE): ○ DATE DUE: ____
NUMBER OF COOLERS SUBMITTED PER SHIPMENT:

Matrix type: COMPOSITE (C) OR GRAB (G) INDICATE; AQUEOUS (WATER); SOLID OR SEMISOLID; AIR; NONAQUEOUS LIQUID (OIL, SOLVENT,...)

Required analysis / Number of containers submitted: pH; Grain Size; TOC

SAMPLE DATE	SAMPLE TIME	SAMPLE IDENTIFICATION	C/G	AQUEOUS	SOLID	AIR	NONAQUEOUS	pH	Grain Size	TOC	REMARKS
4/28/07	0900	1B-SS09	C		X			X	X	X	
	1244	1B-SS13	C		X			X	X	X	
	1248	1B-SS15	C		X			X	X	X	
	1045	1B-SS18	C		X			X	X	X	
	1025	1B-SS19	C		X			X	X	X	
	1326	1B-SS29	C		X			X	X	X	
	1309	1B-SS33	C		X			X	X	X	
	1442	1B-SS37	C		X			X	X	X	
	1446	1B-SS39	C		X			X	X	X	
	1600	1B-SS46	C		X			X	X	X	
	1604	1B-SS48	C		X			X	X	X	
↓	1606	1B-SS49	C		X			X	X	X	

RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME
[signature]	5/3/07	1500						
RECEIVED BY: (SIGNATURE)	DATE	TIME	RECEIVED BY: (SIGNATURE)	DATE	TIME	RECEIVED BY: (SIGNATURE)	DATE	TIME

LABORATORY USE ONLY

RECEIVED FOR LABORATORY BY: (SIGNATURE)	DATE	TIME	CUSTODY INTACT	CUSTODY SEAL NO.	STL SAVANNAH LOG NO.	LABORATORY REMARKS
[signature]	05/04/07	0915	YES ○ NO ○ NA			No custody Seals on Cooler

STL8240-680 (12/02)

Serial Number 53623

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

SEVERN TRENT **STL**

FED EX AIRBILL 8462 4707 7042

STL Savannah
5102 LaRoche Avenue
Savannah, GA 31404

Website: www.stl-inc.com
Phone: (912) 354-7858
Fax: (912) 352-0165

1B-007

● Alternate Laboratory Name/Location: STL BURLINGTON, 30 Community Dr. Suite 11 S. Burlington VT 05403
Phone: 802 660 1990
Fax:

PROJECT REFERENCE	SWMU 1 STEP 6
PROJECT NO.	CTO-108
PROJECT LOCATION (STATE)	PR
STL (LAB) PROJECT MANAGER	KATHY SMITH
P.O. NUMBER	
CONTRACT NO.	
CLIENT (SITE) PM	MARK KIMES
CLIENT PHONE	412 337 7465
CLIENT FAX	
CLIENT NAME	BAKER
CLIENT E-MAIL	mkimes@mbakercorp.com
CLIENT ADDRESS	100 Airside Drive, Moon Twp, PA 15108
COMPANY CONTRACTING THIS WORK (if applicable)	CH2M HILL
PAGE	2 OF 2

STANDARD REPORT DELIVERY ● DATE DUE ______

EXPEDITED REPORT DELIVERY (SURCHARGE) ○ DATE DUE ______

NUMBER OF COOLERS SUBMITTED PER SHIPMENT:

REQUIRED ANALYSIS: pH, Grain Size, TOC

SAMPLE DATE	SAMPLE TIME	SAMPLE IDENTIFICATION	COMPOSITE (C) OR GRAB (G) INDICATE	AQUEOUS (WATER)	SOLID OR SEMISOLID	AIR	NONAQUEOUS LIQUID (OIL, SOLVENT,...)	pH	Grain Size	TOC	REMARKS
4/28/07	1608	1B-SS50	C		X			X	X	X	
4/28/07	1640	1B-SS51	C		X			X	X	X	
4/29/07	0914	1B-REF03	C		X			X	X	X	
4/29/07	1016	1B-REF05	C		X			X	X	X	
4/29/07	1026	1B-REF06	C		X			X	X	X	

RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME
Joe Bernar[illegible]	5/3/07	1500						
RECEIVED BY: (SIGNATURE)	DATE	TIME	RECEIVED BY: (SIGNATURE)	DATE	TIME	RECEIVED BY: (SIGNATURE)	DATE	TIME

LABORATORY USE ONLY

RECEIVED FOR LABORATORY BY: (SIGNATURE)	DATE	TIME	CUSTODY INTACT	CUSTODY SEAL NO.	STL SAVANNAH LOG NO.	LABORATORY REMARKS
[signature]	05/04/07	0915	YES ○ NO ○ (NA)			No custody seals on cooler

ESI
EnviroSystems, Inc.
1 Lafayette Road
P.O. Box 778
Hampton, N.H. 03843

Voice: 603-926-3345
FAX: 603-926-3521

ESI Job No:

CHAIN OF CUSTODY DOCUMENTATION

1B-008

Client: Baker Environmental | Contact: Mark Kimes | Project Name: SWMU 1 STEP | Page 1 of 2

Report to: Baker | Address: 100 Airside Drive | Project Number: CTO-108

Invoice to: | Address: ~~Pitt~~ Moon Twp, PA 15108 | Project Manager: | FED EX AIRBILL 8462 4707 7075

Voice: 412 337 7465 | Fax: | email: mkimes@mbakercorp.com | P.O. No: | Quote No:

Protocol: RCRA SDWA NPDES USCOE Other

Lab Number (assigned by lab) CHZM06-00145	Your Field ID: (must agree with container)	Date Sampled	Time Sampled	Sampled By	Grab or composit (G/C)	Container Size (ml.)	Container Type (P/G/T)	Field Preservation	Matrix S=Solid W=Water	Filter N=Not needed F=Done in field L=Lab to do	Analyses Requested\ Special Instructions:
001	1B-SS09	4/28/07	0900		C	1 Gal	P	N	S		28-Day Earthworm Test - Survival, Growth, Reproduction
002	1B-SS13	↓	1244		C	1 Gal	P	N	S		↓
003	1B-SS15		1248		C	1 Gal	P	N	S		
004	1B-SS18		1045		C	1 Gal	P	N	S		
005	1B-SS19		1025		C	1 Gal	P	N	S		
006	1B-SS29		1326		C	1 Gal	P	N	S		
007	1B-SS33		1309		C	1 Gal	P	N	S		
008	1B-SS37		1442		C	1 Gal	P	N	S		
009	1B-SS39		1446		C	1 Gal	P	N	S		
010	1B-SS46		1600		C	1 Gal	P	N	S		
011	1B-SS48		1604		C	1 Gal	P	N	S		
012	1B-SS49		1606		C	1 Gal	P	N	S		

Relinquished By: Joe Bu[illegible] Date: 5/3/07 Time: 1500 | Received By: Date: Time:

Relinquished By: Date: Time: | Received at Lab By: [signature] Date: 5/4/07 Time: 1000

Comments:

Temp = 4°C

No: № 2236 | Sample Delivery Group No: | Page of

ESI

EnviroSystems, Inc.
1 Lafayette Road
P.O. Box 778
Hampton, N.H. 03843

Voice: 603-926-3345
FAX: 603-926-3521

ESI Job No:

CHAIN OF CUSTODY DOCUMENTATION

IB-008

Client: Baker Environmental	Contact: Mark Kimes	Project Name: SWMU 1 STEP 6	Page 2 of 2
Report to: Baker	Address: 100 Airside Drive	Project Number: CTO-108	FED EX AIRBILL 8462 4707 7075
Invoice to:	Address: Moon Twp, PA 15108	Project Manager:	
Voice: 412 337 7465	Fax:	email: mkimes@mbakercorp.com	P.O. No: Quote No:

Protocol: RCRA SDWA NPDES USCOE Other

Lab Number (assigned by lab) CH2M 08-00145	Your Field ID: (must agree with container)	Date Sampled	Time Sampled	Sampled By	Grab or composit (G/C)	Container Size (ml.)	Container Type (P/G/T)	Field Preservation	Matrix S=Solid W=Water	Filter N=Not needed F=Done in field L=Lab to do	Analyses Requested\ Special Instructions:
013	1B - SS50	4/28/07	1608		C	1 Gal	P	N	S		28 Day Earthworm Test Survival, Growth, Reproduction
014	1B - SS51	4/28/07	1640		C	1 Gal	P	N	S		↓
015	1B - REF03	4/29/07	0914		C	1 Gal	P	N	S		↓
016	1B - REF05	4/29/07	1016		C	1 Gal	P	N	S		↓
017	1B - REF06	4/29/07	1026		C	1 Gal	P	N	S		↓

Relinquished By: [signature]	Date: 5/3/07	Time: 1500	Received By:	Date:	Time:
Relinquished By:	Date:	Time:	Received at Lab By: [signature]	Date: 5/4/07	Time: 1000

Comments:

Temp = 4°C

Sample Delivery Group No: Page of

No: № 2235

CHAIN OF CUSTODY RECORD

PLEASE COMPLETE THIS FORM AS THOROUGHLY AS POSSIBLE, USING BLACK INK

Client:	CH2M HILL
Submit Report To:	JOHN MALINOWSKI
Sampler's Signature:	[signature]
P.O. #:	

FORT ENVIRONMENTAL LABORATORIES
515 South Duncan Street
Stillwater, OK 74074
405-624-6771 Fax 405-533-1250
info@fortlabs.com

Lab Use Only
Client/Project # - WO #: CH2M06-00145

PER VIAL

Sample #	Sample Location	Sample Collected Date-Time	# of Cont.	Cont. Type P/G	Type of Preserv.	Analysis Requested	# OF WORMS	TOTAL WEIGHT (g)	Lab ID#	Temp	pH
00145-018	1B-SS09 RED WORMS	6/22/07-1600	1	G	FROZEN	BIOACCUMULATION	80	~~19.5260~~	19.5260		
019	1B-SS13	↓	↓	↓	↓	↓	80	19.3867			
020	1B-SS15						78	18.5952			
021	1B-SS18						61	11.3634			
022	1B-SS19						76	16.8199			
023	1B-SS29						78	16.3772			
024	1B-SS33						77	18.4741			
025	1B-SS37						78	18.6090			
026	1B-SS39						79	15.683			
027	1B-SS46						80	19.8250			
028	1B-SS48						80	21.4108			
029	1B-SS49						80	15.4098			
030	1B-SS50						78	16.6443			
031	1B-SS51					680.28224	80	19.2898			
032	1B-REF03	↓	↓	↓	↓	↓	80	15.6785			

SPECIAL INSTRUCTIONS:
EACH SAMPLE IS A COMPOSITE OF 8 REPLICATES FROM EACH SOIL TREATMENT.
ALL SPECIMENS WERE DEPURATED FOR 24h BEFORE FREEZING.

DATE:
INITIALS:

Sample Relinquished By:	Date-Time	Sample Received By:	Date-Time
Robert Rogers	7/9/07-1700	[signature]	07/10/07 0921

*UNLESS OTHERWISE NOTED, ALL SAMPLES ARE STORED AT 4° C.

CHAIN OF CUSTODY RECORD

PLEASE COMPLETE THIS FORM AS THOROUGHLY AS POSSIBLE, USING BLACK INK

Client:	CH2M HILL
Submit Report To:	JOHN MALINOWSKI
Sampler's Signature:	Warren Hanson
P.O. #:	

FORT ENVIRONMENTAL LABORATORIES

515 South Duncan Street
Stillwater, OK 74074
405-624-6771 Fax 405-533-1250
info@fortlabs.com

Lab Use Only
Client/Project # - WO #
CH2M06-00145

PER VIAL

Sample #	Sample Location	Sample Collected Date-Time	# of Cont.	Cont. Type P/G	Type of Preserv.	Analysis Requested	# OF WORMS	TOTAL WEIGHT (g)	ID#	Temp	pH
00145-033	1B-REF05 REDWORMS	6/22/07-1600	1	G	FROZEN	BIOACCUMULATION	78	16.4283			
034	1B-REF06	↓	↓	↓	↓	↓	78	17.3670			
035	LAB CONTROL ↓	↓	↓	↓	↓	↓	80	19.1991			

680-28224

SPECIAL INSTRUCTIONS:

EACH SAMPLE VIAL IS A COMPOSITE OF 8 REPLICATES FROM EACH SOIL TREATMENT. ALL SPECIMENS WERE DEPURATED FOR 24 h. BEFORE FREEZING.

DATE:
INITIALS:

Sample Relinquished By	Date-Time	Sample Received By	Date-Time
Robert Ritzen	7/9/07-1700	[signature]	07/10/07 0921

*UNLESS OTHERWISE NOTED, ALL SAMPLES ARE STORED AT 4° C.

Serial Number 42554

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

SEVERN TRENT **STL**

STL Savannah
5102 LaRoche Avenue
Savannah, GA 31404

Website: www.stl-inc.com
Phone: (912) 354-7858
Fax: (912) 352-0165

Alternate Laboratory Name/Location
Phone:
Fax:

PROJECT REFERENCE: SWMU 1 STEP 6	PROJECT NO.: CTO-108	PROJECT LOCATION (STATE): PR
STL (LAB) PROJECT MANAGER: Kathy Smith	P.O. NUMBER:	CONTRACT NO.:
CLIENT (SITE) PM: Mark Kimes	CLIENT PHONE: 412-337-7465	CLIENT FAX:
CLIENT NAME: Baker Environmental, Inc.	CLIENT E-MAIL: mkimes@mbakercorp.com	
CLIENT ADDRESS: 100 Airside Drive, Moon Township, PA 15108		
COMPANY CONTRACTING THIS WORK (if applicable): CH2M Hill		

PAGE 1 OF 1

STANDARD REPORT DELIVERY ● DATE DUE 28 DAY
EXPEDITED REPORT DELIVERY (SURCHARGE) ○ DATE DUE ____
NUMBER OF COOLERS SUBMITTED PER SHIPMENT:

MATRIX TYPE: COMPOSITE (C) OR GRAB (G) INDICATE; AQUEOUS (WATER); SOLID OR SEMISOLID; AIR; NONAQUEOUS LIQUID (OIL, SOLVENT,...)

REQUIRED ANALYSIS: Total As, Cd, Cu, Hg, Se, Zn; TOC; Grain Size

PRESERVATIVE

SAMPLE DATE	SAMPLE TIME	SAMPLE IDENTIFICATION	C/G	AQUEOUS	SOLID	AIR	NONAQUEOUS	Total As, Cd, Cu, Hg, Se, Zn	TOC	Grain Size	REMARKS
		~~1B-OWSD01~~									
		~~1B-OWSD02~~									
		~~1B-OWSD02D~~									
		~~1B-OWSD02MS/MSD~~									
		~~1B-OWSD03~~									
4/30/07	1115	1B-SG01-AG	C					X			
4/30/07	1115	1B-SG01-WP	C					X			
4/30/07	1030	1B-SG02-AG	C					X			
4/30/07	10/30	1B-SG02-WP	C					X			TEMP.: 0.2, 0.4
4/30/07	0945	1B-SG03-AG	C					X			
4/30/07	0945	1B-SG03-WP	C					X			

RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME
[signature]	5/1/07	1500						
RECEIVED BY: (SIGNATURE)	DATE	TIME	RECEIVED BY: (SIGNATURE)	DATE	TIME	RECEIVED BY: (SIGNATURE)	DATE	TIME

LABORATORY USE ONLY

RECEIVED FOR LABORATORY BY: (SIGNATURE)	DATE	TIME	CUSTODY INTACT	CUSTODY SEAL NO.	STL SAVANNAH LOG NO.	LABORATORY REMARKS
[signature]	5-2-07	925	YES ○ NO ○		680-26318	

Page 16 of 16

STL8240-680 (12/02)

Serial Number 42533

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

SEVERN TRENT **STL**

FEDEX AIRBILL NO: 8480 3122 4395

STL Savannah
5102 LaRoche Avenue
Savannah, GA 31404

Website: www.stl-inc.com
Phone: (912) 354-7858
Fax: (912) 352-0165

1B-004

Alternate Laboratory Name/Location
Phone:
Fax:

PROJECT REFERENCE	PROJECT NO.	PROJECT LOCATION (STATE)	CONTRACT NO.
SWMU 1 STEP 6	CTO-108	PR	

STL (LAB) PROJECT MANAGER: Kathy Smith
P.O. NUMBER:
CLIENT (SITE) PM: Mark Kimes
CLIENT PHONE: 412-337-7465
CLIENT FAX:
CLIENT NAME: Baker Environmental, Inc.
CLIENT E-MAIL: mkimes@mbakercorp.com
CLIENT ADDRESS: 100 Airside Drive, Moon Township, PA 15108
COMPANY CONTRACTING THIS WORK (if applicable): CH2M Hill

PAGE 1 OF 1

STANDARD REPORT DELIVERY (selected)
DATE DUE 28 Day TAT
EXPEDITED REPORT DELIVERY (SURCHARGE)
DATE DUE
NUMBER OF COOLERS SUBMITTED PER SHIPMENT:

MATRIX TYPE: COMPOSITE (C) OR GRAB (G) INDICATE; AQUEOUS (WATER); SOLID OR SEMISOLID; AIR; NONAQUEOUS LIQUID (OIL, SOLVENT,...)

REQUIRED ANALYSIS / NUMBER OF CONTAINERS SUBMITTED:
- A: Total Sb, Cd, Cu, Pb, Hg, Sn, Zn — HNO_3
- B: 4,4'-DDD, 4,4'-DDE, 4,4'-DDT — —
- C: Total As, Cd, Cu, Hg, Se, Zn, Sb, Pb, Sn — HNO_3
- D: Total As, Cd, Cu, Hg, Se, Zn — —

DATE	TIME	SAMPLE IDENTIFICATION	C/G	AQUEOUS	SOLID	AIR	NONAQ.	A	B	C	D	REMARKS
4/29/07	1340	1B-ER01	G	X				1	2			
		~~1B-ER02~~ e OMEK										
		~~1B-ER03~~ e 4/30/07										
		~~1B-ER04~~ e										
4/29/07	1345	1B-FB01	G	X				~~1~~ OMEK 4/30/07	2	1		
4/30/07	1115	1B-OWSDØ1	G		X						1	
↓	1030	1B-OWSDØ2	G		X						1	
↓	0945	1B-OWSDØ3	G		X						1	
↓	0945	1B-OWSDØ3D	G		X						1	TEMP.: 3.2, 1.6, 2.0
↓	0945	1B-OWSDØ3MS/MSD	G		X						1	

RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME
			Mark Kimes (signature)	4/30/07	1500			

RECEIVED BY: (SIGNATURE)	DATE	TIME	RECEIVED BY: (SIGNATURE)	DATE	TIME	RECEIVED BY: (SIGNATURE)	DATE	TIME
Mark Kimes (signature)	4/28/07	0630						

LABORATORY USE ONLY

RECEIVED FOR LABORATORY BY: (SIGNATURE)	DATE	TIME	CUSTODY INTACT	CUSTODY SEAL NO.	STL SAVANNAH LOG NO.	LABORATORY REMARKS
T. Adler (signature)	5-1-07	922	YES ○ NO ○		680-26275	

Serial Number 54665

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

SEVERN TRENT **STL**

FedEx Airbill No.: 8462 4707 7031

STL Savannah
5102 LaRoche Avenue
Savannah, GA 31404

Website: www.stl-inc.com
Phone: (912) 354-7858
Fax: (912) 352-0165

1B-005

Alternate Laboratory Name/Location (selected)
STL Burlington
30 Community Dr.
South Burlington, VT 05403

Phone: (802) 660-1990
Fax:

PROJECT REFERENCE	SWMU 1 STEP 6
PROJECT NO.	CTO-108
PROJECT LOCATION (STATE)	PR
STL (LAB) PROJECT MANAGER	Kathy Smith
P.O. NUMBER	
CONTRACT NO.	
CLIENT (SITE) PM	Mark Kimes
CLIENT PHONE	412-337-7465
CLIENT FAX	
CLIENT NAME	Baker Environmental, Inc.
CLIENT E-MAIL	
CLIENT ADDRESS	100 Airside Drive, Moon Twp., PA 15108
COMPANY CONTRACTING THIS WORK (if applicable)	CH2M Hill
PAGE	1 OF 1
STANDARD REPORT DELIVERY	(selected) DATE DUE 28 Day TAT
EXPEDITED REPORT DELIVERY (SURCHARGE)	DATE DUE
NUMBER OF COOLERS SUBMITTED PER SHIPMENT:	

REQUIRED ANALYSIS: TOC, Grain Size

SAMPLE DATE	SAMPLE TIME	SAMPLE IDENTIFICATION	COMPOSITE (C) OR GRAB (G) INDICATE	AQUEOUS (WATER)	SOLID OR SEMISOLID	AIR	NONAQUEOUS LIQUID (OIL, SOLVENT,...)	TOC	GRAIN SIZE	REMARKS
								–	–	
4/30/07	1115	1B-OWSD01	G		X			1	1	
↓	1030	1B-OWSD02	G		X			1	1	
↓	0945	1B-OWSD03	G		X			1	1	
↓	~~0945~~ e	MEK 4/30/07	~~G~~		~~X~~					

(NUMBER OF CONTAINERS SUBMITTED)

RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME
			Mark E. Kimes	4/30/07	1500			
RECEIVED BY: (SIGNATURE)	**DATE**	**TIME**	**RECEIVED BY: (SIGNATURE)**	**DATE**	**TIME**	**RECEIVED BY: (SIGNATURE)**	**DATE**	**TIME**
Mark E. Kimes	4/28/07	0630	[signature]	5-1-07	0915			

LABORATORY USE ONLY

RECEIVED FOR LABORATORY BY: (SIGNATURE)	DATE	TIME	CUSTODY INTACT	CUSTODY SEAL NO.	STL SAVANNAH LOG NO.	LABORATORY REMARKS
			YES ○ NO ○			

STL8240-680 (12/02)

Serial Number 45204

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

SEVERN TRENT **STL**

FedEx Int'l Airbill No.: 8471-8519-9504

STL Savannah
5102 LaRoche Avenue
Savannah, GA 31404

Website: www.stl-inc.com
Phone: (912) 354-7858
Fax: (912) 352-0165 45BER4-02

Alternate Laboratory Name/Location
Phone:
Fax:

PROJECT REFERENCE: SWMU 45 Step 6	PROJECT NO.: CTO-108	PROJECT LOCATION (STATE): PR
STL (LAB) PROJECT MANAGER: Kathy Smith	P.O. NUMBER:	CONTRACT NO.:
CLIENT (SITE) PM: Mark Kimes	CLIENT PHONE: 412-337-7465	CLIENT FAX:
CLIENT NAME: Baker Environmental, Inc.	CLIENT E-MAIL: mkimes@mbakercorp.com	
CLIENT ADDRESS: 100 Airside Drive, Moon Township, PA 15108		
COMPANY CONTRACTING THIS WORK (if applicable): CH2M Hill		

PAGE 3 OF 3

STANDARD REPORT DELIVERY: ● DATE DUE: 28day TAT
EXPEDITED REPORT DELIVERY (SURCHARGE): ○ DATE DUE:
NUMBER OF COOLERS SUBMITTED PER SHIPMENT:

MATRIX TYPE: COMPOSITE (C) OR GRAB (G) INDICATE; AQUEOUS (WATER); SOLID OR SEMISOLID; AIR; NONAQUEOUS LIQUID (OIL, SOLVENT,...)

REQUIRED ANALYSIS / NUMBER OF CONTAINERS SUBMITTED

DATE	TIME	SAMPLE IDENTIFICATION (SWMU 45)	C/G	AQUEOUS	SOLID	AIR	NONAQUEOUS	Aroclor 1260 (24 hr TAT)	As, Cd, Cu, Hg, Sb	As, Cd, Hg, Se	TOC	Grain Size	pH	Ammonia	As, Cd, Cu, Hg, Se, Sb		REMARKS
1/30/07	0830	45B-VEG-AB01								1							
	0830	45B-VEG-WB01								1							
	0920	45B-VEG-AB02								1							
	0920	45B-VEG-WB02								1							
↓	1000	45B-VEG-AB03								1							
1/30/07	1000	45B-VEG-WB03								1							
		~~Reference Area 2~~															
		~~REF2-VEG-AB01~~															
		~~REF2-VEG-WB01~~ MK 1/31/07															
		~~REF2-VEG-AB02~~															
		~~REF2-VEG-WB02~~															
		~~REF2-VEG-AB03~~															

RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME
			[signature]	1/31/07	1500			
RECEIVED BY: (SIGNATURE)	**DATE**	**TIME**	**RECEIVED BY: (SIGNATURE)**	**DATE**	**TIME**	**RECEIVED BY: (SIGNATURE)**	**DATE**	**TIME**
[signature]	1/28/07	0630						

LABORATORY USE ONLY

RECEIVED FOR LABORATORY BY: (SIGNATURE)	DATE	TIME	CUSTODY INTACT	CUSTODY SEAL NO.	STL SAVANNAH LOG NO.	LABORATORY REMARKS
[signature]	020107	0920	YES ○ NO ○		680-23902	

STL8240-680 (12/02)

Serial Number 11456

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

SEVERN TRENT **STL**

FEDEX INT'L AIRBILL NO: 8471 8519 9504

STL Savannah
5102 LaRoche Avenue
Savannah, GA 31404

Website: www.stl-inc.com
Phone: (912) 354-7858
Fax: (912) 352-0165 45BERA-02

Alternate Laboratory Name/Location
Phone:
Fax:

PROJECT REFERENCE	SWMU 45 Step 6
PROJECT NO.	CTO-108
PROJECT LOCATION (STATE)	PR
STL (LAB) PROJECT MANAGER	Kathy Smith
P.O. NUMBER	
CONTRACT NO.	
CLIENT (SITE) PM	Mark Kimes
CLIENT PHONE	412-337-7465
CLIENT FAX	
CLIENT NAME	Baker Environmental, Inc.
CLIENT E-MAIL	mkimes@mbakercorp.com
CLIENT ADDRESS	100 Airside Drive, Moon Township, PA 15108
COMPANY CONTRACTING THIS WORK (if applicable)	CH2M Hill
PAGE	1 OF 3
STANDARD REPORT DELIVERY	● DATE DUE 28day TAT
EXPEDITED REPORT DELIVERY (SURCHARGE)	DATE DUE
NUMBER OF COOLERS SUBMITTED PER SHIPMENT:	

MATRIX TYPE: COMPOSITE (C) OR GRAB (G) INDICATE / AQUEOUS (WATER) / SOLID OR SEMISOLID / AIR / NONAQUEOUS LIQUID (OIL, SOLVENT,...)

REQUIRED ANALYSIS (NUMBER OF CONTAINERS SUBMITTED): Aroclor 1260 (24 hr TAT) / As, Cd, Cu, Hg, Sb / As, Cd, Hg, Se / TOC / Grain Size / pH / Ammonia / As, Cd, Cu, Hg, Se, Sb

PRESERVATIVE

DATE	TIME	SAMPLE IDENTIFICATION SWMU 45	C/G	AQUEOUS	SOLID	AIR	NONAQ.	Aroclor 1260 (24 hr TAT)	As, Cd, Cu, Hg, Sb	As, Cd, Hg, Se	TOC	Grain Size	pH	Ammonia	As, Cd, Cu, Hg, Se, Sb		REMARKS
1/30/07	0900	45B-VEG-SED01	G		X					X	X	1					
1/30/07	0900	45B-VEG-SED01D	G		X					X	X						
1/30/07	0900	45B-VEG-SED01MS/MSD	G		X					X	X						
1/30/07	1100	45B-VEG-SED02	G		X					X	X	1					
1/30/07	1000	45B-VEG-SED03	G		X					X	X	1					
		Reference Area 2															
1/31/07	0830	REF2-VEG-SED01	G		X					X	X	1					
1/31/07	0920	REF2-VEG-SED02	G		X					X	X	1					
1/31/07	1000	REF2-VEG-SED03	G		X					X	X	1					

RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME
			Mark E. Kimes	1/31/07	1500			
RECEIVED BY: (SIGNATURE)	**DATE**	**TIME**	**RECEIVED BY: (SIGNATURE)**	**DATE**	**TIME**	**RECEIVED BY: (SIGNATURE)**	**DATE**	**TIME**
Mark E. Kimes	1/28/07	0630						

LABORATORY USE ONLY

RECEIVED FOR LABORATORY BY: (SIGNATURE)	DATE	TIME	CUSTODY INTACT	CUSTODY SEAL NO.	STL SAVANNAH LOG NO.	LABORATORY REMARKS
[signature]	020107	0920	YES ○ NO ○		680-23902	

Page 75 of 77

Serial Number [illegible]

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

SEVERN TRENT **STL**

FedEx Int'l Airbill No.: 8471 8519 9504

STL Savannah
5102 LaRoche Avenue
Savannah, GA 31404

Website: www.stl-inc.com
Phone: (912) 354-7858
Fax: (912) 352-0165 45BERA-02

◯ Alternate Laboratory Name/Location
Phone:
Fax:

PROJECT REFERENCE	PROJECT NO.	PROJECT LOCATION (STATE)	PAGE
SWMU 45 Step 6	CTO-108	PR	2 OF 3

Field	Value
STL (LAB) PROJECT MANAGER	Kathy Smith
P.O. NUMBER	
CONTRACT NO.	
CLIENT (SITE) PM	Mark Kimes
CLIENT PHONE	412-337-7465
CLIENT FAX	
CLIENT NAME	Baker Environmental, Inc.
CLIENT E-MAIL	mkimes@mbakercorp.com
CLIENT ADDRESS	100 Airside Drive, Moon Township, PA 15108
COMPANY CONTRACTING THIS WORK (if applicable)	CH2M Hill

STANDARD REPORT DELIVERY ● DATE DUE 28day TAT

EXPEDITED REPORT DELIVERY (SURCHARGE) ◯ DATE DUE ______

NUMBER OF COOLERS SUBMITTED PER SHIPMENT:

MATRIX TYPE / REQUIRED ANALYSIS / NUMBER OF CONTAINERS SUBMITTED

SAMPLE DATE	SAMPLE TIME	SAMPLE IDENTIFICATION	COMPOSITE (C) OR GRAB (G) INDICATE	AQUEOUS (WATER)	SOLID OR SEMISOLID	AIR	NONAQUEOUS LIQUID (OIL, SOLVENT,...)	Aroclor 1260 ~~(24 hr TAT)~~	As, Cd, Cu, Hg, Sb	As, Cd, Hg, Se	TOC	Grain Size	pH	Ammonia	As, Cd, Cu, Hg, Se, Sb			REMARKS
~~1/31/07~~		Equipment Rinsates																
1/31/07	1110	45B-ER01						1							1			
		~~45B-ER02~~ → QMEK																
		~~45B-ER03~~ →																
		Field Blanks																
1/31/07	1115	45B-FB01						2							1			

RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME
			[signature]	1/31/07	1500			

RECEIVED BY: (SIGNATURE)	DATE	TIME	RECEIVED BY: (SIGNATURE)	DATE	TIME	RECEIVED BY: (SIGNATURE)	DATE	TIME
[signature]	1/28/07	0630						

LABORATORY USE ONLY

RECEIVED FOR LABORATORY BY (SIGNATURE)	DATE	TIME	CUSTODY INTACT	CUSTODY SEAL NO.	STL SAVANNAH LOG NO.	LABORATORY REMARKS
[signature]	020107	0920	YES ◯ NO ◯		680-23902	

Page 76 of 77

APPENDIX E
EISENIA FETIDA TOXICITY TEST REPORT

July 12, 2007

John Malinowski
Airside Business Park
100 Airside Drive
Moon Township, PA 15108

Re: 28-d soil toxicity testing with *Eisenia fetida* conducted under Navy Clean III Contract Task Orders (CTO) 0108.

Dear John,

The following report documents the results of the 28-d soil toxicity screen with an earthworm test species. Sample handling documents and raw data are attached to this report.

INTRODUCTION

Fort Environmental Laboratories, Inc. (FEL) was contracted by CH2M Hill to perform a whole soil toxicity test with earthworm species *Eisenia fetida* under Navy Clean III CTO 0108. Baker Environmental, Inc. (Baker), also contracted by CH2M Hill, was responsible for sample collection and shipment to FEL, and review of this report. The major endpoints for the soil toxicity study were mortality, growth, and production. Bioaccumulation of soil contaminants in earthworm tissue collected by FEL at toxicity test conclusion will be performed and presented by TestAmerica Laboratories, Savannah, GA in a separate report. The methods used and the results and conclusions derived from the whole soil toxicity test is presented in this report. The chains-of-custody and supporting raw data (mortality, growth, reproduction, statistical data, and soil chemistry) are attached.

MATERIALS AND METHODS

APPARATUS

- Temperature controlled (22°C, ± 3°C) chemical free room,
- Test vessels (500-1000 mL glass jars with ventilated lids), and
- Dissecting scope (10X or 15X power).

TEST SUBSTANCES

Seventeen soil samples (14 test sites and 3 reference sites) were collected at Solid Waste Management Unit (SWMU) 1 (Army Cremator Disposal Site), at Naval Activity Puerto Rico, Ceiba, Puerto Rico.

Sample Handling and Tracking

Test site samples were collected on April 28, 2007 and reference site samples were collected on April 29, 2007. All samples were shipped on May 3, 2007 via commercial carrier and received at FEL on May 4, 2007. Upon arrival, samples were inventoried using the attached chains of custody. The chains-of-custody were then signed and dated and the samples were assigned appropriate tracking numbers and recorded in the sample check-in logbook. Tracking numbers were also recorded on the individual sample bottles. Samples were stored at 4°C throughout the testing and holding periods.

LABORATORY CONTROL AND HYDRATION WATER

Laboratory prepared soil consisting of an organic top soil and peat moss mixture was used as the laboratory control in the soil toxicity test. Laboratory-prepared water, referred to as dechlorinated ($DeCl_2$) water, was used when needed to hydrate the soil samples. $DeCl_2$ water was prepared by passing tap water through 3 filters; a 10” pre-treatment filter (5 µm) to remove solids, a 3.6 cf activated virgin carbon treatment filter to remove chlorine, ammonia, and higher molecular weight organics, and a 5 µm post-filter to remove any carbon particles from the carbon treatment phase.

TEST SYSTEM

Eisenia fetida (Manure or Red Worm)

E. fetida, commonly known as red or manure worm, is readily available in nature and is easily cultured in the laboratory. The red worm has a short life-cycle and its sensitivity makes it a good indicator of toxicity in several types test media including soil, sediment, and sludge. Sexually mature, fully clitellate adults were used at test initiation. *E. fetida* were purchased from Aquatic Research Organisms (Hampton, NH) and shipped next day delivery to FEL. Upon arrival at FEL, worms were sorted and chosen for testing. Worms were not fed during the 28-d assay. The worms were handled as little as possible to reduce stress to the organisms. Any worms injured or dropped while handling were discarded.

STUDY DESIGN

The soil toxicity test with *Eisenia fetida* was performed in accordance with ASTM Standard E-1676-04 (*Standard Guide for Conducting Laboratory Soil Toxicity or Bioaccumulation Tests with the Lumbricid Earthworm Eisenia fetida and the Enchytraeid Potworm Enchytraeus albidus*). Each treatment (site and reference soil samples) plus laboratory control consisted of 8 replicate 1 L glass jars containing 350 g of soil and 10 red worms. Jar lids were perforated for ventilation. Each soil sample was homogenized prior to test setup. The assay was conducted in a temperature controlled room (22°C ± 3°) for 28 days under continuous light intensity ranging from 400-1,000 lux.

Room temperature and light intensity were monitored and recorded daily. The pH, % moisture, and total organic carbon (TOC) of each soil sample was measured prior to test setup and at test takedown. The % moistures of 10 of the soil samples were below acceptable limits (25%) and were hydrated using $DeCl_2$ water, after approval from Baker. Test jars were examined at test termination for survival (mortality), growth, and reproduction endpoints. Growth was expressed as the mean wet weight loss per surviving earthworm in each replicate at test termination. Reproduction was expressed as the mean number of juveniles plus cocoons per surviving earthworm in each replicate at test termination. Test specifications are outlined in Table 1. After test takedown, test specimens were depurated for an additional 24 h and reweighed. The surviving worm specimens from each set of 8 replicates were composited for each soil treatment. Specimens were then frozen and shipped to TestAmerica Labs for tissue residue analysis.

DATA ANALYSIS

The percent mortality was calculated for each treatment. Percent growth was determined by dividing the mean weight data from the appropriate treatment by the corresponding data collected from the laboratory control and the reference samples. Percent reproduction was determined by dividing the mean reproduction data from each treatment by the corresponding data collected from the laboratory control and the reference samples. Statistical calculations, including hypothesis testing (Kruskal-Wallis [KW] ANOVA on ranks with Dunn's Method [$P < 0.05$] for nonparametric data sets were performed using SigmaStat® 2.03 statistical software (SPSS® Inc., Chicago, IL). All statistical evaluations included comparison of site soil data for each endpoint to each individual reference sample and laboratory control.

TEST RESULTS AND DISCUSSION

CONTROL

Results from the laboratory control are provided in Table 2. Mean survival (0.0%) met the acceptability criteria established in ASTM E1676-04.

REFERENCE SEDIMENTS

Comparison of the laboratory control results to the reference sediments is provided in Table 2. Mean mortality in the reference site samples were 0.0% for 1B-REF03 and 2.5% for both 1B-REF05 and 1B-REF06. Mean weight loss ranged from 122.0% (1B-REF03) to 148.6% (1B-REF06) and reproduction (offspring/organism) ranged from 9.1% (1B-REF06) to 15.8% (1B-REF05), reported as a percentage of the laboratory control. Mortality, growth, and reproduction in the reference samples were not found to be significantly different from the laboratory control (KW-ANOVA, Dunn's Method, $P<0.05$) with the exception of 1B-REF06, which induced weight loss which was significantly greater than the control. No statistical differences in the frequency of mortality, growth, or reproduction were detected between the reference sites (KW-ANOVA, Dunn's Method, P<0.05) (Table 3).

TEST SITES

Comparison of the laboratory control results to the test site soils is provided in Table 2. Comparison of test site and reference soils results to each respective reference sediment result, with statistical comparisons, is provided in Table 3. The frequency of mortality in test site sample 1B-SS18 was significantly greater than the laboratory control (KW-ANOVA, Dunn's Method, P<0.05). Weight loss was greater in test site samples 1B-SS09, -18, -29, -39, and -49 than the laboratory control (KW-ANOVA, Dunn's Method, P<0.05). Reproduction (offspring/organism) was less than the laboratory control in all test site samples with the exception of 1B-SS33 and -37 (KW-ANOVA, Dunn's Method, P<0.05).

In comparison with reference site 1B-REF03, only the frequency of mortality in test site 1B-SS18 was found to be significantly greater (KW-ANOVA, Dunn's Method, P<0.05). Weight loss was found to be significantly greater, however, in test sites 1B-SS09, -18, -29, and -39 (KW-ANOVA, Dunn's Method, P<0.05). Reproduction in the test site treatments was not found to be significantly different from reference site 1B-REF03 (KW-ANOVA, Dunn's Method, P<0.05).

In comparison with reference site 1B-REF05, none of the tests site samples induced significantly greater frequency of mortality or significantly less reproduction (KW-ANOVA, Dunn's Method, P<0.05, for both). Only weight loss (growth) in worms exposed to test site 1B-SS51 was less than reference site 1B-REF05 (KW-ANOVA, Dunn's Method, P<0.05).

In comparison with reference site 1B-REF06, only the frequency of mortality in test site 1B-SS18 was found to be significantly greater (KW-ANOVA, Dunn's Method, P<0.05). Weight loss (growth) in worms exposed to test site 1B-SS51 was less than reference site 1B-REF06 (KW-ANOVA, Dunn's Method, P<0.05). Reproduction in test site sample 1B-SS37 was significantly greater than reference site 1B-REF06 (KW-ANOVA, Dunn's Method, P<0.05).

Results of soil pH, % moisture, and total organic carbon (TOC) analyses are attached.

CONCLUSIONS

Overall, results from the 28-d static toxicity tests with *E. fetida* indicated that only test site 1B-SS18 induced significant effects on survival when compared to either the laboratory control or 2 of the reference soils (1B-REF03 and -06). Several samples, including 1B-SS09, -18, -29, and -39, and induced significant weight loss (growth) compared to either the laboratory control or the reference sites (KW-ANOVA, Dunn's Method, P<0.05). The majority of the samples (excluding 1B-SS33 and -37) reduced reproduction compared to the laboratory control, however little effect was noted when compared to the three reference sites. Of the test site samples, 1B-SS18 induced the greatest response. More subtle effects of growth were noted in test site samples 1B-SS09, -29, and -39.

If you have any questions concerning this report, please do not hesitate to contact us at 405-624-6771, or by e-mail at djfort@fortlabs.com or rrogers@fortlabs.com.

Sincerely,

Douglas J. Fort, Ph.D.
President

Attachments

Table 1
Soil Toxicity Test Specifications with *Eisenia fetida*

Test type	Fixed exposure system
Test species	*Eisenia fetida* (red worm)
Test initiation	Within 14 days from sample receipt
Species age (test setup)	Sexually mature adult with clitella
Feeding regime	Do not feed
Test duration	28 days
Test treatments	17 soils (including 3 reference sites)
Laboratory control	Laboratory reference soil
Replicates	8 per soil treatment
Number of test animals	10 per replicate (80 per treatment)
Soil volume	350 g per test jar
Test vessel	1 L glass jar with perforated lid
Light quality	Ambient laboratory
Light intensity	400 to 1000 lux
Photoperiod	Continuous light
Room temperature	$22 \pm 3^{o}C$
% moisture, pH, TOC	Days 0 and 28
Room temperature and light intensity	Daily
Survival counts	Day 28
Organism weights	Days 0 and 28
Hatchling counts (including cocoon contents)	Day 28
Test validation	≤ 20% mortality in control animals

Table 2
Comparison of Site and Reference Soil Results and Hypothesis Testing to Laboratory Control Results of Whole Soil Toxicity Tests with *Eisenia fetida*

		Endpoints Compared to Lab Control		Significantly Different from Lab Control		
Sediment ID	Mean Mortality[1] (%)	Weight Loss[2] (%)	Reproduction[3] (%)	Mortality[4]	Weight Loss[4]	Reproduction[4]
Lab Soil Control	0.00	-	-	-	-	-
1B-REF03	0.00	122.02	15.13	No	No	No
1B-REF05	2.50	144.95	15.81	No	No	No
1B-REF06	2.50	148.62	9.08	No	Yes (>)	No
1B-SS09	0.00	163.30	0.00	No	Yes (>)	Yes (<)
1B-SS13	0.00	112.84	0.00	No	No	Yes (<)
1B-SS15	2.50	126.61	3.03	No	No	Yes (<)
1B-SS18	23.75	218.35	0.00	Yes (>)	Yes (>)	Yes (<)
1B-SS19	5.00	144.04	0.00	No	No	Yes (<)
1B-SS29	2.50	167.89	0.00	No	Yes (>)	Yes (<)
1B-SS33	3.75	136.70	16.13	No	No	No
1B-SS37	2.50	132.11	158.35	No	No	No
1B-SS39	2.50	195.41	0.00	No	Yes (>)	Yes (<)
1B-SS46	0.00	144.04	0.00	No	No	Yes (<)
1B-SS48	0.00	115.60	0.00	No	No	Yes (<)
1B-SS49	0.00	155.96	0.00	No	Yes (>)	Yes (<)
1B-SS50	2.50	133.03	0.00	No	No	Yes (<)
1B-SS51	0.00	99.08	0.00	No	No	Yes (<)

[1] Mean mortality was calculated by averaging the percent mortality of the replicates from each soil treatment.
[2] Weight loss was calculated by dividing the mean weight loss (g) of each soil sample by the mean weight loss of the lab control, expressed as a percent.
[3] Reproduction was calculated by dividing the mean worm reproduction count (juveniles + cocoons) of each soil sample by the mean worm reproduction count of the lab control, expressed as a percent.
[4] Hypothesis testing for mortality, weight loss, and reproduction was performed using Kruskal-Wallis ANOVA on ranks with Dunn's Method ($P < 0.05$) for nonparametric data. (<) denotes statistical differences that are significantly less than the reference sediment. (>) denotes statistical differences that are significantly greater than the reference sediment.

FEL

Table 3
Comparison of Site and Reference Soil Results and Hypothesis Testing to Reference Soil Results of Whole Sediment Toxicity Tests with *Eisenia fetida*

		Growth Compared to References[2]						Results Significantly Different From References[3]								
		1B-REF03		1B-REF05		1B-REF06		1B-REF03			1B-REF05			1B-REF06		
Sediment ID	Mean Mortality[1] (%)	Wt Loss (%)	Repro (%)	Wt Loss (%)	Repro (%)	Wt Loss (%)	Repro (%)	Mortality	Wt Loss	Repro	Mortality	Wt Loss	Repro	Mortality	Wt Loss	Repro
1B-REF03	0.00	-	-	84.18	95.71	82.10	166.67	-	-	-	No	No	No	No	No	No
1B-REF05	2.50	118.80	104.48	-	-	97.53	174.13	No	No	No	-	-	-	No	No	No
1B-REF06	2.50	121.80	60.00	102.53	57.43	-	-	No	No	No	No	No	No	-	-	-
1B-SS09	0.00	133.83	0.00	112.66	0.00	109.88	0.00	No	Yes (>)	No	No	No	No	No	No	No
1B-SS13	0.00	92.48	0.00	77.85	0.00	75.93	0.00	No	No	No	No	No	No	No	No	No
1B-SS15	2.50	103.76	20.00	87.34	19.14	85.19	33.33	No	No	No	No	No	No	No	No	No
1B-SS18	23.75	178.95	0.00	150.63	0.00	146.91	0.00	Yes (>)	Yes (>)	No	No	No	No	Yes (>)	No	No
1B-SS19	5.00	118.05	0.00	99.37	0.00	96.91	0.00	No	No	No	No	No	No	No	No	No
1B-SS29	2.50	137.59	0.00	115.82	0.00	112.96	0.00	No	Yes (>)	No	No	No	No	No	No	No
1B-SS33	3.75	112.03	106.56	94.30	101.99	91.98	177.60	No	No	No	No	No	No	No	No	No
1B-SS37	2.50	108.27	1046.40	91.14	1001.53	88.89	1744.00	No	No	No	No	No	No	No	No	Yes (>)
1B-SS39	2.50	160.15	0.00	134.81	0.00	131.48	0.00	No	Yes (>)	No	No	No	No	No	No	No
1B-SS46	0.00	118.05	0.00	99.37	0.00	96.91	0.00	No	No	No	No	No	No	No	No	No
1B-SS48	0.00	94.74	0.00	79.75	0.00	77.78	0.00	No	No	No	No	No	No	No	No	No
1B-SS49	0.00	127.82	0.00	107.59	0.00	104.94	0.00	No	No	No	No	No	No	No	No	No
1B-SS50	2.50	109.02	0.00	91.77	0.00	89.51	0.00	No	No	No	No	No	No	No	No	No
1B-SS51	0.00	81.20	0.00	68.35	0.00	66.67	0.00	No	No	No	No	Yes (<)	No	No	Yes (<)	No

[1] Mean mortality was calculated by averaging the percent mortality of the replicates from each soil treatment.
[2] Weight loss was calculated by dividing the mean weight loss (g) of each soil sample by the mean weight loss of each reference soil, expressed as a percent. Reproduction was calculated by dividing the mean worm reproduction count (juveniles + cocoons) of each soil sample by the mean worm reproduction count of each reference soil, expressed as a percent.
[3] Hypothesis testing for mortality, weight loss, and reproduction was performed using Kruskal-Wallis ANOVA on ranks with Dunn's Method ($P < 0.05$) for nonparametric data. (<) denotes statistical differences that are significantly less than the reference sediment. (>) denotes statistical differences that are significantly greater than the reference sediment.

ATTACHMENTS:

Eisenia fetida Toxicity Test

Chains of Custody

Raw Data

Statistics

Soil Chemistry

ESI EnviroSystems, Inc.
1 Lafayette Road
P.O. Box 778
Hampton, N.H. 03843

Voice: 603-926-3345
FAX: 603-926-3521

ESI Job No:

CHAIN OF CUSTODY DOCUMENTATION

1B-008

Client: Baker Environmental	Contact: Mark Kimes	Project Name: SWMU 1 STEP 6	Page 1 of 2
Report to: Baker	Address: 100 Airside Drive	Project Number: CTO-108	
Invoice to:	Address: ~~PA~~ Moon Twp, PA 15108	Project Manager:	FED EX AIRBILL 8462 4707 7075
Voice: 412 337 7465	Fax:	email: mkimes@mbakercorp.com	P.O. No: Quote No:

Protocol: RCRA SDWA NPDES USCOE Other

Lab Number (assigned by lab) CH2M06-00145	Your Field ID: (must agree with container)	Date Sampled	Time Sampled	Sampled By	Grab or composit (G/C)	Container Size (ml.)	Container Type (P/G/T)	Field Preservation	Matrix S=Solid W=Water	Filter N=Not needed F=Done in field L=Lab to do	Analyses Requested\ Special Instructions:
001	1B-SS09	4/28/07	0900		C	1 Gal	P	N	S		28-Day Earthworm Test Survival, Growth, Reproduction
002	1B-SS13	↓	1244		C	1 Gal	P	N	S		↓
003	1B-SS15		1248		C	1 Gal	P	N	S		
004	1B-SS18		1045		C	1 Gal	P	N	S		
005	1B-SS19		1025		C	1 Gal	P	N	S		
006	1B-SS29		1326		C	1 Gal	P	N	S		
007	1B-SS33		1309		C	1 Gal	P	N	S		
008	1B-SS37		1442		C	1 Gal	P	N	S		
009	1B-SS39		1446		C	1 Gal	P	N	S		
010	1B-SS46		1600		C	1 Gal	P	N	S		
011	1B-SS48		1604		C	1 Gal	P	N	S		
012	1B-SS49		1606		C	1 Gal	P	N	S		

Relinquished By: Joe Bauer	Date: 5/3/07	Time: 1500	Received By:	Date:	Time:
Relinquished By:	Date:	Time:	Received at Lab By: [signature]	Date: 5/4/07	Time: 1000

Comments:

Temp = 4°C

No: Nº 2236

Sample Delivery Group No: Page of

ESI

EnviroSystems, Inc.
1 Lafayette Road
P.O. Box 778
Hampton, N.H. 03843

Voice: 603-926-3345
FAX: 603-926-3521

ESI Job No:

CHAIN OF CUSTODY DOCUMENTATION

1B-008

Client: Baker Environmental	Contact: Mark Kimes	Project Name: SWMU 1 STEP6	Page 2 of 2
Report to: Baker	Address: 100 Airside Drive	Project Number: CTO-108	FED EX AIRBILL 8462 4707 7075
Invoice to:	Address: Moon Twp, PA 15108	Project Manager:	
Voice: 412 337 7465	Fax:	email: mkimes@mbakercorp.com	P.O. No: Quote No:

Protocol: RCRA SDWA NPDES USCOE Other

Lab Number (assigned by lab) CHZM06-00145	Your Field ID: (must agree with container)	Date Sampled	Time Sampled	Sampled By	Grab or composit (G/C)	Container Size (ml.)	Container Type (P/G/T)	Field Preservation	Matrix S=Solid W=Water	Filter N=Not needed F=Done in field L=Lab to do	Analyses Requested\ Special Instructions:
013	1B-SS50	4/28/07	1608		C	1 Gal	P	N	S		28 Day Earthworm Test survival, Growth, Reproduction
014	1B-SS51	4/28/07	1640		C	1 Gal	P	N	S		↓
015	1B-REF03	4/29/07	0914		C	1 Gal	P	N	S		↓
016	1B-REF05	4/29/07	1016		C	1 Gal	P	N	S		↓
017	1B-REF06	4/29/07	1026		C	1 Gal	P	N	S		↓

Relinquished By: [signature]	Date: 5/3/07	Time: 1500	Received By:	Date:	Time:
Relinquished By:	Date:	Time:	Received at Lab By: [signature]	Date: 5/4/07	Time: 1000

Comments:

Temp = 4°C

Sample Delivery Group No: Page of

No: № 2235

CHAIN OF CUSTODY RECORD

PLEASE COMPLETE THIS FORM AS THOROUGHLY AS POSSIBLE, USING BLACK INK

Client:	CH2M HILL
Submit Report To:	JOHN MALINOWSKI
Sampler's Signature:	Warner Larson
P.O. #:	

FORT ENVIRONMENTAL LABORATORIES
515 South Duncan Street
Stillwater, OK 74074
405-624-6771 Fax 405-533-1250
info@fortlabs.com

Lab Use Only
Client/Project # - WO #
CH2M06-00145

PER VIAL

Sample #	Sample Location	Sample Collected Date-Time	# of Cont.	Cont. Type P/G	Type of Preserv.	Analysis Requested	# OF WORMS	TOTAL WEIGHT (g)	Lab Use Only ID#	Temp	pH
00145-018	1B-SS09 RED WORMS	6/22/07-1600	1	G	FROZEN	BIOACCUMULATION	80	~~19.5260~~	RR 19.5260		
019	1B-SS13	↓	↓	↓	↓	↓	80	19.3867			
020	1B-SS15	↓	↓	↓	↓	↓	78	18.5952			
021	1B-SS18	↓	↓	↓	↓	↓	61	11.3634			
022	1B-SS19	↓	↓	↓	↓	↓	76	16.8199			
023	1B-SS29	↓	↓	↓	↓	↓	78	16.3772			
024	1B-SS33	↓	↓	↓	↓	↓	77	18.4741			
025	1B-SS37	↓	↓	↓	↓	↓	78	18.6090			
026	1B-SS39	↓	↓	↓	↓	↓	79	15.683			
027	1B-SS46	↓	↓	↓	↓	↓	80	~~19.8250~~	RR 17.5865		
028	1B-SS48	↓	↓	↓	↓	↓	80	21.4108			
029	1B-SS49	↓	↓	↓	↓	↓	80	15.4098			
030	1B-SS50	↓	↓	↓	↓	↓	78	16.6443			
031	1B-SS51	↓	↓	↓	↓	↓	80	19.2898			
032	1B-REF03	↓	↓	↓	↓	↓	80	15.6785			

SPECIAL INSTRUCTIONS:
EACH SAMPLE IS A COMPOSITE OF 8 REPLICATES FROM EACH SOIL TREATMENT.
ALL SPECIMENS WERE DEPURATED FOR 24h BEFORE FREEZING.

DATE:
INITIALS:

Sample Relinquished By:	Date-Time	Sample Received By:	Date-Time
Robert Rogers	7/9/07-1700		

*UNLESS OTHERWISE NOTED, ALL SAMPLES ARE STORED AT 4° C.

CHAIN OF CUSTODY RECORD

PLEASE COMPLETE THIS FORM AS THOROUGHLY AS POSSIBLE, USING BLACK INK

FORT ENVIRONMENTAL LABORATORIES

515 South Duncan Street

Stillwater, OK 74074

405-624-6771 Fax 405-533-1250

info@fortlabs.com

Client:	CH2MHILL
Submit Report To:	JOHN MALINOWSKI
Sampler's Signature:	Warren Hanson
P.O. #:	

Lab Use Only
Client/Project # - WO #
CH2M06-00145

PER VIAL

Sample #	Sample Location	Sample Collected Date-Time	# of Cont.	Cont. Type P/G	Type of Preserv.	Analysis Requested	# OF WORMS	TOTAL WEIGHT (g)	ID#	Temp	pH
00145-033	1B-REF05 REDWORMS	6/22/07-1600	1	G	FROZEN	BIOACCUMULATION	78	16.4283			
↓ 034	1B-REF06 ↓	↓	↓	↓	↓	↓	78	17.3670			
↓ 035	LAB CONTROL ↓	↓	↓	↓	↓	↓	80	19.1991			

SPECIAL INSTRUCTIONS:

EACH SAMPLE VIAL IS A COMPOSITE OF 8 REPLICATES FROM EACH SOIL TREATMENT. ALL SPECIMENS WERE DEPURATED FOR 24 h. BEFORE FREEZING.

DATE:

INITIALS:

Sample Relinquished By:	Date-Time	Sample Received By:	Date-Time
Robert Riegen	7/9/07-1700		

*UNLESS OTHERWISE NOTED, ALL SAMPLES ARE STORED AT 4° C.

FEL

Client/Project-WO No: CH2M06-00145 (SWMU 1)
Survival/Weight/Reproduction Data
Test Species *Eisenia fetida*

			Mortality				Weight Loss					Bioaccumulation		Reproduction			
FEL Sample No.	Sample ID	Rep	Survival Count/ Replicate (n)	Mortality/ Replicate (%)	Mean Mortality/ Sample (%)	Mortality SEM	Day 0 Wet Worm Wt (g)	Day 28 Wet Worm Wt (g)	Wt Loss/ Worm/ Replicate (g)	Mean Wt Loss/ Worm (g)	Wt Loss SEM	Day 29 Wet Worm Wt (g)	Total Wet Wt/ Sample (g)	Day 28 Repro Count (n)	Repro/ Worm/ Replicate (n)	Mean Repro/ Worm (n)	Repro SEM
-	Lab Ctl	A	10	0.0	0.00	0.00	3.4656	2.5707	0.0895	0.1089	0.008	2.4860	19.1991	4	0.400	0.413	0.044
-	Lab Ctl	B	10	0.0			3.5685	2.6419	0.0927			2.5238		2	0.200		
-	Lab Ctl	C	10	0.0			3.8033	2.5840	0.1219			2.5595		5	0.500		
-	Lab Ctl	D	10	0.0			3.5331	2.0056	0.1528			2.1333		6	0.600		
-	Lab Ctl	E	10	0.0			3.0167	2.0436	0.0973			2.2375		5	0.500		
-	Lab Ctl	F	10	0.0			3.3540	2.3120	0.1042			2.4772		3	0.300		
-	Lab Ctl	G	10	0.0			3.2522	2.0700	0.1182			2.0979		4	0.400		
-	Lab Ctl	H	10	0.0			3.7434	2.7965	0.0947			2.6839		4	0.400		
001	1B-SS09	A	10	0.0	0.00	0.00	4.3094	2.3273	0.1982	0.1779	0.005	2.4062	19.5260	0	0.000	0.000	0.000
001	1B-SS09	B	10	0.0			4.3053	2.6896	0.1616			2.6692		0	0.000		
001	1B-SS09	C	10	0.0			4.1823	2.4091	0.1773			2.5751		0	0.000		
001	1B-SS09	D	10	0.0			3.9591	2.2801	0.1679			2.2897		0	0.000		
001	1B-SS09	E	10	0.0			3.6988	2.0545	0.1644			2.2698		0	0.000		
001	1B-SS09	F	10	0.0			4.2512	2.5309	0.1720			2.6109		0	0.000		
001	1B-SS09	G	10	0.0			4.0285	2.1807	0.1848			2.3613		0	0.000		
001	1B-SS09	H	10	0.0			4.1270	2.1580	0.1969			2.3438		0	0.000		

FEL

Client/Project-WO No: CH2M06-00145 (SWMU 1)
Survival/Weight/Reproduction Data
Test Species *Eisenia fetida*

			Mortality				Weight Loss					Bioaccumulation		Reproduction			
FEL Sample No.	Sample ID	Rep	Survival Count/ Replicate (n)	Mortality/ Replicate (%)	Mean Mortality/ Sample (%)	Mortality SEM	Day 0 Wet Worm Wt (g)	Day 28 Wet Worm Wt (g)	Wt Loss/ Worm/ Replicate (g)	Mean Wt Loss/ Worm (g)	Wt Loss SEM	Day 29 Wet Worm Wt (g)	Total Wet Wt/ Sample (g)	Day 28 Repro Count (n)	Repro/ Worm/ Replicate (n)	Mean Repro/ Worm (n)	Repro SEM
002	1B-SS13	A	10	0.0	0.00	0.00	3.3056	2.0823	0.1223	0.1226	0.004	2.1687	19.3867	0	0.000	0.000	0.000
002	1B-SS13	B	10	0.0			3.8320	2.4499	0.1382			2.5152		0	0.000		
002	1B-SS13	C	10	0.0			3.7356	2.5824	0.1153			2.5206		0	0.000		
002	1B-SS13	D	10	0.0			3.9308	2.7066	0.1224			2.7390		0	0.000		
002	1B-SS13	E	10	0.0			3.4410	2.1125	0.1329			2.0402		0	0.000		
002	1B-SS13	F	10	0.0			3.8520	2.6069	0.1245			2.5859		0	0.000		
002	1B-SS13	G	10	0.0			3.6332	2.6302	0.1003			2.6563		0	0.000		
002	1B-SS13	H	10	0.0			3.4776	2.2324	0.1245			2.1608		0	0.000		
003	1B-SS15	A	10	0.0	2.50	1.64	4.1424	2.6060	0.1536	0.1380	0.006	2.5701	18.5952	0	0.000	0.013	0.013
003	1B-SS15	B	9	10.0			3.4691	2.0673	0.1402			2.0671		0	0.000		
003	1B-SS15	C	10	0.0			3.5455	2.2411	0.1304			2.2606		1	0.100		
003	1B-SS15	D	9	10.0			3.0885	1.8659	0.1223			1.8555		0	0.000		
003	1B-SS15	E	10	0.0			3.5883	2.2555	0.1333			2.2862		0	0.000		
003	1B-SS15	F	10	0.0			3.7099	2.4921	0.1218			2.3426		0	0.000		
003	1B-SS15	G	10	0.0			3.6733	2.3192	0.1354			2.2805		0	0.000		
003	1B-SS15	H	10	0.0			4.6271	2.9542	0.1673			2.9326		0	0.000		

FEL

Client/Project-WO No: CH2M06-00145 (SWMU 1)
Survival/Weight/Reproduction Data
Test Species *Eisenia fetida*

FEL Sample No.	Sample ID	Rep	Mortality: Survival Count/ Replicate (n)	Mortality/ Replicate (%)	Mean Mortality/ Sample (%)	Mortality SEM	Weight Loss: Day 0 Wet Worm Wt (g)	Day 28 Wet Worm Wt (g)	Wt Loss/ Worm/ Replicate (g)	Mean Wt Loss/ Worm (g)	Wt Loss SEM	Bioaccumulation: Day 29 Wet Worm Wt (g)	Total Wet Wt/ Sample (g)	Reproduction: Day 28 Repro Count (n)	Repro/ Worm/ Replicate (n)	Mean Repro/ Worm (n)	Repro SEM
004	1B-SS18	A	7	30.0	23.75	4.20	3.3736	1.1350	0.2239	0.2381	0.014	1.2463	11.3634	0	0.000	0.000	0.000
004	1B-SS18	B	6	40.0			3.6624	1.1092	0.2553			1.1984		0	0.000		
004	1B-SS18	C	7	30.0			3.1078	1.1415	0.1966			1.1713		0	0.000		
004	1B-SS18	D	7	30.0			3.6914	1.1846	0.2507			1.3386		0	0.000		
004	1B-SS18	E	9	10.0			4.1045	1.4956	0.2609			1.8063		0	0.000		
004	1B-SS18	F	7	30.0			3.8862	0.8555	0.3031			0.9271		0	0.000		
004	1B-SS18	G	9	10.0			3.4633	1.6369	0.1826			1.8880		0	0.000		
004	1B-SS18	H	9	10.0			3.7680	1.4526	0.2315			1.7874		0	0.000		
005	1B-SS19	A	10	0.0	5.00	2.67	3.1050	2.3200	0.0785	0.1566	0.018	2.1472	16.8199	0	0.000	0.000	0.000
005	1B-SS19	B	9	10.0			3.2322	1.9724	0.1260			1.8995		0	0.000		
005	1B-SS19	C	10	0.0			3.6637	2.3008	0.1363			2.2407		0	0.000		
005	1B-SS19	D	10	0.0			3.8505	2.3029	0.1548			2.2965		0	0.000		
005	1B-SS19	E	10	0.0			4.1177	2.3566	0.1761			2.3552		0	0.000		
005	1B-SS19	F	10	0.0			3.4930	2.1387	0.1354			2.0368		0	0.000		
005	1B-SS19	G	9	10.0			4.5945	2.0810	0.2514			2.2907		0	0.000		
005	1B-SS19	H	8	20.0			3.5185	1.5772	0.1941			1.5533		0	0.000		

FEL

Client/Project-WO No: CH2M06-00145 (SWMU 1)
Survival/Weight/Reproduction Data
Test Species *Eisenia fetida*

			Mortality				Weight Loss					Bioaccumulation		Reproduction			
FEL Sample No.	Sample ID	Rep	Survival Count/ Replicate (n)	Mortality/ Replicate (%)	Mean Mortality/ Sample (%)	Mortality SEM	Day 0 Wet Worm Wt (g)	Day 28 Wet Worm Wt (g)	Wt Loss/ Worm/ Replicate (g)	Mean Wt Loss/ Worm (g)	Wt Loss SEM	Day 29 Wet Worm Wt (g)	Total Wet Wt/ Sample (g)	Day 28 Repro Count (n)	Repro/ Worm/ Replicate (n)	Mean Repro/ Worm (n)	Repro SEM
006	1B-SS29	A	9	10.0	2.50	1.64	3.5950	1.6818	0.1913	0.1826	0.003	1.8118	16.3772	0	0.000	0.000	0.000
006	1B-SS29	B	10	0.0			3.6988	1.8892	0.1810			2.1062		0	0.000		
006	1B-SS29	C	10	0.0			3.7992	1.9405	0.1859			2.1027		0	0.000		
006	1B-SS29	D	10	0.0			3.2027	1.5695	0.1633			1.7409		0	0.000		
006	1B-SS29	E	9	10.0			3.8684	1.9366	0.1932			2.1691		0	0.000		
006	1B-SS29	F	10	0.0			3.7793	1.9383	0.1841			2.1556		0	0.000		
006	1B-SS29	G	10	0.0			3.6382	1.8437	0.1795			2.1461		0	0.000		
006	1B-SS29	H	10	0.0			3.6078	1.7850	0.1823			2.1448		0	0.000		
007	1B-SS33	A	10	0.0	3.75	1.83	3.1948	1.9804	0.1214	0.1491	0.007	2.2499	18.4741	0	0.000	0.067	0.029
007	1B-SS33	B	10	0.0			3.2785	2.0601	0.1218			2.4240		0	0.000		
007	1B-SS33	C	10	0.0			3.6996	2.0678	0.1632			2.4378		1	0.100		
007	1B-SS33	D	9	10.0			3.2636	1.7794	0.1484			2.0087		2	0.222		
007	1B-SS33	E	9	10.0			3.7427	2.0346	0.1708			2.1888		0	0.000		
007	1B-SS33	F	10	0.0			4.0449	2.3912	0.1654			2.6662		1	0.100		
007	1B-SS33	G	9	10.0			3.6846	2.1297	0.1555			2.1376		1	0.111		
007	1B-SS33	H	10	0.0			3.8892	2.4275	0.1462			2.3611		0	0.000		

Client/Project-WO No: CH2M06-00145 (SWMU 1)
Survival/Weight/Reproduction Data
Test Species *Eisenia fetida*

			Mortality				Weight Loss					Bioaccumulation		Reproduction			
FEL Sample No.	Sample ID	Rep	Survival Count/ Replicate (n)	Mortality/ Replicate (%)	Mean Mortality/ Sample (%)	Mortality SEM	Day 0 Wet Worm Wt (g)	Day 28 Wet Worm Wt (g)	Wt Loss/ Worm/ Replicate (g)	Mean Wt Loss/ Worm (g)	Wt Loss SEM	Day 29 Wet Worm Wt (g)	Total Wet Wt/ Sample (g)	Day 28 Repro Count (n)	Repro/ Worm/ Replicate (n)	Mean Repro/ Worm (n)	Repro SEM
008	1B-SS37	A	10	0.0	2.50	1.64	3.5134	2.2506	0.1263	0.1440	0.007	2.2943	18.6090	5	0.500	0.654	0.098
008	1B-SS37	B	10	0.0			3.7853	2.3821	0.1403			2.2869		7	0.700		
008	1B-SS37	C	9	10.0			3.6801	2.0498	0.1630			2.1195		6	0.667		
008	1B-SS37	D	10	0.0			3.5646	2.1675	0.1397			2.2130		12	1.200		
008	1B-SS37	E	9	10.0			3.4091	1.9401	0.1469			1.9021		6	0.667		
008	1B-SS37	F	10	0.0			3.8036	2.2028	0.1601			2.1053		4	0.400		
008	1B-SS37	G	10	0.0			3.9388	2.8384	0.1100			3.0754		8	0.800		
008	1B-SS37	H	10	0.0			4.2877	2.6329	0.1655			2.6125		3	0.300		
009	1B-SS39	A	10	0.0	2.50	1.64	3.7458	1.7946	0.1951	0.2132	0.008	2.0681	15.6830	0	0.000	0.000	0.000
009	1B-SS39	B	10	0.0			3.9373	1.8516	0.2086			2.1867		0	0.000		
009	1B-SS39	C	9	10.0			4.0172	1.5335	0.2484			1.8579		0	0.000		
009	1B-SS39	D	10	0.0			3.5718	1.5718	0.2000			1.8704		0	0.000		
009	1B-SS39	E	9	10.0			3.8322	1.3639	0.2468			1.4429		0	0.000		
009	1B-SS39	F	10	0.0			3.8740	1.8115	0.2063			2.1603		0	0.000		
009	1B-SS39	G	10	0.0			4.0333	1.8916	0.2142			2.1904		0	0.000		
009	1B-SS39	H	10	0.0			3.5177	1.6522	0.1866			1.9063		0	0.000		

Client/Project-WO No: CH2M06-00145 (SWMU 1)
Survival/Weight/Reproduction Data
Test Species *Eisenia fetida*

			Mortality				Weight Loss					Bioaccumulation		Reproduction			
FEL Sample No.	Sample ID	Rep	Survival Count/ Replicate (n)	Mortality/ Replicate (%)	Mean Mortality/ Sample (%)	Mortality SEM	Day 0 Wet Worm Wt (g)	Day 28 Wet Worm Wt (g)	Wt Loss/ Worm/ Replicate (g)	Mean Wt Loss/ Worm (g)	Wt Loss SEM	Day 29 Wet Worm Wt (g)	Total Wet Wt/ Sample (g)	Day 28 Repro Count (n)	Repro/ Worm/ Replicate (n)	Mean Repro/ Worm (n)	Repro SEM
010	1B-SS46	A	10	0.0	0.00	0.00	3.1936	1.9106	0.1283	0.1571	0.007	2.1166	17.5865	0	0.000	0.000	0.000
010	1B-SS46	B	10	0.0			3.3078	1.7970	0.1511			1.8837		0	0.000		
010	1B-SS46	C	10	0.0			3.4041	1.8939	0.1510			1.9942		0	0.000		
010	1B-SS46	D	10	0.0			3.2775	1.9936	0.1284			2.2155		0	0.000		
010	1B-SS46	E	10	0.0			3.8578	2.2061	0.1652			2.2385		0	0.000		
010	1B-SS46	F	10	0.0			3.9855	2.2463	0.1739			2.5359		0	0.000		
010	1B-SS46	G	10	0.0			3.7656	1.9656	0.1800			2.1040		0	0.000		
010	1B-SS46	H	10	0.0			4.0839	2.2955	0.1788			2.4981		0	0.000		
011	1B-SS48	A	10	0.0	0.00	0.00	3.9600	2.3580	0.1602	0.1257	0.008	2.4492	21.4108	0	0.000	0.000	0.000
011	1B-SS48	B	10	0.0			3.5997	2.6461	0.0954			2.7214		0	0.000		
011	1B-SS48	C	10	0.0			3.9552	2.8259	0.1129			2.9566		0	0.000		
011	1B-SS48	D	10	0.0			3.8781	2.5735	0.1305			2.7273		0	0.000		
011	1B-SS48	E	10	0.0			3.6590	2.4901	0.1169			2.5561		0	0.000		
011	1B-SS48	F	10	0.0			4.0788	2.5158	0.1563			2.7679		0	0.000		
011	1B-SS48	G	10	0.0			3.4243	2.3710	0.1053			2.5103		0	0.000		
011	1B-SS48	H	10	0.0			3.8448	2.5615	0.1283			2.7220		0	0.000		

Client/Project-WO No: CH2M06-00145 (SWMU 1)
Survival/Weight/Reproduction Data
Test Species *Eisenia fetida*

			Mortality				Weight Loss					Bioaccumulation		Reproduction			
FEL Sample No.	Sample ID	Rep	Survival Count/ Replicate (n)	Mortality/ Replicate (%)	Mean Mortality/ Sample (%)	Mortality SEM	Day 0 Wet Worm Wt (g)	Day 28 Wet Worm Wt (g)	Wt Loss/ Worm/ Replicate (g)	Mean Wt Loss/ Worm (g)	Wt Loss SEM	Day 29 Wet Worm Wt (g)	Total Wet Wt/ Sample (g)	Day 28 Repro Count (n)	Repro/ Worm/ Replicate (n)	Mean Repro/ Worm (n)	Repro SEM
012	1B-SS49	A	10	0.0	0.00	0.00	3.2781	1.7530	0.1525	0.1697	0.007	1.7821	15.4098	0	0.000	0.000	0.000
012	1B-SS49	B	10	0.0			4.2434	2.1958	0.2048			2.2036		0	0.000		
012	1B-SS49	C	10	0.0			3.4425	1.7421	0.1700			1.8676		0	0.000		
012	1B-SS49	D	10	0.0			3.9824	2.1254	0.1857			2.1399		0	0.000		
012	1B-SS49	E	10	0.0			3.3950	1.6989	0.1696			1.7899		0	0.000		
012	1B-SS49	F	10	0.0			3.3296	1.7497	0.1580			1.8300		0	0.000		
012	1B-SS49	G	10	0.0			3.0881	1.6972	0.1391			1.8472		0	0.000		
012	1B-SS49	H	10	0.0			3.6348	1.8581	0.1777			1.9495		0	0.000		
013	1B-SS50	A	8	20.0	2.50	2.50	3.5924	1.8228	0.1770	0.1449	0.007	1.7631	16.6443	0	0.000	0.000	0.000
013	1B-SS50	B	10	0.0			3.6308	2.1356	0.1495			2.0345		0	0.000		
013	1B-SS50	C	10	0.0			3.8945	2.5530	0.1342			2.3645		0	0.000		
013	1B-SS50	D	10	0.0			3.6309	2.1396	0.1491			2.0301		0	0.000		
013	1B-SS50	E	10	0.0			3.3441	2.1138	0.1230			2.0220		0	0.000		
013	1B-SS50	F	10	0.0			3.5399	2.2780	0.1262			2.2251		0	0.000		
013	1B-SS50	G	10	0.0			3.6836	2.3338	0.1350			2.2972		0	0.000		
013	1B-SS50	H	10	0.0			3.7360	2.0842	0.1652			1.9078		0	0.000		

FEL

Client/Project-WO No: CH2M06-00145 (SWMU 1)
Survival/Weight/Reproduction Data
Test Species *Eisenia fetida*

			Mortality				Weight Loss					Bioaccumulation		Reproduction			
FEL Sample No.	Sample ID	Rep	Survival Count/ Replicate (n)	Mortality/ Replicate (%)	Mean Mortality/ Sample (%)	Mortality SEM	Day 0 Wet Worm Wt (g)	Day 28 Wet Worm Wt (g)	Wt Loss/ Worm/ Replicate (g)	Mean Wt Loss/ Worm (g)	Wt Loss SEM	Day 29 Wet Worm Wt (g)	Total Wet Wt/ Sample (g)	Day 28 Repro Count (n)	Repro/ Worm/ Replicate (n)	Mean Repro/ Worm (n)	Repro SEM
014	1B-SS51	A	10	0.0	0.00	0.00	3.7588	2.4800	0.1279	0.1084	0.007	2.3711	19.2898	0	0.000	0.000	0.000
014	1B-SS51	B	10	0.0			3.3160	2.2290	0.1087			2.1083		0	0.000		
014	1B-SS51	C	10	0.0			3.0722	2.1700	0.0902			2.0393		0	0.000		
014	1B-SS51	D	10	0.0			4.0026	2.7230	0.1280			2.5229		0	0.000		
014	1B-SS51	E	10	0.0			3.4770	2.7821	0.0695			2.6420		0	0.000		
014	1B-SS51	F	10	0.0			4.0728	2.9364	0.1136			2.7550		0	0.000		
014	1B-SS51	G	10	0.0			4.0151	2.8102	0.1205			2.6270		0	0.000		
014	1B-SS51	H	10	0.0			3.4463	2.3604	0.1086			2.2242		0	0.000		
015	1B-REF03	A	10	0.0	0.00	0.00	3.0996	1.9274	0.1172	0.1325	0.005	1.8524	15.6785	0	0.000	0.063	0.026
015	1B-REF03	B	10	0.0			3.8162	2.2104	0.1606			2.0770		1	0.100		
015	1B-REF03	C	10	0.0			3.5427	2.1308	0.1412			1.9947		0	0.000		
015	1B-REF03	D	10	0.0			3.5104	2.1300	0.1380			1.9949		0	0.000		
015	1B-REF03	E	10	0.0			3.0349	1.8191	0.1216			1.7084		1	0.100		
015	1B-REF03	F	10	0.0			3.3852	2.1524	0.1233			1.9297		2	0.200		
015	1B-REF03	G	10	0.0			3.3676	1.9893	0.1378			2.0680		0	0.000		
015	1B-REF03	H	10	0.0			3.3183	2.1118	0.1207			2.0534		1	0.100		

Client/Project-WO No: CH2M06-00145 (SWMU 1)
Survival/Weight/Reproduction Data
Test Species *Eisenia fetida*

			Mortality				Weight Loss					Bioaccumulation		Reproduction			
FEL Sample No.	Sample ID	Rep	Survival Count/ Replicate (n)	Mortality/ Replicate (%)	Mean Mortality/ Sample (%)	Mortality SEM	Day 0 Wet Worm Wt (g)	Day 28 Wet Worm Wt (g)	Wt Loss/ Worm/ Replicate (g)	Mean Wt Loss/ Worm (g)	Wt Loss SEM	Day 29 Wet Worm Wt (g)	Total Wet Wt/ Sample (g)	Day 28 Repro Count (n)	Repro/ Worm/ Replicate (n)	Mean Repro/ Worm (n)	Repro SEM
016	1B-REF05	A	10	0.0	2.50	1.64	3.7657	2.3064	0.1459	0.1576	0.005	2.2762	16.4283	0	0.000	0.065	0.034
016	1B-REF05	B	10	0.0			3.3070	1.7240	0.1583			1.7210		0	0.000		
016	1B-REF05	C	10	0.0			4.0055	2.3652	0.1640			2.4758		1	0.100		
016	1B-REF05	D	9	10.0			3.4869	1.7016	0.1785			1.7151		0	0.000		
016	1B-REF05	E	10	0.0			3.9409	2.4201	0.1521			2.2994		2	0.200		
016	1B-REF05	F	9	10.0			3.0376	1.6387	0.1399			1.6599		2	0.222		
016	1B-REF05	G	10	0.0			3.6484	2.1687	0.1480			2.0759		0	0.000		
016	1B-REF05	H	10	0.0			3.9504	2.2137	0.1737			2.2050		0	0.000		
017	1B-REF06	A	10	0.0	2.50	2.50	3.5059	2.0029	0.1503	0.1616	0.008	1.7403	17.3670	0	0.000	0.038	0.026
017	1B-REF06	B	10	0.0			3.8083	2.2822	0.1526			2.2129		0	0.000		
017	1B-REF06	C	10	0.0			4.3307	2.5073	0.1823			2.5784		0	0.000		
017	1B-REF06	D	8	20.0			3.9738	1.9677	0.2006			1.9619		0	0.000		
017	1B-REF06	E	10	0.0			3.6349	2.1776	0.1457			2.1322		0	0.000		
017	1B-REF06	F	10	0.0			3.7081	2.3361	0.1372			2.2775		0	0.000		
017	1B-REF06	G	10	0.0			3.9479	2.1881	0.1760			2.2075		2	0.200		
017	1B-REF06	H	10	0.0			3.7641	2.2860	0.1478			2.2563		1	0.100		

Figure 1
CH2M06-00145 (SWMU 1)
28-d Soil Toxicity Test with *Eisenia fetida*

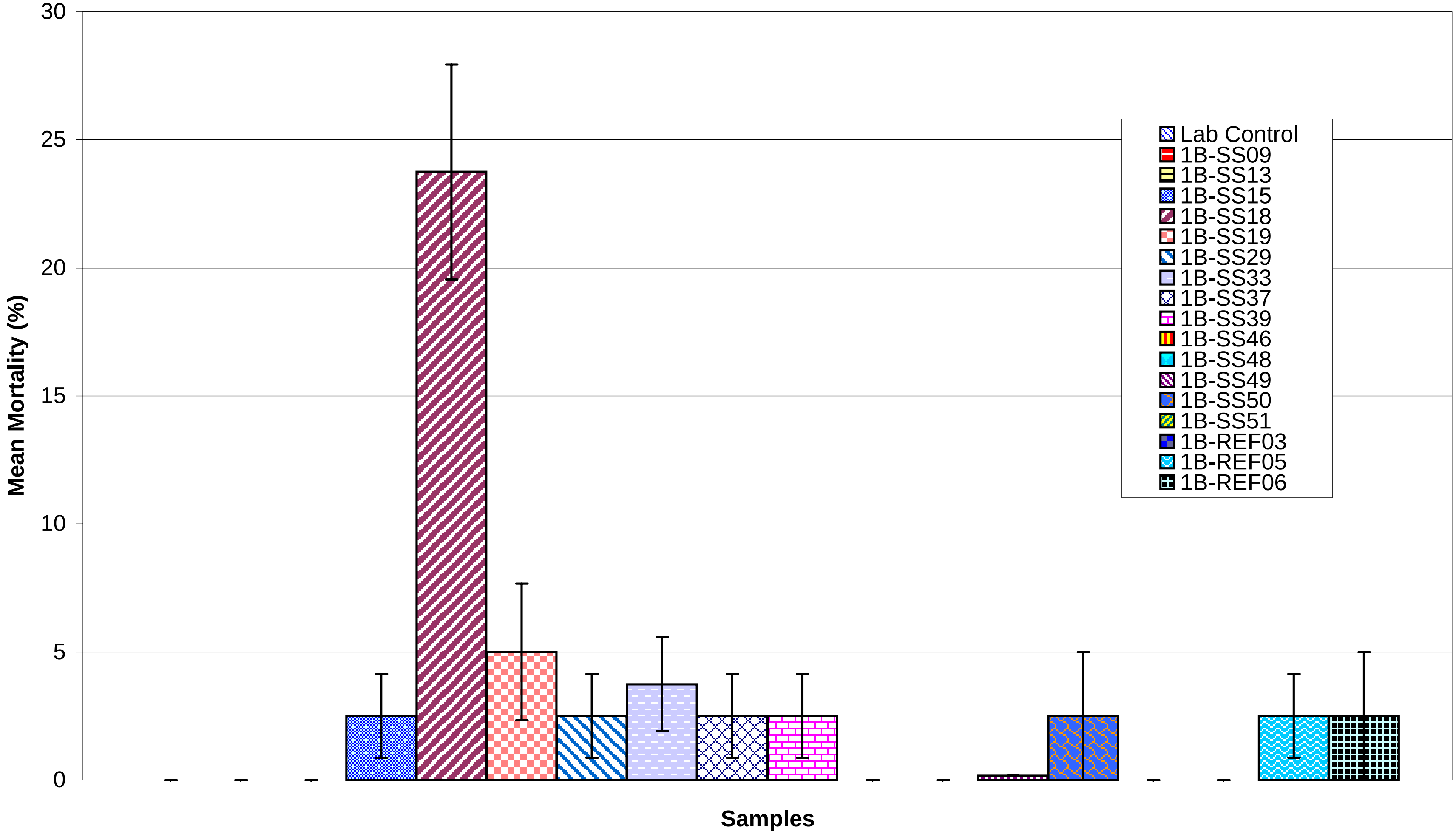


Figure 2
CH2M06-00145 (SWMU 1)
28-d Soil Toxicity Test with *Eisenia fetida*

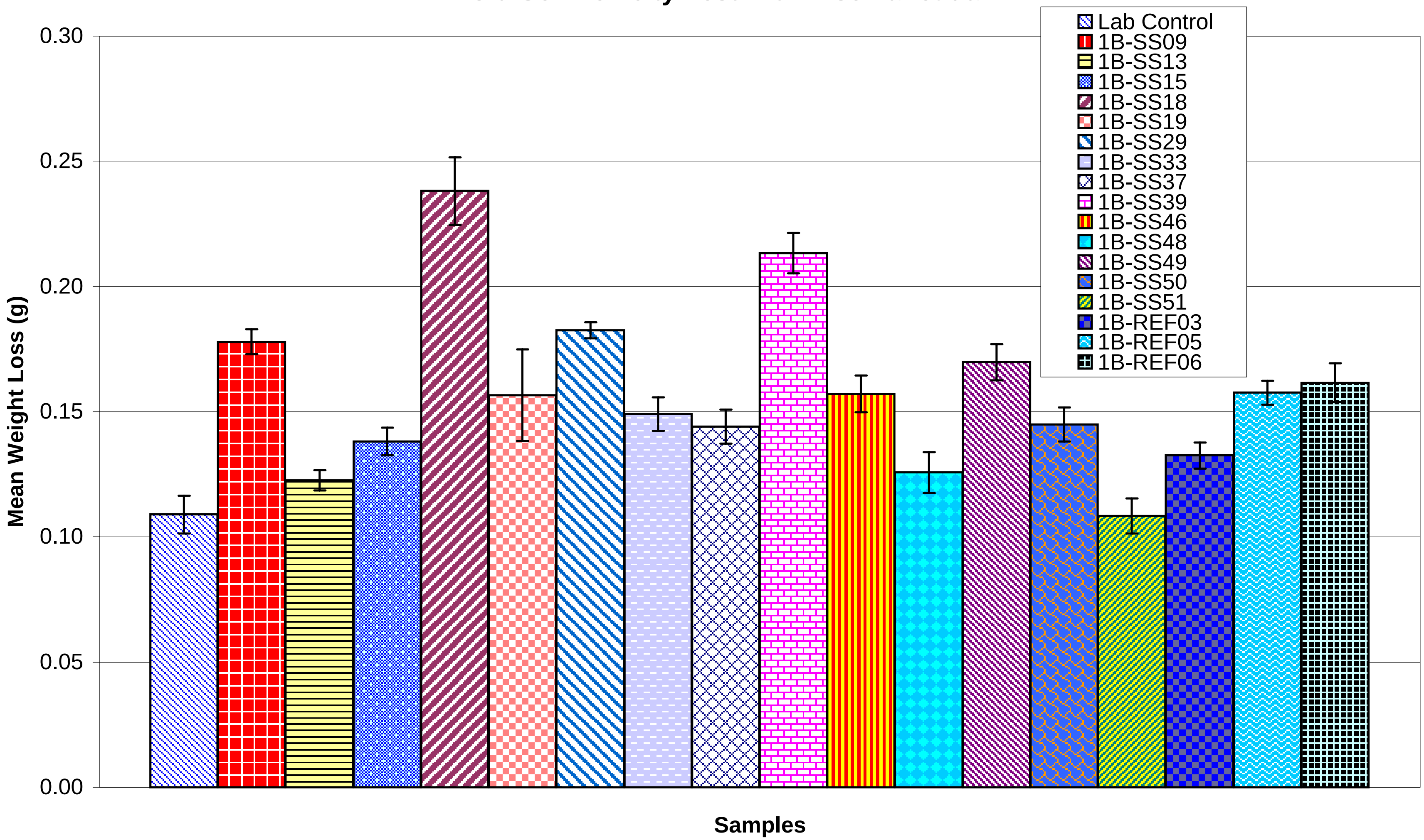
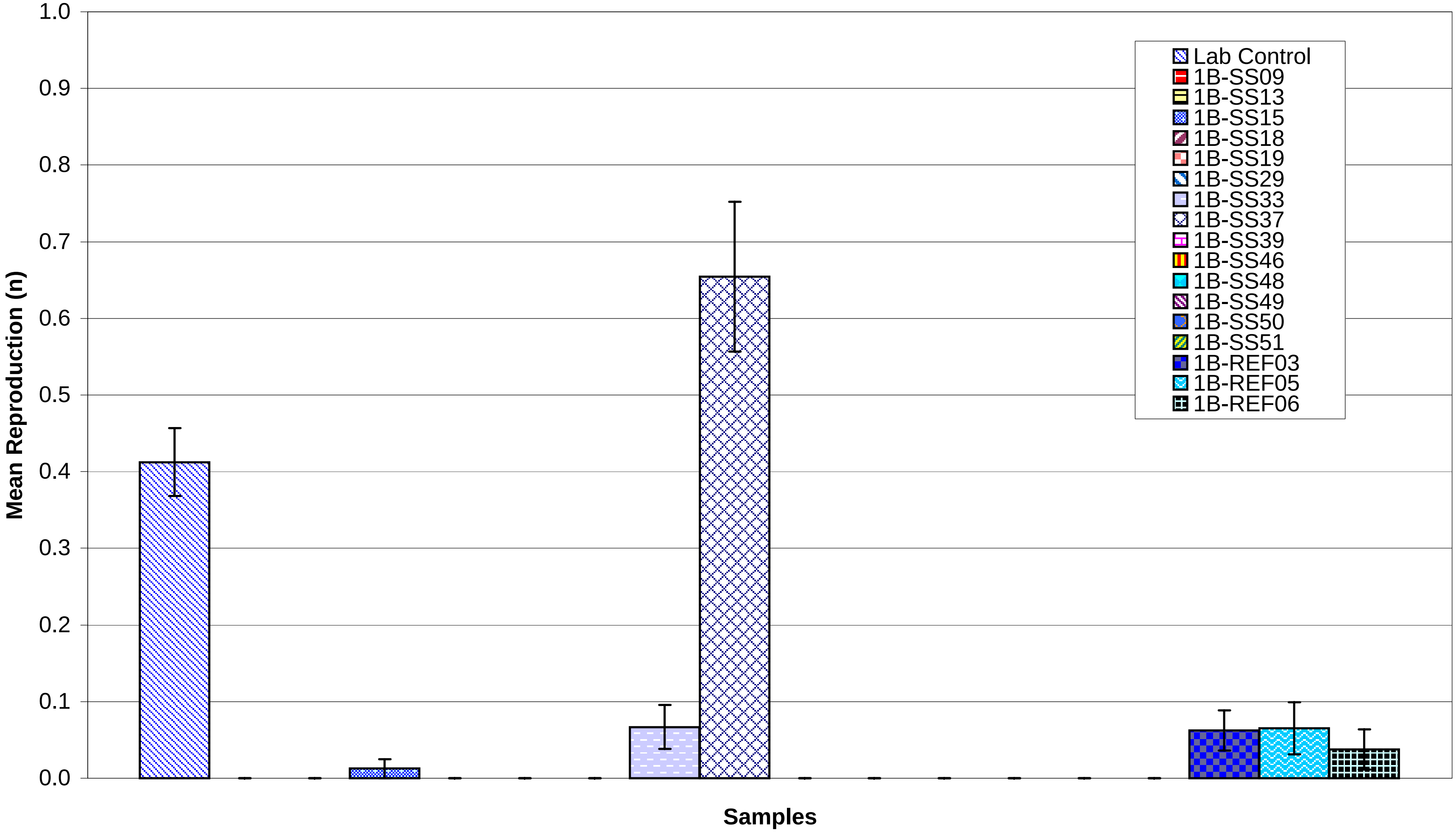


Figure 3
CH2M06-00145 (SWMU 1)
28-d Soil Toxicity Test with *Eisenia fetida*



Descriptive Statistics:

Data source: Mortality (%) in CH2M01-00145 (SWMU 1)_*Eisenia fetida*

Column	Size	Missing	Mean	Std Dev	Std. Error	C.I. of Mean
LabCtl	8	0	0	0	0	0
1B-REF03	8	0	0	0	0	0
1B-REF05	8	0	0.025	0.0463	0.0164	0.0387
1B-REF06	8	0	0.025	0.0707	0.025	0.0591
1B-SS09	8	0	0	0	0	0
1B-SS13	8	0	0	0	0	0
1B-SS15	8	0	0.025	0.0463	0.0164	0.0387
1B-SS18	8	0	0.238	0.119	0.042	0.0993
1B-SS19	8	0	0.05	0.0756	0.0267	0.0632
1B-SS29	8	0	0.025	0.0463	0.0164	0.0387
1B-SS33	8	0	0.0375	0.0518	2%	4%
1B-SS37	8	0	0.025	0.0463	2%	4%
1B-SS39	8	0	0.025	0.0463	0.0164	0.0387
1B-SS46	8	0	0	0	0	0
1B-SS48	8	0	0	0	0	0
1B-SS49	8	0	0	0	0	0
1B-SS50	8	0	0.025	0.0707	0.025	0.0591
1B-SS51	8	0	0	0	0	0

Column	Range	Max	Min	Median	5%	95%
LabCtl	0	0	0	0	0	0
1B-REF03	0	0	0	0	0	0
1B-REF05	0.1	0.1	0	0	0	0.1
1B-REF06	0.2	0.2	0	0	0	0.2
1B-SS09	0	0	0	0	0	0
1B-SS13	0	0	0	0	0	0
1B-SS15	0.1	0.1	0	0	0	0.1
1B-SS18	0.3	0.4	0.1	0.3	0.1	0.4
1B-SS19	0.2	0.2	0	0	0	0.2
1B-SS29	0.1	0.1	0	0	0	0.1
1B-SS33	0.1	0.1	0	0	0	0.1
1B-SS37	0.1	0.1	0	0	0	0.1
1B-SS39	0.1	0.1	0	0	0	0.1
1B-SS46	0	0	0	0	0	0
1B-SS48	0	0	0	0	0	0
1B-SS49	0	0	0	0	0	0
1B-SS50	0.2	0.2	0	0	0	0.2
1B-SS51	0	0	0	0	0	0

Column	Skewness	Kurtosis	K-S Dist.	K-S Prob.	Sum	Sum of Squares
LabCtl	0	-2.8	0	<0.001	0	0
1B-REF03	0	-2.8	0	<0.001	0	0
1B-REF05	1.44	0	0.455	<0.001	0.2	0.02
1B-REF06	2.828	8	0.513	<0.001	0.2	0.04
1B-SS09	0	-2.8	0	<0.001	0	0
1B-SS13	0	-2.8	0	<0.001	0	0
1B-SS15	1.44	0	0.455	<0.001	0.2	0.02
1B-SS18	-0.288	-1.746	0.326	0.013	1.9	0.55
1B-SS19	1.323	0.875	0.371	0.002	0.4	0.06
1B-SS29	1.44	0	0.455	<0.001	0.2	0.02
1B-SS33	0.644	-2.24	0.391	<0.001	0.3	0.03
1B-SS37	1.44	0	0.455	<0.001	0.2	0.02
1B-SS39	1.44	0	0.455	<0.001	0.2	0.02
1B-SS46	0	-2.8	0	<0.001	0	0
1B-SS48	0	-2.8	0	<0.001	0	0
1B-SS49	0	-2.8	0	<0.001	0	0
1B-SS50	2.828	8	0.513	<0.001	0.2	0.04
1B-SS51	0	-2.8	0	<0.001	0	0

One Way Analysis of Variance

Data source: Mortality (%) in CH2M01-00145 (SWMU 1)_*Eisenia fetida*

Normality Test: **Failed** **(P = <0.001)**

Test execution ended by user request, ANOVA on Ranks begun

Kruskal-Wallis One Way Analysis of Variance on Ranks

Group	N	Missing	Median	25%	75%
asinsqrt-LabCtl	8	0	0	0%	0%
asinsqrt-REF03	8	0	0	0	0
asinsqrt-REF05	8	0	0	0	0.161
asinsqrt-REF06	8	0	0	0	0
asinsqrt-SS09	8	0	0	0	0
asinsqrt-SS13	8	0	0	0	0%
asinsqrt-SS15	8	0	0	0	16%
asinsqrt-SS18	8	0	0.58	0.322	0.58
asinsqrt-SS19	8	0	0	0	0.322
asinsqrt-SS29	8	0	0	0	0.161
asinsqrt-SS33	8	0	0	0	0.322
asinsqrt-SS37	8	0	0	0	0.161
asinsqrt-SS39	8	0	0	0	0.161
asinsqrt-SS46	8	0	0	0	0
asinsqrt-SS48	8	0	0	0	0
asinsqrt-SS49	8	0	0	0	0
asinsqrt-SS50	8	0	0	0	0
asinsqrt-SS51	8	0	0	0	0

H = 57.197 with 17 degrees of freedom. (P = <0.001)

The differences in the median values among the treatment groups are greater than would be expected by chance; **there is a statistically significant difference (P = <0.001)**

To isolate the group or groups that differ from the others use a multiple comparison procedure.

Multiple Comparisons versus Control Group (**Dunn's Method**) :

Comparison	Diff of Ranks	Q	P<0.05
asinsqrt-SS18 vs asinsqrt-LabCtl	77.188	3.701	Yes
asinsqrt-SS19 vs asinsqrt-LabCtl	26.688	1.28	No
asinsqrt-SS33 vs asinsqrt-LabCtl	25.313	1.214	Do Not Test
asinsqrt-SS39 vs asinsqrt-LabCtl	16.875	0.809	Do Not Test
asinsqrt-SS37 vs asinsqrt-LabCtl	16.875	0.809	Do Not Test
asinsqrt-SS29 vs asinsqrt-LabCtl	16.875	0.809	Do Not Test
asinsqrt-SS15 vs asinsqrt-LabCtl	16.875	0.809	Do Not Test
asinsqrt-REF05 vs asinsqrt-LabCtl	16.875	0.809	Do Not Test
asinsqrt-SS50 vs asinsqrt-LabCtl	9.813	0.47	Do Not Test
asinsqrt-REF06 vs asinsqrt-LabCtl	9.813	0.47	Do Not Test
asinsqrt-SS13 vs asinsqrt-LabCtl	9.813	0.47	Do Not Test
asinsqrt-SS46 vs asinsqrt-LabCtl	0	0	Do Not Test
asinsqrt-SS49 vs asinsqrt-LabCtl	0	0	Do Not Test
asinsqrt-SS51 vs asinsqrt-LabCtl	0	0	Do Not Test
asinsqrt-SS48 vs asinsqrt-LabCtl	0	0	Do Not Test
asinsqrt-REF03 vs asinsqrt-LabCtl	0	0	Do Not Test
asinsqrt-SS09 vs asinsqrt-LabCtl	0	0	Do Not Test

Note: The multiple comparisons on ranks do not include an adjustment for ties.

One Way Analysis of Variance

Data source: Mortality (%) in CH2M01-00145 (SWMU 1)_Eisenia fetida

Normality Test: **Failed** **(P = <0.001)**

Test execution ended by user request, ANOVA on Ranks begun

Kruskal-Wallis One Way Analysis of Variance on Ranks

Group	N	Missing	Median	25%	75%
asinsqrt-REF03	8	0	0	0	0
asinsqrt-REF05	8	0	0	0	0.161
asinsqrt-REF06	8	0	0	0	0
asinsqrt-SS09	8	0	0	0	0
asinsqrt-SS13	8	0	0	0	0
asinsqrt-SS15	8	0	0	0	0.161
asinsqrt-SS18	8	0	0.58	0.322	0.58
asinsqrt-SS19	8	0	0	0	0.322
asinsqrt-SS29	8	0	0	0	0.161
asinsqrt-SS33	8	0	0	0	0.322
asinsqrt-SS37	8	0	0	0	0.161
asinsqrt-SS39	8	0	0	0	0.161
asinsqrt-SS46	8	0	0	0	0
asinsqrt-SS48	8	0	0	0	0
asinsqrt-SS49	8	0	0	0	0
asinsqrt-SS50	8	0	0	0	0
asinsqrt-SS51	8	0	0	0	0

H = 53.142 with 16 degrees of freedom. (P = <0.001)

The differences in the median values among the treatment groups are greater than would be expected by chance; **there is a statistically significant difference (P = <0.001)**

To isolate the group or groups that differ from the others use a multiple comparison procedure.

Multiple Comparisons versus Control Group (**Dunn's Method**) :

Comparison	Diff of Ranks	Q	P<0.05
asinsqrt-SS18 vs asinsqrt-REF03	73.188	3.715	Yes
asinsqrt-SS19 vs asinsqrt-REF03	25.188	1.278	No
asinsqrt-SS33 vs asinsqrt-REF03	23.813	1.209	Do Not Test
asinsqrt-SS39 vs asinsqrt-REF03	15.875	0.806	Do Not Test
asinsqrt-SS37 vs asinsqrt-REF03	15.875	0.806	Do Not Test
asinsqrt-REF05 vs asinsqrt-REF03	15.875	0.806	Do Not Test
asinsqrt-SS29 vs asinsqrt-REF03	15.875	0.806	Do Not Test
asinsqrt-SS15 vs asinsqrt-REF03	15.875	0.806	Do Not Test
asinsqrt-SS13 vs asinsqrt-REF03	9.313	0.473	Do Not Test
asinsqrt-SS50 vs asinsqrt-REF03	9.313	0.473	Do Not Test
asinsqrt-REF06 vs asinsqrt-REF03	9.313	0.473	Do Not Test
asinsqrt-SS46 vs asinsqrt-REF03	0	0	Do Not Test
asinsqrt-SS49 vs asinsqrt-REF03	0	0	Do Not Test
asinsqrt-SS51 vs asinsqrt-REF03	0	0	Do Not Test
asinsqrt-SS48 vs asinsqrt-REF03	0	0	Do Not Test
asinsqrt-SS09 vs asinsqrt-REF03	0	0	Do Not Test

Note: The multiple comparisons on ranks do not include an adjustment for ties.

One Way Analysis of Variance

Data source: Mortality (%) in CH2M01-00145 (SWMU 1)_*Eisenia fetida*

Normality Test: **Failed** **(P = <0.001)**

Test execution ended by user request, ANOVA on Ranks begun

Kruskal-Wallis One Way Analysis of Variance on Ranks

Group	N	Missing	Median	25%	75%
asinsqrt-REF03	8	0	0	0	0
asinsqrt-REF05	8	0	0	0	0.161
asinsqrt-REF06	8	0	0	0	0
asinsqrt-SS09	8	0	0	0	0
asinsqrt-SS13	8	0	0	0	0
asinsqrt-SS15	8	0	0	0	0.161
asinsqrt-SS18	8	0	0.58	0.322	0.58
asinsqrt-SS19	8	0	0	0	0.322
asinsqrt-SS29	8	0	0	0	0.161
asinsqrt-SS33	8	0	0	0	0.322
asinsqrt-SS37	8	0	0	0	0.161
asinsqrt-SS39	8	0	0	0	0.161
asinsqrt-SS46	8	0	0	0	0
asinsqrt-SS48	8	0	0	0	0
asinsqrt-SS49	8	0	0	0	0
asinsqrt-SS50	8	0	0	0	0
asinsqrt-SS51	8	0	0	0	0

H = 53.142 with 16 degrees of freedom. (P = <0.001)

The differences in the median values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001)

To isolate the group or groups that differ from the others use a multiple comparison procedure.

Multiple Comparisons versus Control Group (**Dunn's Method**) :

Comparison	Diff of Ranks	Q	P<0.05
asinsqrt-SS18 vs asinsqrt-REF05	57.313	2.909	No
asinsqrt-SS49 vs asinsqrt-REF05	15.875	0.806	Do Not Test
asinsqrt-SS48 vs asinsqrt-REF05	15.875	0.806	Do Not Test
asinsqrt-SS46 vs asinsqrt-REF05	15.875	0.806	Do Not Test
asinsqrt-REF03 vs asinsqrt-REF05	15.875	0.806	Do Not Test
asinsqrt-SS51 vs asinsqrt-REF05	15.875	0.806	Do Not Test
asinsqrt-SS09 vs asinsqrt-REF05	15.875	0.806	Do Not Test
asinsqrt-SS19 vs asinsqrt-REF05	9.313	0.473	Do Not Test
asinsqrt-SS33 vs asinsqrt-REF05	7.938	0.403	Do Not Test
asinsqrt-SS50 vs asinsqrt-REF05	6.563	0.333	Do Not Test
asinsqrt-REF06 vs asinsqrt-REF05	6.563	0.333	Do Not Test
asinsqrt-SS13 vs asinsqrt-REF05	6.563	0.333	Do Not Test
asinsqrt-SS39 vs asinsqrt-REF05	0	0	Do Not Test
asinsqrt-SS29 vs asinsqrt-REF05	0	0	Do Not Test
asinsqrt-SS37 vs asinsqrt-REF05	0	0	Do Not Test
asinsqrt-SS15 vs asinsqrt-REF05	0	0	Do Not Test

Note: The multiple comparisons on ranks do not include an adjustment for ties.

One Way Analysis of Variance

Data source: Mortality (%) in CH2M01-00145 (SWMU 1)_*Eisenia fetida*

Normality Test: **Failed** **(P = <0.001)**

Test execution ended by user request, ANOVA on Ranks begun

Kruskal-Wallis One Way Analysis of Variance on Ranks

Group	N	Missing	Median	25%	75%
asinsqrt-REF03	8	0	0	0	0
asinsqrt-REF05	8	0	0	0	0.161
asinsqrt-REF06	8	0	0	0	0
asinsqrt-SS09	8	0	0	0	0
asinsqrt-SS13	8	0	0	0	0
asinsqrt-SS15	8	0	0	0	0.161
asinsqrt-SS18	8	0	0.58	0.322	0.58
asinsqrt-SS19	8	0	0	0	0.322
asinsqrt-SS29	8	0	0	0	0.161
asinsqrt-SS33	8	0	0	0	0.322
asinsqrt-SS37	8	0	0	0	0.161
asinsqrt-SS39	8	0	0	0	0.161
asinsqrt-SS46	8	0	0	0	0
asinsqrt-SS48	8	0	0	0	0
asinsqrt-SS49	8	0	0	0	0
asinsqrt-SS50	8	0	0	0	0
asinsqrt-SS51	8	0	0	0	0

H = 53.142 with 16 degrees of freedom. (P = <0.001)

The differences in the median values among the treatment groups are greater than would be expected by chance; **there is a statistically significant difference (P = <0.001)**

To isolate the group or groups that differ from the others use a multiple comparison procedure.

Multiple Comparisons versus Control Group (**Dunn's Method**) :

Comparison	Diff of Ranks	Q	P<0.05
asinsqrt-SS18 vs asinsqrt-REF06	63.875	3.242	Yes
asinsqrt-SS19 vs asinsqrt-REF06	15.875	0.806	No
asinsqrt-SS33 vs asinsqrt-REF06	14.5	0.736	Do Not Test
asinsqrt-SS49 vs asinsqrt-REF06	9.313	0.473	Do Not Test
asinsqrt-SS48 vs asinsqrt-REF06	9.313	0.473	Do Not Test
asinsqrt-SS46 vs asinsqrt-REF06	9.313	0.473	Do Not Test
asinsqrt-REF03 vs asinsqrt-REF06	9.313	0.473	Do Not Test
asinsqrt-SS51 vs asinsqrt-REF06	9.313	0.473	Do Not Test
asinsqrt-SS09 vs asinsqrt-REF06	9.313	0.473	Do Not Test
asinsqrt-REF05 vs asinsqrt-REF06	6.563	0.333	Do Not Test
asinsqrt-SS15 vs asinsqrt-REF06	6.563	0.333	Do Not Test
asinsqrt-SS29 vs asinsqrt-REF06	6.563	0.333	Do Not Test
asinsqrt-SS39 vs asinsqrt-REF06	6.563	0.333	Do Not Test
asinsqrt-SS37 vs asinsqrt-REF06	6.563	0.333	Do Not Test
asinsqrt-SS50 vs asinsqrt-REF06	0	0	Do Not Test
asinsqrt-SS13 vs asinsqrt-REF06	0	0	Do Not Test

Note: The multiple comparisons on ranks do not include an adjustment for ties.

Descriptive Statistics:

Data source: Weight Loss (g) in CH2M01-00145 (SWMU 1)_*Eisenia fetida*

							% Weight Loss Compared to:			
Column	**Size**	**Missing**	**Mean**	**Std Dev**	**Std. Error**	**C.I. of Mean**	**LabCtl**	**1B-REF03**	**1B-REF05**	**1B-REF06**
LabCtl	8	0	0.109	0.0213	0.00754	0.0178	-			
1B-REF03	8	0	0.133	0.0146	0.00518	0.0122	122.02	-	84.18	82.10
1B-REF05	8	0	0.158	0.0137	0.00484	0.0114	144.95	118.80	-	97.53
1B-REF06	8	0	0.162	0.0221	0.0078	0.0184	148.62	121.80	102.53	-
1B-SS09	8	0	0.178	0.0142	0.00501	0.0118	163.30	133.83	112.66	109.88
1B-SS13	8	0	0.123	0.0114	0.00403	0.00952	112.84	92.48	77.85	75.93
1B-SS15	8	0	0.138	0.0156	0.00551	0.013	126.61	103.76	87.34	85.19
1B-SS18	8	0	0.238	0.0383	0.0135	0.032	218.35	178.95	150.63	146.91
1B-SS19	8	0	0.157	0.0517	0.0183	0.0432	144.04	118.05	99.37	96.91
1B-SS29	8	0	0.183	0.00915	0.00323	0.00765	167.89	137.59	115.82	112.96
1B-SS33	8	0	0.149	0.0189	1%	2%	136.70	112.03	94.30	91.98
1B-SS37	8	0	0.144	0.0192	1%	2%	132.11	108.27	91.14	88.89
1B-SS39	8	0	0.213	0.0228	0.00807	0.0191	195.41	160.15	134.81	131.48
1B-SS46	8	0	0.157	0.0209	0.0074	0.0175	144.04	118.05	99.37	96.91
1B-SS48	8	0	0.126	0.0231	0.00816	0.0193	115.60	94.74	79.75	77.78
1B-SS49	8	0	0.17	0.0204	0.00722	0.0171	155.96	127.82	107.59	104.94
1B-SS50	8	0	0.145	0.019	0.00671	0.0159	133.03	109.02	91.77	89.51
1B-SS51	8	0	0.108	0.0199	0.00705	0.0167	99.08	81.20	68.35	66.67

Column	**Range**	**Max**	**Min**	**Median**	**5%**	**95%**
LabCtl	0.0633	0.153	0.0895	0.101	0.0895	0.153
1B-REF03	0.0434	0.161	0.117	0.131	0.117	0.161
1B-REF05	0.0386	0.178	0.14	0.155	0.14	0.178
1B-REF06	0.0634	0.201	0.137	0.151	0.137	0.201
1B-SS09	0.0366	0.198	0.162	0.175	0.162	0.198
1B-SS13	0.0379	0.138	0.1	0.123	0.1	0.138
1B-SS15	0.0455	0.167	0.122	0.134	0.122	0.167
1B-SS18	0.12	0.303	0.183	0.241	0.183	0.303
1B-SS19	0.173	0.251	0.0785	0.146	0.0785	0.251
1B-SS29	0.0299	0.193	0.163	0.183	0.163	0.193
1B-SS33	0.0494	0.171	0.121	0.152	0.121	0.171
1B-SS37	0.0555	0.166	0.11	0.144	0.11	0.166
1B-SS39	0.0618	0.248	0.187	0.207	0.187	0.248
1B-SS46	0.0517	0.18	0.128	0.158	0.128	0.18
1B-SS48	0.0648	0.16	0.0954	0.123	0.0954	0.16
1B-SS49	0.0657	0.205	0.139	0.17	0.139	0.205
1B-SS50	0.054	0.177	0.123	0.142	0.123	0.177
1B-SS51	0.0585	0.128	0.0695	0.111	0.0695	0.128

Column	**Skewness**	**Kurtosis**	**K-S Dist.**	**K-S Prob.**	**Sum**	**Sum of Squares**
LabCtl	1.405	1.773	0.212	0.335	0.871	0.0981
1B-REF03	0.949	0.497	0.236	0.206	1.06	0.142
1B-REF05	0.414	-1.111	0.155	0.697	1.26	0.2
1B-REF06	0.856	-0.515	0.283	0.059	1.292	0.212
1B-SS09	0.51	-1.338	0.161	0.662	1.423	0.255
1B-SS13	-0.831	1.616	0.241	0.184	0.98	0.121
1B-SS15	1.009	0.473	0.195	0.447	1.104	0.154
1B-SS18	0.166	0.0174	0.15	0.718	1.905	0.464
1B-SS19	0.54	0.948	0.153	0.707	1.253	0.215
1B-SS29	-1.316	2.773	0.243	0.175	1.461	0.267
1B-SS33	-0.676	-0.924	0.189	0.485	1.193	0.18
1B-SS37	-0.636	-0.29	0.174	0.585	1.152	0.168
1B-SS39	0.857	-0.555	0.233	0.22	1.706	0.367
1B-SS46	-0.422	-1.425	0.165	0.643	1.257	0.2
1B-SS48	0.472	-0.871	0.168	0.622	1.006	0.13
1B-SS49	0.284	0.163	0.124	0.799	1.357	0.233
1B-SS50	0.623	-0.658	0.199	0.42	1.159	0.17
1B-SS51	-1.15	0.979	0.255	0.133	0.867	0.0967

FEL

One Way Analysis of Variance

Data source: Weight Loss (g) in CH2M01-00145 (SWMU 1)_*Eisenia fetida*

Normality Test: **Passed** **(P = 0.085)**

Equal Variance Test: **Failed** **(P = 0.015)**

Test execution ended by user request, ANOVA on Ranks begun

Kruskal-Wallis One Way Analysis of Variance on Ranks

Group	**N**	**Missing**	**Median**	**25%**	**75%**
LabCtl	8	0	0.101	0.0937	0.12
1B-REF03	8	0	0.131	0.121	0.14
1B-REF05	8	0	0.155	0.147	0.169
1B-REF06	8	0	0.151	0.147	18%
1B-SS09	8	0	0.175	0.166	19%
1B-SS13	8	0	0.123	0.119	0.129
1B-SS15	8	0	0.134	0.126	0.147
1B-SS18	8	0	0.241	0.21	0.258
1B-SS19	8	0	0.146	0.131	0.185
1B-SS29	8	0	0.183	0.18	0.189
1B-SS33	8	0	0.152	0.134	0.164
1B-SS37	8	0	0.144	0.133	0.162
1B-SS39	8	0	0.207	0.198	0.23
1B-SS46	8	0	0.158	0.14	0.176
1B-SS48	8	0	0.123	0.109	0.143
1B-SS49	8	0	0.17	0.155	0.182
1B-SS50	8	0	0.142	0.13	0.157
1B-SS51	8	0	0.111	0.0994	0.124

H = 99.071 with 17 degrees of freedom. (P = <0.001)

The differences in the median values among the treatment groups are greater than would be expected by chance; **there is a statistically significant difference (P = <0.001)**

To isolate the group or groups that differ from the others use a multiple comparison procedure.

Multiple Comparisons versus Control Group (**Dunn's Method**) :

Comparison	**Diff of Ranks**	**Q**	**P<0.05**
1B-SS18 vs LabCtl	116.25	5.574	Yes
1B-SS39 vs LabCtl	112.625	5.4	Yes
1B-SS29 vs LabCtl	95.188	4.564	Yes
1B-SS09 vs LabCtl	88.375	4.237	Yes
1B-SS49 vs LabCtl	77.125	3.698	Yes
1B-REF06 vs LabCtl	65.313	3.131	Yes
1B-SS46 vs LabCtl	61.625	2.955	No
1B-REF05 vs LabCtl	61.625	2.955	Do Not Test
1B-SS19 vs LabCtl	54.063	2.592	Do Not Test
1B-SS33 vs LabCtl	48.688	2.334	Do Not Test
1B-SS50 vs LabCtl	43.188	2.071	Do Not Test
1B-SS37 vs LabCtl	43.125	2.068	Do Not Test
1B-SS15 vs LabCtl	33.813	1.621	Do Not Test
1B-REF03 vs LabCtl	24.375	1.169	Do Not Test
1B-SS48 vs LabCtl	18.188	0.872	Do Not Test
1B-SS13 vs LabCtl	11.938	0.572	Do Not Test
1B-SS51 vs LabCtl	1.5	0.0719	Do Not Test

Note: The multiple comparisons on ranks do not include an adjustment for ties.

One Way Analysis of Variance

Data source: Weight Loss (g) in CH2M01-00145 (SWMU 1)_*Eisenia fetida*

Normality Test: **Passed** **(P = 0.078)**

Equal Variance Test: **Failed** **(P = 0.009)**

Test execution ended by user request, ANOVA on Ranks begun

Kruskal-Wallis One Way Analysis of Variance on Ranks

Group	N	Missing	Median	25%	75%
1B-REF03	8	0	0.131	0.121	0.14
1B-REF05	8	0	0.155	0.147	0.169
1B-REF06	8	0	0.151	0.147	0.179
1B-SS09	8	0	0.175	0.166	0.191
1B-SS13	8	0	0.123	0.119	0.129
1B-SS15	8	0	0.134	0.126	0.147
1B-SS18	8	0	0.241	0.21	0.258
1B-SS19	8	0	0.146	0.131	0.185
1B-SS29	8	0	0.183	0.18	0.189
1B-SS33	8	0	0.152	0.134	0.164
1B-SS37	8	0	0.144	0.133	0.162
1B-SS39	8	0	0.207	0.198	0.23
1B-SS46	8	0	0.158	0.14	0.176
1B-SS48	8	0	0.123	0.109	0.143
1B-SS49	8	0	0.17	0.155	0.182
1B-SS50	8	0	0.142	0.13	0.157
1B-SS51	8	0	0.111	0.0994	0.124

H = 91.383 with 16 degrees of freedom. (P = <0.001)

The differences in the median values among the treatment groups are greater than would be expected by chance; **there is a statistically significant difference (P = <0.001)**

To isolate the group or groups that differ from the others use a multiple comparison procedure.

Multiple Comparisons versus Control Group (**Dunn's Method**) :

Comparison	Diff of Ranks	Q	P<0.05
1B-SS18 vs 1B-REF03	90.5	4.593	Yes
1B-SS39 vs 1B-REF03	86.875	4.409	Yes
1B-SS29 vs 1B-REF03	69.438	3.524	Yes
1B-SS09 vs 1B-REF03	62.625	3.179	Yes
1B-SS49 vs 1B-REF03	51.625	2.62	No
1B-REF06 vs 1B-REF03	40.188	2.04	Do Not Test
1B-SS46 vs 1B-REF03	36.375	1.846	Do Not Test
1B-REF05 vs 1B-REF03	36.375	1.846	Do Not Test
1B-SS19 vs 1B-REF03	29.688	1.507	Do Not Test
1B-SS51 vs 1B-REF03	23.75	1.205	Do Not Test
1B-SS33 vs 1B-REF03	23.688	1.202	Do Not Test
1B-SS37 vs 1B-REF03	18.25	0.926	Do Not Test
1B-SS50 vs 1B-REF03	18.188	0.923	Do Not Test
1B-SS13 vs 1B-REF03	12.188	0.619	Do Not Test
1B-SS15 vs 1B-REF03	8.938	0.454	Do Not Test
1B-SS48 vs 1B-REF03	5.563	0.282	Do Not Test

Note: The multiple comparisons on ranks do not include an adjustment for ties.

One Way Analysis of Variance

Data source: Weight Loss (g) in CH2M01-00145 (SWMU 1)_*Eisenia fetida*

Normality Test: **Passed** **(P = 0.078)**

Equal Variance Test: **Failed** **(P = 0.009)**

Test execution ended by user request, ANOVA on Ranks begun

Kruskal-Wallis One Way Analysis of Variance on Ranks

Group	N	Missing	Median	25%	75%
1B-REF03	8	0	0.131	0.121	0.14
1B-REF05	8	0	0.155	0.147	0.169
1B-REF06	8	0	0.151	0.147	0.179
1B-SS09	8	0	0.175	0.166	0.191
1B-SS13	8	0	0.123	0.119	0.129
1B-SS15	8	0	0.134	0.126	0.147
1B-SS18	8	0	0.241	0.21	0.258
1B-SS19	8	0	0.146	0.131	0.185
1B-SS29	8	0	0.183	0.18	0.189
1B-SS33	8	0	0.152	0.134	0.164
1B-SS37	8	0	0.144	0.133	0.162
1B-SS39	8	0	0.207	0.198	0.23
1B-SS46	8	0	0.158	0.14	0.176
1B-SS48	8	0	0.123	0.109	0.143
1B-SS49	8	0	0.17	0.155	0.182
1B-SS50	8	0	0.142	0.13	0.157
1B-SS51	8	0	0.111	0.0994	0.124

H = 91.383 with 16 degrees of freedom. (P = <0.001)

The differences in the median values among the treatment groups are greater than would be expected by chance; **there is a statistically significant difference (P = <0.001)**

To isolate the group or groups that differ from the others use a multiple comparison procedure.

Multiple Comparisons versus Control Group (**Dunn's Method**) :

Comparison	Diff of Ranks	Q	P<0.05
1B-SS51 vs 1B-REF05	60.125	3.052	Yes
1B-SS18 vs 1B-REF05	54.125	2.747	No
1B-SS39 vs 1B-REF05	50.5	2.563	Do Not Test
1B-SS13 vs 1B-REF05	48.563	2.465	Do Not Test
1B-SS48 vs 1B-REF05	41.938	2.129	Do Not Test
1B-REF03 vs 1B-REF05	36.375	1.846	Do Not Test
1B-SS29 vs 1B-REF05	33.063	1.678	Do Not Test
1B-SS15 vs 1B-REF05	27.438	1.393	Do Not Test
1B-SS09 vs 1B-REF05	26.25	1.332	Do Not Test
1B-SS50 vs 1B-REF05	18.188	0.923	Do Not Test
1B-SS37 vs 1B-REF05	18.125	0.92	Do Not Test
1B-SS49 vs 1B-REF05	15.25	0.774	Do Not Test
1B-SS33 vs 1B-REF05	12.688	0.644	Do Not Test
1B-SS19 vs 1B-REF05	6.688	0.339	Do Not Test
1B-REF06 vs 1B-REF05	3.813	0.194	Do Not Test
1B-SS46 vs 1B-REF05	0	0	Do Not Test

Note: The multiple comparisons on ranks do not include an adjustment for ties.

One Way Analysis of Variance

Data source: Weight Loss (g) in CH2M01-00145 (SWMU 1)_*Eisenia fetida*

Normality Test: **Passed** **(P = 0.078)**

Equal Variance Test: **Failed** **(P = 0.009)**

Test execution ended by user request, ANOVA on Ranks begun

Kruskal-Wallis One Way Analysis of Variance on Ranks

Group	N	Missing	Median	25%	75%
1B-REF03	8	0	0.131	0.121	0.14
1B-REF05	8	0	0.155	0.147	0.169
1B-REF06	8	0	0.151	0.147	0.179
1B-SS09	8	0	0.175	0.166	0.191
1B-SS13	8	0	0.123	0.119	0.129
1B-SS15	8	0	0.134	0.126	0.147
1B-SS18	8	0	0.241	0.21	0.258
1B-SS19	8	0	0.146	0.131	0.185
1B-SS29	8	0	0.183	0.18	0.189
1B-SS33	8	0	0.152	0.134	0.164
1B-SS37	8	0	0.144	0.133	0.162
1B-SS39	8	0	0.207	0.198	0.23
1B-SS46	8	0	0.158	0.14	0.176
1B-SS48	8	0	0.123	0.109	0.143
1B-SS49	8	0	0.17	0.155	0.182
1B-SS50	8	0	0.142	0.13	0.157
1B-SS51	8	0	0.111	0.0994	0.124

H = 91.383 with 16 degrees of freedom. (P = <0.001)

The differences in the median values among the treatment groups are greater than would be expected by chance; **there is a statistically significant difference (P = <0.001)**

To isolate the group or groups that differ from the others use a multiple comparison procedure.

Multiple Comparisons versus Control Group (**Dunn's Method**) :

Comparison	Diff of Ranks	Q	P<0.05
1B-SS51 vs 1B-REF06	63.938	3.245	Yes
1B-SS13 vs 1B-REF06	52.375	2.658	No
1B-SS18 vs 1B-REF06	50.313	2.554	Do Not Test
1B-SS39 vs 1B-REF06	46.688	2.37	Do Not Test
1B-SS48 vs 1B-REF06	45.75	2.322	Do Not Test
1B-REF03 vs 1B-REF06	40.188	2.04	Do Not Test
1B-SS15 vs 1B-REF06	31.25	1.586	Do Not Test
1B-SS29 vs 1B-REF06	29.25	1.485	Do Not Test
1B-SS09 vs 1B-REF06	22.438	1.139	Do Not Test
1B-SS50 vs 1B-REF06	22	1.117	Do Not Test
1B-SS37 vs 1B-REF06	21.938	1.113	Do Not Test
1B-SS33 vs 1B-REF06	16.5	0.837	Do Not Test
1B-SS49 vs 1B-REF06	11.438	0.581	Do Not Test
1B-SS19 vs 1B-REF06	10.5	0.533	Do Not Test
1B-REF05 vs 1B-REF06	3.813	0.194	Do Not Test
1B-SS46 vs 1B-REF06	3.813	0.194	Do Not Test

Note: The multiple comparisons on ranks do not include an adjustment for ties.

Descriptive Statistics:

Data source: Reproduction (n) in CH2M01-00145 (SWMU 1)_*Eisenia fetida*

							% Reproduction Compared to:			
Column	**Size**	**Missing**	**Mean**	**Std Dev**	**Std. Error**	**C.I. of Mean**	**LabCtl**	**1B-REF03**	**1B-REF05**	**1B-REF06**
LabCtl	8	0	0.413	0.125	0.0441	0.104	-			
1B-REF03	8	0	0.0625	0.0744	0.0263	0.0622	15.13	-	95.71	166.67
1B-REF05	8	0	0.0653	0.0916	0.0324	0.0766	15.81	104.48	-	174.13
1B-REF06	8	0	0.0375	0.0744	0.0263	0.0622	9.08	60.00	57.43	-
1B-SS09	8	0	0	0	0	0	0.00	0.00	0.00	0.00
1B-SS13	8	0	0	0	0	0	0.00	0.00	0.00	0.00
1B-SS15	8	0	0.0125	0.0354	0.0125	0.0296	3.03	20.00	19.14	33.33
1B-SS18	8	0	0	0	0	0	0.00	0.00	0.00	0.00
1B-SS19	8	0	0	0	0	0	0.00	0.00	0.00	0.00
1B-SS29	8	0	0	0	0	0	0.00	0.00	0.00	0.00
1B-SS33	8	0	0.0666	0.0744	3%	6%	16.13	106.56	101.99	177.60
1B-SS37	8	0	0.654	0.277	10%	23%	158.35	1046.40	1001.53	1744.00
1B-SS39	8	0	0	0	0	0	0.00	0.00	0.00	0.00
1B-SS46	8	0	0	0	0	0	0.00	0.00	0.00	0.00
1B-SS48	8	0	0	0	0	0	0.00	0.00	0.00	0.00
1B-SS49	8	0	0	0	0	0	0.00	0.00	0.00	0.00
1B-SS50	8	0	0	0	0	0	0.00	0.00	0.00	0.00
1B-SS51	8	0	0	0	0	0	0.00	0.00	0.00	0.00

Column	**Range**	**Max**	**Min**	**Median**	**5%**	**95%**
LabCtl	0.4	0.6	0.2	0.4	0.2	0.6
1B-REF03	0.2	0.2	0	0.05	0	0.2
1B-REF05	0.2	0.2	0	0	0	0.2
1B-REF06	0.2	0.2	0	0	0	0.2
1B-SS09	0	0	0	0	0	0
1B-SS13	0	0	0	0	0	0
1B-SS15	0.1	0.1	0	0	0	0.1
1B-SS18	0	0	0	0	0	0
1B-SS19	0.00E+00	0	0	0	0	0
1B-SS29	0	0	0	0	0	0
1B-SS33	0.2	0.2	0	0.05	0	0.2
1B-SS37	0.9	1.2	0.3	0.7	0.3	1.2
1B-SS39	0	0	0	0	0	0
1B-SS46	0	0	0	0	0	0
1B-SS48	0	0	0	0	0	0
1B-SS49	0	0	0	0	0	0
1B-SS50	0	0	0	0	0	0
1B-SS51	0	0	0	0	0	0

Column	**Skewness**	**Kurtosis**	**K-S Dist.**	**K-S Prob.**	**Sum**	**Sum of Squares**
LabCtl	-0.304	0.146	0.21	0.35	3.3	1.47
1B-REF03	0.824	-0.152	0.3	0.033	0.5	0.07
1B-REF05	0.999	-1.039	0.377	0.001	0.5	0.09
1B-REF06	1.951	3.205	0.443	<0.001	0.3	0.05
1B-SS09	0	-2.8	0	<0.001	0	0
1B-SS13	0	-2.8	0	<0.001	0	0
1B-SS15	2.828	8	0.513	<0.001	0.1	0.01
1B-SS18	0	-2.8	0	<0.001	0	0
1B-SS19	0	-2.8	0	<0.001	0	0
1B-SS29	0	-2.8	0	<0.001	0	0
1B-SS33	0.824	-0.152	0.3	0.033	0.5	0.07
1B-SS37	0.785	1.267	0.196	0.438	5.3	4.05
1B-SS39	0	-2.8	0	<0.001	0	0
1B-SS46	0	-2.8	0	<0.001	0	0
1B-SS48	0	-2.8	0	<0.001	0	0
1B-SS49	0	-2.8	0	<0.001	0	0
1B-SS50	0	-2.8	0	<0.001	0	0
1B-SS51	0	-2.8	0	<0.001	0	0

One Way Analysis of Variance

Data source: Reproduction (n) in CH2M01-00145 (SWMU 1)_*Eisenia fetida*

Normality Test: **Failed** **(P = <0.001)**

Test execution ended by user request, ANOVA on Ranks begun

Kruskal-Wallis One Way Analysis of Variance on Ranks

Group	N	Missing	Median	25%	75%
LabCtl	8	0	0.4	0.35	0.5
1B-REF03	8	0	0.05	0	0.1
1B-REF05	8	0	0	0	0.15
1B-REF06	8	0	0	0	5%
1B-SS09	8	0	0	0	0%
1B-SS13	8	0	0	0	0
1B-SS15	8	0	0	0	0
1B-SS18	8	0	0	0	0
1B-SS19	8	0	0	0	0
1B-SS29	8	0	0	0	0
1B-SS33	8	0	0.05	0	0.1
1B-SS37	8	0	0.7	0.45	0.75
1B-SS39	8	0	0	0	0
1B-SS46	8	0	0	0	0
1B-SS48	8	0	0	0	0
1B-SS49	8	0	0	0	0
1B-SS50	8	0	0	0	0
1B-SS51	8	0	0	0	0

H = 103.650 with 17 degrees of freedom. (P = <0.001)

The differences in the median values among the treatment groups are greater than would be expected by chance; **there is a statistically significant difference (P = <0.001)**

To isolate the group or groups that differ from the others use a multiple comparison procedure.

Multiple Comparisons versus Control Group (**Dunn's Method**) :

Comparison	Diff of Ranks	Q	P<0.05
1B-SS29 vs LabCtl	76.313	3.659	Yes
1B-SS50 vs LabCtl	76.313	3.659	Yes
1B-SS49 vs LabCtl	76.313	3.659	Yes
1B-SS48 vs LabCtl	76.313	3.659	Yes
1B-SS46 vs LabCtl	76.313	3.659	Yes
1B-SS39 vs LabCtl	76.313	3.659	Yes
1B-SS19 vs LabCtl	76.313	3.659	Yes
1B-SS51 vs LabCtl	76.313	3.659	Yes
1B-SS09 vs LabCtl	76.313	3.659	Yes
1B-SS13 vs LabCtl	76.313	3.659	Yes
1B-SS18 vs LabCtl	76.313	3.659	Yes
1B-SS15 vs LabCtl	68.625	3.29	Yes
1B-REF06 vs LabCtl	60	2.877	No
1B-REF05 vs LabCtl	51.375	2.463	Do Not Test
1B-REF03 vs LabCtl	44.625	2.14	Do Not Test
1B-SS33 vs LabCtl	44.625	2.14	Do Not Test
1B-SS37 vs LabCtl	5.063	0.243	Do Not Test

Note: The multiple comparisons on ranks do not include an adjustment for ties.

One Way Analysis of Variance

Data source: Reproduction (n) in CH2M01-00145 (SWMU 1)_*Eisenia fetida*

Normality Test: **Failed** **(P = <0.001)**

Test execution ended by user request, ANOVA on Ranks begun

Kruskal-Wallis One Way Analysis of Variance on Ranks

Data source: Reproduction (n) in CH2M01-00145 (SWMU 1)_Eisenia fetida

Group	N	Missing	Median	25%	75%
1B-REF03	8	0	0.05	0	0.1
1B-REF05	8	0	0	0	0.15
1B-REF06	8	0	0	0	0.05
1B-SS09	8	0	0	0	0%
1B-SS13	8	0	0	0	0%
1B-SS15	8	0	0	0	0
1B-SS18	8	0	0	0	0
1B-SS19	8	0	0	0	0
1B-SS29	8	0	0	0	0
1B-SS33	8	0	0.05	0	0.1
1B-SS37	8	0	0.7	0.45	0.75
1B-SS39	8	0	0	0	0
1B-SS46	8	0	0	0	0
1B-SS48	8	0	0	0	0
1B-SS49	8	0	0	0	0
1B-SS50	8	0	0	0	0
1B-SS51	8	0	0	0	0

H = 81.636 with 16 degrees of freedom. (P = <0.001)

The differences in the median values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001)

To isolate the group or groups that differ from the others use a multiple comparison procedure.

Multiple Comparisons versus Control Group (**Dunn's Method**) :

Comparison	Diff of Ranks	Q	P<0.05
1B-SS37 vs 1B-REF03	43.375	2.202	No
1B-SS29 vs 1B-REF03	31.625	1.605	Do Not Test
1B-SS50 vs 1B-REF03	31.625	1.605	Do Not Test
1B-SS49 vs 1B-REF03	31.625	1.605	Do Not Test
1B-SS48 vs 1B-REF03	31.625	1.605	Do Not Test
1B-SS46 vs 1B-REF03	31.625	1.605	Do Not Test
1B-SS39 vs 1B-REF03	31.625	1.605	Do Not Test
1B-SS51 vs 1B-REF03	31.625	1.605	Do Not Test
1B-SS09 vs 1B-REF03	31.625	1.605	Do Not Test
1B-SS13 vs 1B-REF03	31.625	1.605	Do Not Test
1B-SS18 vs 1B-REF03	31.625	1.605	Do Not Test
1B-SS19 vs 1B-REF03	31.625	1.605	Do Not Test
1B-SS15 vs 1B-REF03	23.938	1.215	Do Not Test
1B-REF06 vs 1B-REF03	15.375	0.78	Do Not Test
1B-REF05 vs 1B-REF03	6.813	0.346	Do Not Test
1B-SS33 vs 1B-REF03	0	0	Do Not Test

Note: The multiple comparisons on ranks do not include an adjustment for ties.

One Way Analysis of Variance

Data source: Reproduction (n) in CH2M01-00145 (SWMU 1)_ *Eisenia fetida*

Normality Test: **Failed** **(P = <0.001)**

Test execution ended by user request, ANOVA on Ranks begun

Kruskal-Wallis One Way Analysis of Variance on Ranks

Group	N	Missing	Median	25%	75%
1B-REF03	8	0	0.05	0%	10%
1B-REF05	8	0	0	0%	15%
1B-REF06	8	0	0	0	0.05
1B-SS09	8	0	0	0	0
1B-SS13	8	0	0	0	0
1B-SS15	8	0	0	0	0%
1B-SS18	8	0	0	0	0%
1B-SS19	8	0	0	0	0
1B-SS29	8	0	0	0	0
1B-SS33	8	0	0.05	0	0.1
1B-SS37	8	0	0.7	0.45	0.75
1B-SS39	8	0	0	0	0
1B-SS46	8	0	0	0	0
1B-SS48	8	0	0	0	0
1B-SS49	8	0	0	0	0
1B-SS50	8	0	0	0	0
1B-SS51	8	0	0	0	0

H = 81.636 with 16 degrees of freedom. (P = <0.001)

The differences in the median values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001)

To isolate the group or groups that differ from the others use a multiple comparison procedure.

Multiple Comparisons versus Control Group (**Dunn's Method**) :

Comparison	Diff of Ranks	Q	P<0.05
1B-SS37 vs 1B-REF05	50.188	2.547	No
1B-SS29 vs 1B-REF05	24.813	1.259	Do Not Test
1B-SS50 vs 1B-REF05	24.813	1.259	Do Not Test
1B-SS49 vs 1B-REF05	24.813	1.259	Do Not Test
1B-SS48 vs 1B-REF05	24.813	1.259	Do Not Test
1B-SS46 vs 1B-REF05	24.813	1.259	Do Not Test
1B-SS39 vs 1B-REF05	24.813	1.259	Do Not Test
1B-SS51 vs 1B-REF05	24.813	1.259	Do Not Test
1B-SS09 vs 1B-REF05	24.813	1.259	Do Not Test
1B-SS13 vs 1B-REF05	24.813	1.259	Do Not Test
1B-SS18 vs 1B-REF05	24.813	1.259	Do Not Test
1B-SS19 vs 1B-REF05	24.813	1.259	Do Not Test
1B-SS15 vs 1B-REF05	17.125	0.869	Do Not Test
1B-REF06 vs 1B-REF05	8.563	0.435	Do Not Test
1B-SS33 vs 1B-REF05	6.813	0.346	Do Not Test
1B-REF03 vs 1B-REF05	6.813	0.346	Do Not Test

Note: The multiple comparisons on ranks do not include an adjustment for ties.

One Way Analysis of Variance

Data source: Reproduction (n) in CH2M01-00145 (SWMU 1)_ *Eisenia fetida*

Normality Test: **Failed** **(P = <0.001)**

Test execution ended by user request, ANOVA on Ranks begun

Kruskal-Wallis One Way Analysis of Variance on Ranks

Group	N	Missing	Median	25%	75%
1B-REF03	8	0	0.05	0%	10%
1B-REF05	8	0	0	0%	15%
1B-REF06	8	0	0	0	0.05
1B-SS09	8	0	0	0	0
1B-SS13	8	0	0	0	0
1B-SS15	8	0	0	0	0%
1B-SS18	8	0	0	0	0%
1B-SS19	8	0	0	0	0
1B-SS29	8	0	0	0	0
1B-SS33	8	0	0.05	0	0.1
1B-SS37	8	0	0.7	0.45	0.75
1B-SS39	8	0	0	0	0
1B-SS46	8	0	0	0	0
1B-SS48	8	0	0	0	0
1B-SS49	8	0	0	0	0
1B-SS50	8	0	0	0	0
1B-SS51	8	0	0	0	0

H = 81.636 with 16 degrees of freedom. (P = <0.001)

The differences in the median values among the treatment groups are greater than would be expected by chance; **there is a statistically significant difference (P = <0.001)**

To isolate the group or groups that differ from the others use a multiple comparison procedure.

Multiple Comparisons versus Control Group (**Dunn's Method**) :

Comparison	Diff of Ranks	Q	P<0.05
1B-SS37 vs 1B-REF06	58.75	2.982	Yes
1B-SS29 vs 1B-REF06	16.25	0.825	No
1B-SS50 vs 1B-REF06	16.25	0.825	Do Not Test
1B-SS49 vs 1B-REF06	16.25	0.825	Do Not Test
1B-SS48 vs 1B-REF06	16.25	0.825	Do Not Test
1B-SS46 vs 1B-REF06	16.25	0.825	Do Not Test
1B-SS39 vs 1B-REF06	16.25	0.825	Do Not Test
1B-SS51 vs 1B-REF06	16.25	0.825	Do Not Test
1B-SS09 vs 1B-REF06	16.25	0.825	Do Not Test
1B-SS13 vs 1B-REF06	16.25	0.825	Do Not Test
1B-SS18 vs 1B-REF06	16.25	0.825	Do Not Test
1B-SS19 vs 1B-REF06	16.25	0.825	Do Not Test
1B-SS33 vs 1B-REF06	15.375	0.78	Do Not Test
1B-REF03 vs 1B-REF06	15.375	0.78	Do Not Test
1B-SS15 vs 1B-REF06	8.563	0.435	Do Not Test
1B-REF05 vs 1B-REF06	8.563	0.435	Do Not Test

Note: The multiple comparisons on ranks do not include an adjustment for ties.

FEL

SOIL CHEMISTRY - SWMU 1

Client/Project-WO No: CH2M06-00145 **Test Species: *Eisenia fetida***

Study Day	Analysis Date	Tech Initials	FEL Sample No.	Sample ID	pH (su)	TOC (mg/Kg) (wet wt)	Initial Moisture (%)	Adjusted Moisture[1] (%)
-16	05/08/07	WH	-	Lab Control	7.2	5526	19.2	25.5
			001	1B-SS09	6.3	659	16.3	26.1
			002	1B-SS13	7.1	452	27.0	-
			003	1B-SS15	7.4	231	31.9	-
			004	1B-SS18	9.1	647	21.0	25.0
			005	1B-SS19	8.7	1174	25.5	-
			006	1B-SS29	8.3	488	21.0	25.7
			007	1B-SS33	7.7	431	13.1	26.8
			008	1B-SS37	8.3	417	20.6	26.3
			009	1B-SS39	8.1	286	16.7	25.4
			010	1B-SS46	8.3	1096	25.0	-
			011	1B-SS48	7.9	526	46.9	-
			012	1B-SS49	7.7	997	31.1	-
			013	1B-SS50	8.7	1581	22.4	26.8
			014	1B-SS51	7.6	1396	15.4	26.6
			015	1B-REF03	8.5	1238	24.5	25.0
			016	1B-REF05	7.9	1226	21.9	26.7
			017	1B-REF06	8.8	127	28.9	-

[1] Initial soil moistures below 25% were rehydrated with dechlorinated lab water for test setup, targeting 25% - 45%.

FEL

SOIL CHEMISTRY - SWMU 1

Client/Project-WO No: CH2M06-00145 **Test Species: *Eisenia fetida***

Study Day	Analysis Date	Tech Initials	FEL Sample No.	Sample ID	pH (su)	TOC (mg/Kg) (wet wt)	Final Moisture (%)
28	06/21/07	WH	-	Lab Control	7.6	1246	29.8
			001	1B-SS09	7.9	284	15.0
			002	1B-SS13	7.9	610	26.0
			003	1B-SS15	8.2	796	29.5
			004	1B-SS18	8.5	2551	20.0
			005	1B-SS19	8.5	888	25.5
			006	1B-SS29	8.3	855	22.5
			007	1B-SS33	7.6	523	16.3
			008	1B-SS37	8.4	562	19.1
			009	1B-SS39	8.2	223	16.5
			010	1B-SS46	8.2	554	21.3
			011	1B-SS48	8.2	642	22.1
			012	1B-SS49	7.8	961	33.1
			013	1B-SS50	8.5	692	21.3
			014	1B-SS51	6.5	200	19.9
			015	1B-REF03	8.0	1039	21.5
			016	1B-REF05	8.2	736	25.2
			017	1B-REF06	8.5	2089	27.1

FEL

Client/Project-WO No: CH2M06-00145
EXPOSURE ROOM PARAMETERS
Test Species *Eisenia fetida*

Study Day	Analysis Date	Tech Initials	Room Temperature (ºC)	Light Intensity (lux)
0	05/24/07	MB	25.0	532
1	05/25/07	MB	25.0	566
2	05/26/07	WH	25.0	516
3	05/27/07	MB	24.0	535
4	05/28/07	MB	25.0	549
5	05/29/07	WH	25.0	667
6	05/30/07	WH	25.0	735
7	05/31/07	WH	25.0	568
8	06/01/07	WH	25.0	520
9	06/02/07	MB	25.0	531
10	06/03/07	MB	25.0	528
11	06/04/07	WH	25.0	553
12	06/05/07	MB	25.0	533
13	06/06/07	MB	25.0	589
14	06/07/07	WH	25.0	552
15	06/08/07	WH	25.0	555
16	06/09/07	DF	25.0	557
17	06/10/07	DF	25.0	563
18	06/11/07	RR	25.0	570
19	06/12/07	RR	25.0	638
20	06/13/07	RR	24.0	556
21	06/14/07	RR	25.0	562
22	06/15/07	RR	25.0	567
23	06/16/07	RR	25.0	582
24	06/17/07	DF	25.0	593
25	06/18/07	RR	25.0	561
26	06/19/07	WH	25.0	580
27	06/20/07	WH	25.0	506
28	06/21/07	WH	25.0	515

APPENDIX F
DATA VALIDATION NARRATIVES

SEVERN TRENT - SAVANNAH SDG SWMU24740-1

Project: Aquatic BERA, SWMU 1 and 2, CTO-108
Laboratory: Severn Trent Laboratories
Sample Delivery Group: 680-24740-1
Fraction: Inorganic
Matrix: Soil
Report Date: 10/9/2007

This analytical quality assurance report is based upon a review of analytical data generated for soil and sediment samples. One matrix spike sample/matrix spike duplicate was submitted with the samples for this Sample Delivery Group. The sample locations, laboratory identification numbers, sample collection dates, sample matrix, and analyses performed are presented in Table 1.

The samples were analyzed for miscellaneous parameters: pH, total organic carbon, ammonia, and sulfide. The sample analyses were performed in accordance with the procedures outlined in the method referenced at the end of this report.

All sample analyses have undergone an analytical quality assurance review to ensure adherence to the required protocols. Results have been validated or qualified according to general guidance provided in "Evaluation of Metals Data for the CLP Program", SOP HW-2, Revision 13, September 2005. The parameters presented on the following page were evaluated.

X	•	Data Completeness
X	•	Chain of Custody Documentation
X	•	Holding Times
X	•	Initial and Continuing Calibrations
X	•	ICP Interference Check Sample Results
X	•	Laboratory and Field Blank Analysis Results
X	•	Matrix Spike Recoveries and Reproducibility
X	•	Laboratory Duplicate Analysis Results
	•	ICP Serial Dilution Results
	•	Field Duplicate Analysis Results
X	•	Laboratory Control Sample Results
	•	GFAA Post-Digestion Spike Recovery/Duplicate Burn Precision
X	•	Qualitative Identification
X	•	Quantitation/Reporting Limits

X - Denotes parameter evaluated.

It is recommended that the data only be used according to the qualifiers presented, and discussed in this report. All other data should be considered qualitatively and quantitatively valid as reported by the laboratory, based on the items evaluated.

Report Approved By:

Shawne M. Rodgers
President

10/9/2007

Date

1.0 DATA COMPLETENESS

All criteria were met. No qualifiers were applied.

2.0 CHAIN OF CUSTODY DOCUMENTATION

All chain of custody documentation was complete.

3.0 HOLDING TIMES

All criteria were met. No qualifiers were applied.

4.0 INITIAL AND CONTINUING CALIBRATIONS

All criteria were met. No qualifiers were applied.

5.0 ICP INTERFERENCE CHECK SAMPLE RESULTS

This parameter is not applicable to the analyses performed.

6.0 LABORATORY AND FIELD BLANK ANALYSIS RESULTS

All criteria were met. No qualifiers were applied.

7.0 MATRIX SPIKE/MATRIX SPIKE DUPLICATE RECOVERIES AND REPRODUCIBILITY

All criteria were met. No qualifiers were applied.

8.0 *LABORATORY DUPLICATE RESULTS*

All criteria were met. No qualifiers were applied.

9.0 *ICP SERIAL DILUTION RESULTS*

This parameter is not applicable to the analyses performed.

10.0 *FIELD DUPLICATE RESULTS*

There were no field duplicate samples submitted with this SDG.

11.0 *LABORATORY CONTROL SAMPLE RESULTS*

All criteria were met. No qualifiers were applied.

12.0 *GFAA POST-DIGESTION SPIKE/DUPLICATE BURN*

This parameter is not applicable to the analyses performed.

13.0 *QUALITATIVE IDENTIFICATION*

All criteria were met. No qualifiers were applied.

14.0 *QUANTITATION/REPORTING LIMITS*

All criteria were met. No qualifiers were applied.

METHODOLOGY REFERENCES

Analysis	Reference
Ammonia	Method 350.1 , "Methods for Chemical Analysis of Water and Wastes", EPA-600/4-79-020, March 1983, and revisions
Sulfide	Method 9034, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997
Total Organic Carbon	Lloyd-Kahn
pH	Method 9045C, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997

Table 1 Samples For Data Validation Review
Aquatic BERA SWMU 1 and 2 (CTO-108)
Soil Samples Collected February 2007
Severn Trent Sample Delivery Group SWMU24740-1

SAMPLE I.D.	LABORATORY I.D	DATE COLLECTED	MATRIX	ANALYSES PERFORMED		
				MISC1	MISC2	MISC3
1V-SS01	680-24740- 1	2/27/2007	Soil		X	X
1V-SS02	680-24740- 2	2/27/2007	Soil		X	X
1V-SS03	680-24740- 3	2/27/2007	Soil		X	X
1V-SS04	680-24740- 4	2/27/2007	Soil		X	X
1V-SS05	680-24740- 5	2/27/2007	Soil		X	X
1V-SS06	680-24740- 6	2/27/2007	Soil		X	X
2V-SS01	680-24740- 7	2/27/2007	Soil		X	X
2V-SS02	680-24740- 8	2/27/2007	Soil		X	X
2V-SS03	680-24740- 9	2/27/2007	Soil		X	X
2V-SS04	680-24740- 10	2/27/2007	Soil		X	X
2V-SS05	680-24740- 11	2/27/2007	Soil		X	X
2V-SS06	680-24740- 12	2/27/2007	Soil		X	X
2V-SB01	680-24740- 13	2/27/2007	Soil		X	X
2V-SB02	680-24740- 14	2/27/2007	Soil		X	X
2V-SB03	680-24740- 15	2/27/2007	Soil		X	X
2V-SB04	680-24740- 16	2/27/2007	Soil		X	X
2V-SB05	680-24740- 17	2/27/2007	Soil		X	X
2V-SB06	680-24740- 18	2/27/2007	Soil		X	X
2V-EWSD01	680-24740- 19	2/28/2007	Soil	X		X
2V-EWSD02	680-24740- 20	2/28/2007	Soil	X		X
2V-EWSD03	680-24740- 21	2/28/2007	Soil	X		X
2V-EWSD04	680-24740- 22	2/28/2007	Soil	X		X
2V-EWSD05	680-24740- 23	2/28/2007	Soil	X		X
2V-EWSD06	680-24740- 24	2/28/2007	Soil	X		X

MISC1 Ammonia and Sulfide
MISC2 Total Organic Carbon
MISC3 Grain Size and pH

SEVERN TRENT - SAVANNAH SDG SWMU24740-2/SWMU24740-3

Project: Aquatic BERA, SWMU 1 and 2, CTO-108
Laboratory: Severn Trent Laboratories
Sample Delivery Group: 680-24740-2/ 680-24740-3
Fraction: Inorganic
Matrix: Soil
Report Date: 10/12/2007

This analytical quality assurance report is based upon a review of analytical data generated for soil and sediment samples. Three equipment blanks, one field blank, four field duplicates and four matrix spike sample/matrix spike duplicates, were submitted with the samples for this Sample Delivery Group. The sample locations, laboratory identification numbers, sample collection dates, sample matrix, and analyses performed are presented in Table 1.

The samples were analyzed for metals and miscellaneous parameters: pH, total organic carbon, ammonia, and sulfide. The sample analyses were performed in accordance with the procedures outlined in the method referenced at the end of this report.

All sample analyses have undergone an analytical quality assurance review to ensure adherence to the required protocols. Results have been validated or qualified according to general guidance provided in "Evaluation of Metals Data for the CLP Program", SOP HW-2, Revision 13, September 2005. The parameters presented on the following page were evaluated.

X	•	Data Completeness
X	•	Chain of Custody Documentation
X	•	Holding Times
X	•	Initial and Continuing Calibrations
X	•	ICP Interference Check Sample Results
X	•	Laboratory and Field Blank Analysis Results
X	•	Matrix Spike Recoveries and Reproducibility
X	•	Laboratory Duplicate Analysis Results
X	•	ICP Serial Dilution Results
X	•	Field Duplicate Analysis Results
X	•	Laboratory Control Sample Results
	•	GFAA Post-Digestion Spike Recovery/Duplicate Burn Precision
X	•	Qualitative Identification
X	•	Quantitation/Reporting Limits

X - Denotes parameter evaluated.

It is recommended that the data only be used according to the qualifiers presented, and discussed in this report. All other data should be considered qualitatively and quantitatively valid as reported by the laboratory, based on the items evaluated.

Report Approved By:

Shawne M Rodgers

Shawne M. Rodgers
President

10/12/2007

Date

1.0 DATA COMPLETENESS

All criteria were met. No qualifiers were applied.

2.0 CHAIN OF CUSTODY DOCUMENTATION

All chain of custody documentation was complete.

3.0 HOLDING TIMES

All criteria were met. No qualifiers were applied.

4.0 INITIAL AND CONTINUING CALIBRATIONS

All criteria were met. No qualifiers were applied.

5.0 ICP INTERFERENCE CHECK SAMPLE RESULTS

All criteria were met. No qualifiers were applied.

6.0 LABORATORY AND FIELD BLANK ANALYSIS RESULTS

All criteria were met. No qualifiers were applied.

7.0 MATRIX SPIKE/MATRIX SPIKE DUPLICATE RECOVERIES AND REPRODUCIBILITY

Positive results for chromium, copper, vanadium, and zinc for samples REF-SB01, REF-SB01D, REF-SB02, REF-SB04, and REF-SB06, should be considered biased high quantitative estimates and may be lower than reported. The associated matrix spike recoveries were above the acceptance limit for these analytes. The high recoveries indicate the presence of interferences for chromium, copper, vanadium, and zinc for samples of similar matrix. The positive results have been marked "K" to indicate that they are biased high quantitative estimates.

Positive results for zinc for samples REF-EWSD01, REF-EWSD01D, REF-EWSD02, REF-EWSD04, REF-EWSD05, and REF-EWSD06 are biased low quantitative estimates and may be higher than reported. The associated matrix spike recovery was below the acceptance limit for this analyte. The low recovery indicates the presence of interferences for zinc for samples of similar matrix. Positive results have been marked "L" to indicate that they are biased low.

8.0 LABORATORY DUPLICATE RESULTS

All criteria were met. No qualifiers were applied.

9.0 ICP SERIAL DILUTION RESULTS

The following positive results should be considered quantitative estimates. The ICP serial dilution criterion was exceeded for these elements. The lack of precision may be due to interferences in samples of similar matrix. The positive results for these metals have been marked with "J" qualifiers to indicate that they are quantitative estimates.

Analyte	Affected Samples
Barium	REF-SS01, REF-SS01D, REF-SS05, REF-SS06, REF-SS09, REF-SS010
Copper	REF-EWSD01, REF-EWSD01D, REF-EWSD02, REF-EWSD03, REF-EWSD04, REF-EWSD05, REF-EWSD06

10.0 FIELD DUPLICATE RESULTS

Duplicate samples REF-SS01 and REF-SS01D, REF-SS03 and REF-SS03D, REF-SB01 and REF-SB01D, and REF-EWSD01 and REF-EWSD01D were submitted to the laboratory evaluate sampling and analytical precision for those analytes determined to be present. Results for these duplicate samples are presented in Table 2 through 5. The Region II field duplicate criteria were met for the duplicate samples.

11.0 LABORATORY CONTROL SAMPLE RESULTS

All criteria were met. No qualifiers were applied.

12.0 GFAA POST-DIGESTION SPIKE/DUPLICATE BURN

This parameter is not applicable to the analyses performed.

13.0 QUALITATIVE IDENTIFICATION

All criteria were met. No qualifiers were applied.

14.0 *QUANTITATION/REPORTING LIMITS*

Positive results and quantitation limits for all inorganic analytes for samples REF-SS02, REF-EWSD02, REF-EWSD04, and REF-EWSD05, that were not previously qualified for other criteria, should be considered biased low quantitative estimates, and may be higher than reported. The percent solids for these sediment samples were less than 50 percent. The positive results have been marked with "J" qualifiers to indicate that they are biased low quantitative estimates. The quantitation limits have been marked "UJ".

METHODOLOGY REFERENCES

Analysis	Reference
Metals (Except Mercury)	Method 6020, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997
Mercury	Method 7471A, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997
Ammonia	Method 350.1 , "Methods for Chemical Analysis of Water and Wastes", EPA-600/4-79-020, March 1983, and revisions
Sulfide	Method 9034, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997
Total Organic Carbon	Lloyd-Kahn
pH	Method 9045C, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997

Table 1 Samples For Data Validation Review
Aquatic BERA SWMU 1 and 2 (CTO-108)
Samples Collected February and March 2007
Severn Trent Sample Delivery Group 680-24740-2

SAMPLE I.D.	LABORATORY I.D	DATE COLLECTED	MATRIX	ANALYSES PERFORMED								
				PAH	APP IX PEST	TPEST	APP IX MET	TMET1	TMET2	MISC1	MISC2	MISC3
REF-SS01	680-24740-25	2/28/2007	Soil	X	X		X			X		X
REF-SS01D	680-24740-26	2/28/2007	Soil	X	X		X					
REF-SS02	680-24740-27	2/28/2007	Soil	X	X		X			X		X
REF-SS03	680-24740-28	2/28/2007	Soil			X		X		X		X
REF-SS03D	680-24740-29	2/28/2007	Soil			X		X				
REF-SS04	680-24740-30	2/28/2007	Soil			X		X		X		X
REF-SS05	680-24740-31	2/28/2007	Soil	X	X		X			X		X
REF-SS06	680-24740-32	2/28/2007	Soil	X	X		X			X		X
REF-SS07	680-24740-33	2/28/2007	Soil			X		X		X		X
REF-SS08	680-24740-34	2/28/2007	Soil			X		X		X		X
REF-SS09	680-24740-35	2/28/2007	Soil	X	X		X			X		X
REF-SS010	680-24740-36	2/28/2007	Soil	X	X		X			X		X
REF-SS011	680-24740-37	2/28/2007	Soil			X		X		X		X
REF-SS012	680-24740-38	2/28/2007	Soil			X		X		X		X
REF-SB01	680-24740-39	2/28/2007	Soil	X	X		X			X		X
REF-SB01D	680-24740-40	2/28/2007	Soil	X	X		X					
REF-SB02	680-24740-41	2/28/2007	Soil	X	X		X			X		X
REF-SB03	680-24740-42	2/28/2007	Soil			X		X		X		X
REF-SB04	680-24740-43	2/28/2007	Soil			X		X		X		X

Table 1 Samples For Data Validation Review
Aquatic BERA SWMU 1 and 2 (CTO-108)
Samples Collected February and March 2007
Severn Trent Sample Delivery Group 680-24740-2

SAMPLE I.D.	LABORATORY I.D	DATE COLLECTED	MATRIX	ANALYSES PERFORMED								
				PAH	APP IX PEST	TPEST	APP IX MET	TMET1	TMET2	MISC1	MISC2	MISC3
REF-SB06	680-24740-44	2/28/2007	Soil	X	X		X			X		X
REF-SB07	680-24740-45	2/28/2007	Soil			X		X		X		X
REF-SB08	680-24740-46	2/28/2007	Soil			X		X		X		X
REF-SB09	680-24740-47	2/28/2007	Soil	X	X		X			X		X
REF-SB010	680-24740-48	2/28/2007	Soil	X	X		X			X		X
REF-SB011	680-24740-49	2/28/2007	Soil			X		X		X		X
REF-SB012	680-24740-50	2/28/2007	Soil			X		X		X		X
REF-EWSD01	680-24740-51	3/1/2007	Sediment							X	X	X
REF-EWSD01D	680-24740-52	3/1/2007	Sediment						X			
REF-EWSD02	680-24740-53	3/1/2007	Sediment						X	X	X	X
REF-EWSD03	680-24740-54	3/1/2007	Sediment						X	X	X	X
REF-EWSD04	680-24740-55	3/1/2007	Sediment						X	X	X	X
REF-EWSD05	680-24740-56	3/1/2007	Sediment						X	X	X	X
REF-EWSD06	680-24740-57	3/1/2007	Sediment						X	X	X	X

PAH Polynuclear Aromatic Hydrocarbons
APP IX PEST Appendix IX Organochlorine Pesticides
PEST 4,4'-DDD, 4,4'-DDE, 4,4'-DDT
APP IX MET Appendix IX Metals
TMET1 Total Metals: Antimony, Cadmium, Copper, Lead, Mercury, Tin, Zinc
TMET2 Total Metals: Copper, Lead, Mercury, Zinc
MISC1 Ammonia and Sulfide
MISC2 Total Organic Carbon
MISC3 Grain Size and pH

Table 1 Samples For Data Validation Review
Aquatic BERA SWMU 1 and 2 (CTO-108)
Soil Samples Collected February and March 2007
Severn Trent Sample Delivery Group 680-24740-3

SAMPLE I.D.	LABORATORY I.D	DATE COLLECTED	MATRIX	ANALYSES PERFORMED PAH	APP IX PEST	APP IX MET	TMET2
1V-ER01	680-24740- 58	2/27/2007	Equipment Blank	X	X	X	
2V-ER01	680-24740- 59	2/28/2007	Equipment Blank	X	X	X	
REF-ER01	680-24740- 60	3/1/2007	Equipment Blank				X
1V-FB01	680-24740- 61	2/27/2007	Field Blank	X	X	X	

PAH Polynuclear Aromatic Hydrocarbons
APP IX PEST Appendix IX Organochlorine Pesticides
APP IX MET Appendix IX Metals
TMET2 Total Metals: Copper, Lead, Mercury, Zinc

Project: Aquatic BERA, SWMU 1 and 2, CTO-108
Laboratory: Severn Trent Laboratories
Sample Delivery Group: 680-24740-2/ 680-24740-3
Fraction: Organic
Matrix: Soil
Report Date: 10/12/2007

This analytical quality assurance report is based upon a review of analytical data generated for soil and sediment samples. Three equipment blanks, one field blank, three field duplicates and three matrix spike sample/matrix spike duplicates, were submitted with the samples for this Sample Delivery Group. The sample locations, laboratory identification numbers, sample collection dates, sample matrix, and analyses performed are presented in Table 1.

The samples were analyzed for polynuclear aromatic hydrocarbons and pesticide compounds. The sample analyses were performed in accordance with the procedures outlined in the method referenced at the end of this report.

All sample analyses have undergone an analytical quality assurance review to ensure adherence to the required protocols. Results have been validated or qualified according to Region II "Validating Semivolatile Organic Compounds by SW-846 Method 8270C", SOP HW-22 Revision 2, June 2001, and"SW-846 Method 8080A/8000A", SOP HW-23, Revision 0, April 1995. The parameters presented on the following page were evaluated.

X	•	Data Completeness
X	•	Chain of Custody Documentation
X	•	Holding Times
	•	Instrument Performance
X	•	Initial and Continuing Calibrations
X	•	Laboratory and Field Blank Analysis Results
X	•	Surrogate Compound Recoveries
X	•	Matrix Spike/Matrix Spike Duplicate Recoveries and Reproducibility
X	•	Field Duplicate Analysis Results
X	•	Laboratory Control Sample Results
X	•	Internal Standard Performance
X	•	Qualitative Identification
X	•	Quantitation/Reporting Limits

X - Denotes parameter evaluated.

It is recommended that the data only be used according to the qualifiers presented, and discussed in this report. All other data should be considered qualitatively and quantitatively valid as reported by the laboratory, based on the items evaluated.

Report Approved By:

Shawne M. Rodgers
President

10/12/2007

Date

1.0 *DATA COMPLETENESS*

The data package was complete.

2.0 *CHAIN OF CUSTODY DOCUMENTATION*

The chain of custody documentation was complete.

3.0 *HOLDING TIMES*

All criteria were met. No qualifiers were applied.

4.0 *INSTRUMENT PERFORMANCE*

All criteria were met. No qualifiers were applied.

5.0 *INITIAL AND CONTINUING CALIBRATIONS*

The laboratory evaluated the samples using guidance given in the DOD QSM Final Version 3, which allows for 20% difference as the continuing calibration verification criteria. This is a deviation from Method 8081A, which allows for a 15% difference. This has been noted in the case narrative.

6.0 *LABORATORY AND FIELD BLANK ANALYSIS RESULTS*

All criteria were met. No qualifiers were applied.

7.0 *SURROGATE COMPOUND RECOVERIES*

All criteria were met. No qualifiers were applied.

8.0 *MATRIX SPIKE/MATRIX SPIKE DUPLICATE RECOVERIES AND REPRODUCIBILITY*

All criteria were met. No qualifiers were applied.

9.0 *FIELD DUPLICATE RESULTS*

Duplicate samples REF-SS01 and REF-SS01D, REF-SS03 and REF-SS03D, and REF-SB01 and REF-SB01D were submitted to the laboratory to evaluate sampling and analytical precision for those analytes determined to be present. Results for these duplicate samples are presented in Tables 2 through 4. Precision is evaluated by calculating the relative percent difference (%RPD) between duplicate pair results. There are no USEPA-established acceptance criteria for field duplicate samples. EDQ uses internal acceptance criteria of forty percent for extractable compounds to evaluate soil field duplicate samples.

10.0 *LABORATORY CONTROL SAMPLE RESULTS*

All criteria were met. No qualifiers were applied.

11.0 *INTERNAL STANDARD PERFORMANCE*

All criteria were met. No qualifiers were applied.

12.0 *QUALITATIVE IDENTIFICATION*

All criteria were met. No qualifiers were applied.

13.0 *QUANTITATION/REPORTING LIMITS*

As required by USEPA protocol, all compounds, which were qualitatively identified at concentrations below their respective Reporting Limits (RLs), have been marked with "J" qualifiers to indicate that they are quantitative estimates.

METHODOLOGY REFERENCES

Analysis	Reference
Polynuclear Aromatic Hydrocarbons (SIM)	Method 8270C, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997
Pesticide Compounds	Method 8081A, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997

Table 1 Samples For Data Validation Review
Aquatic BERA SWMU 1 and 2 (CTO-108)
Samples Collected February and March 2007
Severn Trent Sample Delivery Group 680-24740-2

SAMPLE I.D.	LABORATORY I.D	DATE COLLECTED	MATRIX	ANALYSES PERFORMED								
				PAH	APP IX PEST	TPEST	APP IX MET	TMET1	TMET2	MISC1	MISC2	MISC3
REF-SS01	680-24740-25	2/28/2007	Soil	X	X		X			X		X
REF-SS01D	680-24740-26	2/28/2007	Soil	X	X		X					
REF-SS02	680-24740-27	2/28/2007	Soil	X	X		X			X		X
REF-SS03	680-24740-28	2/28/2007	Soil			X		X		X		X
REF-SS03D	680-24740-29	2/28/2007	Soil			X		X				
REF-SS04	680-24740-30	2/28/2007	Soil			X		X		X		X
REF-SS05	680-24740-31	2/28/2007	Soil	X	X		X			X		X
REF-SS06	680-24740-32	2/28/2007	Soil	X	X		X			X		X
REF-SS07	680-24740-33	2/28/2007	Soil			X		X		X		X
REF-SS08	680-24740-34	2/28/2007	Soil			X		X		X		X
REF-SS09	680-24740-35	2/28/2007	Soil	X	X		X			X		X
REF-SS010	680-24740-36	2/28/2007	Soil	X	X		X			X		X
REF-SS011	680-24740-37	2/28/2007	Soil			X		X		X		X
REF-SS012	680-24740-38	2/28/2007	Soil			X		X		X		X
REF-SB01	680-24740-39	2/28/2007	Soil	X	X		X			X		X
REF-SB01D	680-24740-40	2/28/2007	Soil	X	X		X					
REF-SB02	680-24740-41	2/28/2007	Soil	X	X		X			X		X
REF-SB03	680-24740-42	2/28/2007	Soil			X		X		X		X
REF-SB04	680-24740-43	2/28/2007	Soil			X		X		X		X

Table 1 Samples For Data Validation Review
Aquatic BERA SWMU 1 and 2 (CTO-108)
Samples Collected February and March 2007
Severn Trent Sample Delivery Group 680-24740-2

SAMPLE I.D.	LABORATORY I.D	DATE COLLECTED	MATRIX	ANALYSES PERFORMED								
				PAH	APP IX PEST	TPEST	APP IX MET	TMET1	TMET2	MISC1	MISC2	MISC3
REF-SB06	680-24740-44	2/28/2007	Soil	X	X		X			X		X
REF-SB07	680-24740-45	2/28/2007	Soil			X		X		X		X
REF-SB08	680-24740-46	2/28/2007	Soil			X		X		X		X
REF-SB09	680-24740-47	2/28/2007	Soil	X	X		X			X		X
REF-SB010	680-24740-48	2/28/2007	Soil	X	X		X			X		X
REF-SB011	680-24740-49	2/28/2007	Soil			X		X		X		X
REF-SB012	680-24740-50	2/28/2007	Soil			X		X		X		X
REF-EWSD01	680-24740-51	3/1/2007	Sediment							X	X	X
REF-EWSD01D	680-24740-52	3/1/2007	Sediment						X			
REF-EWSD02	680-24740-53	3/1/2007	Sediment						X	X	X	X
REF-EWSD03	680-24740-54	3/1/2007	Sediment						X	X	X	X
REF-EWSD04	680-24740-55	3/1/2007	Sediment						X	X	X	X
REF-EWSD05	680-24740-56	3/1/2007	Sediment						X	X	X	X
REF-EWSD06	680-24740-57	3/1/2007	Sediment						X	X	X	X

PAH Polynuclear Aromatic Hydrocarbons
APP IX PEST Appendix IX Organochlorine Pesticides
PEST 4,4'-DDD, 4,4'-DDE, 4,4'-DDT
APP IX MET Appendix IX Metals
TMET1 Total Metals: Antimony, Cadmium, Copper, Lead, Mercury, Tin, Zinc
TMET2 Total Metals: Copper, Lead, Mercury, Zinc
MISC1 Ammonia and Sulfide
MISC2 Total Organic Carbon
MISC3 Grain Size and pH

Table 1 Samples For Data Validation Review
Aquatic BERA SWMU 1 and 2 (CTO-108)
Soil Samples Collected February and March 2007
Severn Trent Sample Delivery Group 680-24740-3

SAMPLE I.D.	LABORATORY I.D	DATE COLLECTED	MATRIX	ANALYSES PERFORMED			
				PAH	APP IX PEST	APP IX MET	TMET2
1V-ER01	680-24740- 58	2/27/2007	Equipment Blank	X	X	X	
2V-ER01	680-24740- 59	2/28/2007	Equipment Blank	X	X	X	
REF-ER01	680-24740- 60	3/1/2007	Equipment Blank				X
1V-FB01	680-24740- 61	2/27/2007	Field Blank	X	X	X	

PAH Polynuclear Aromatic Hydrocarbons
APP IX PEST Appendix IX Organochlorine Pesticides
APP IX MET Appendix IX Metals
TMET2 Total Metals: Copper, Lead, Mercury, Zinc

SEVERN TRENT - SAVANNAH SDG PRN20478

DataQual

Environmental Services, LLC

Michael Baker Jr., Inc.
Airside Business Park
100 Airside Drive
Moon Township, PA 15108

October 31, 2006
SDG# PRN20478, STL Savannah
SWMU 45, CTO-0108, Ceiba Puerto Rico

Dear Mr. Kimes,

The following Data Validation report is provided as requested for the parameters noted in the table below for SDG # PRN20478. The site is in Region II. The validation was performed using the Region II SOP HW-23B, Revision 1.0 for SW-846 method 8082 for AR1260 and the Region II SOP HW-2 Revision 13 for the evaluation of metals data, as applicable. All areas of concern are discussed in the body of the report and a summary of data qualifications is provided.

Sample ID	Lab ID	Matrix	AR1260	Select Metals
45B-SD01V	680-20478-1	sediment	X	X
REF1-SD04V	680-20478-10	sediment	X	X
REF1-SD05V	680-20478-11	sediment	X	X
REF1-SD06V	680-20478-12	sediment	X	X
REF2-SD01V	680-20478-13	sediment	X	X
REF2-SD02V	680-20478-14	sediment	X	X
REF2-SD03V	680-20478-15	sediment	X	X
REF2-SD04V	680-20478-16	sediment	X	X
REF2-SD04VMS	680-20478-16S	sediment	X	X
REF2-SD04VMSD	680-20478-16SD	sediment	X	X
REF2-SD04VD	680-20478-17	sediment	X	X
REF1-SD05V	680-20478-18	sediment	X	X
REF1-SD06V	680-20478-19	sediment	X	X
45B-SD02V	680-20478-2	sediment	X	X
REF3-SD01V	680-20478-20	sediment	X	X
REF3-SD01VD	680-20478-21	sediment	X	X
REF3-SD02V	680-20478-22	sediment	X	X
45B-SD03V	680-20478-3	sediment	X	X
45B-SD04V	680-20478-4	sediment	X	X
45B-SD05V	680-20478-5	sediment	X	X
45B-SD06V	680-20478-6	sediment	X	X
REF1-SD01V	680-20478-7	sediment	X	X
REF1-SD02V	680-20478-8	sediment	X	X
REF1-SD03V	680-20478-9	sediment	X	X
45B-ER01V	680-20478-23	water	X	X
45B-FB01V	680-20478-24	water	X	X

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The field quality control samples provided with this SDG included REF2-SD04VD-field duplicate of sample REF2-SD04V; REF3-SD01VD-field duplicate of sample REF3-SD01V; 45B-ER01V-rinse blank and 45B-FB01V-field blank. The samples were evaluated based on the following criteria:

- Data Completeness *
- Technical Holding Times *
- Initial/Continuing Calibrations *
- CRDL Standards *
- Interference Check Sample *
- Blanks
- Laboratory Control Samples *
- Matrix Spike Recoveries *
- Matrix Duplicate RPDs *
- Post Digestion Spike Recoveries *
- Serial Dilutions *
- Field Duplicates
- Identification/Quantitation
- Reporting Limits *

- - indicates that no qualifications were required based on this criteria

Overall Evaluation of Data/Potential Usability Issues

Specific details regarding qualification of the data are addressed in the Specific Evaluation section of this narrative. If an issue is not addressed there were no actions required based on unmet quality criteria.

Major Problems

Metals

The field duplicate pair of samples REF3-SD01V and REF3-SD01VD exhibited non-compliant reproducibility for lead (absolute difference is 2.93, which is greater than +/- 4X the CRDL for results < 5X the CRDL). Region II guidelines requires rejection of detected results >/= MDL but < 5X CRDL in the field sample and its duplicate. Therefore, the reported result for lead in the field sample was rejected, R. The result reported in the field duplicate sample was greater than 5X the CRDL and therefore, was not rejected.

Minor Problems

Issues requiring qualification of the analytical data were found in the validation of this SDG. A summary of these issues is presented in the following paragraphs. All results qualified as estimated J/UJ should be considered usable but estimated.

Metals

The preparation blank exhibited contamination for zinc for which qualification of the data was required.

AR1260 & Metals

Many of the samples exhibited %solids less than 50% but greater than 10%. Reported results in these samples were qualified as estimated J/UJ based on Region II guidelines.

Specific Evaluation of Data

Data Completeness

Resubmissions were required for the Form 10s submitted for the MS and MSD pair for the PCB data package. Errors were noted in the reporting of the two column quantitation results on these forms and the moisture results were not taken into consideration in the calculation of the results on the Form 10s or in the raw data. The LIMS forms (form 3s and form 1s) were reported correctly. The laboratory resubmitted corrected Form 10s and raw data for the MS and MSD. No other resubmissions were required. A copy of the e-mail correspondence is included in the validation worksheets.

Technical Holding Times

According to chain of custody records, sampling was performed on 9/20-21/06 and samples were received at the laboratory 9/22/06. All sample preparation and analysis was performed within Region II holding time requirements.

Metals

Blanks

In establishing action limits for the metals analytes, the highest concentration reported in associated blanks is used. This is the concentration noted in the following table tabulating blank contamination. If an analyte was detected in a blank but no action was required, it is not listed in the following table. Qualifications were required due to preparation blank contamination.

Blank ID	Analyte	Concentration	Action Level
PB1	zinc	0.422200J mg/Kg	RL

Concentration noted must be adjusted for sample aliquot and moisture content when comparing to associated field samples.

Associated samples and required qualifications are noted in the following table.

Sample ID	Analyte	Q Flag
REF2-SD01V, REF2-SD03V, REF2-SD04V, REF2-SD04VD, REF2-SD05V, REF2-SD06V	lead	U at RL

Identification/Quantitation

AR1260 and Metals

Many of the samples in this SDG exhibited %Solids values <50% but greater than 10%. Region II requires that all results be qualified as estimated J/UJ. Reported results for AR1260 and the metals analytes were qualified as estimated in samples REF1-SD01V, REF1-SD05V, REF2-SD01V, REF2-SD02V and REF2-SD06V.

A summary of qualifications required is provided on the following page. Please do not hesitate to contact DataQual ES with any questions regarding this validation report.

Sincerely,

Jacqueline Cleveland

Jacqueline Cleveland
Vice-President

Summary of Data Qualifications

AR1260

Sample ID	Compound	Results	Q Flag
REF1-SD01V, REF1-SD05V, REF2-SD01V, REF2-SD02V and REF2-SD06V	AR1260	+/-	J/UJ

Metals

Sample ID	Analyte	Results	Q Flag
REF2-SD01V, REF2-SD03V, REF2-SD04V, REF2-SD04VD, REF2-SD05V, REF2-SD06V	zinc	+B	U at RL
REF3-SD01V	lead	+	R
REF3-SD01V, REF3-SD01VD	zinc	+	J
REF1-SD01V, REF1-SD05V, REF2-SD01V, REF2-SD02V and REF2-SD06V	all analytes	+/-	J/UJ

Glossary of Qualification Flags and Abbreviations

Qualification Flags (Q-Flags)

U	not detected above the reported sample quantitation limit
J	estimated value
UJ	reported quantitation limit is qualified as estimated
R	result is rejected; the presence or absence of the analyte cannot be verified
D	result value is based on dilution analysis result
NJ	analyte has been tentatively identified, estimated value
J-	analyte present, biased low
UL	not detected, quantitation limit is probably higher
J+	analyte present, biased high
Q	estimated dioxin/furan concentration
I	interferences present which may cause the results to be biased high

Method Blank Qualification Flags (Q-Flags)

NA	The sample result for the blank contaminant is greater than the sample CRDL and is greater than the action level. The sample result for the blank contaminant is not qualified with any blank qualifiers.
U OR RL	The sample result for the blank contaminant is less than or greater than the sample RL and is less than the action level. The sample result for the blank contaminant is qualified as U or RL depending on the concentration of the result.

General Abbreviations

IDL	Instrument Detection Limit
MDL	Method Detection Limit
RL	Contract Required Reporting Limit
+	positive result
-	non-detect result

SEVERN TRENT - PITTSBURGH SDG C7E010111

Project: Aquatic BERA, SWMU 1 and 2, CTO-108
Laboratory: Severn Trent Laboratories
Sample Delivery Group: C7E010111
Fraction: Inorganic
Matrix: Soil
Report Date: 6/21/2007

This analytical quality assurance report is based upon a review of analytical data generated for soil samples. Two field duplicate samples and one matrix spike sample were submitted with the samples for this Sample Delivery Group. The sample locations, laboratory identification numbers, sample collection dates, sample matrix, and analyses performed are presented in Table 1.

The samples were analyzed for total metals: cadmium, copper, lead, antimony, tin, zinc, and nickel, and mercury. The sample analyses were performed in accordance with the procedures outlined in the method referenced at the end of this report.

All sample analyses have undergone an analytical quality assurance review to ensure adherence to the required protocols. Results have been validated or qualified according to general guidance provided in "Evaluation of Metals Data for the CLP Program", SOP HW-2, Revision 13, September 2005. The parameters presented on the following page were evaluated.

X	•	Data Completeness
X	•	Chain of Custody Documentation
X	•	Holding Times
X	•	Initial and Continuing Calibrations
X	•	ICP Interference Check Sample Results
X	•	Laboratory and Field Blank Analysis Results
X	•	Matrix Spike Recoveries and Reproducibility
	•	Laboratory Duplicate Analysis Results
X	•	ICP Serial Dilution Results
X	•	Field Duplicate Analysis Results
X	•	Laboratory Control Sample Results
	•	GFAA Post-Digestion Spike Recovery/Duplicate Burn Precision
X	•	Qualitative Identification
X	•	Quantitation/Reporting Limits

X - Denotes parameter evaluated.

It is recommended that the data only be used according to the qualifiers presented, and discussed in this report. All other data should be considered qualitatively and quantitatively valid as reported by the laboratory, based on the items evaluated.

Report Approved By:

Shawne M. Rodgers
President

6/24/2007
Date

1.0 DATA COMPLETENESS

The matrix spike summary form for mercury presented an incorrect spike amount and percent recovery. The laboratory was contacted and provided the revised form.

The data package was missing the ICP-MS internal standard summary forms. The laboratory was contacted and provided responded that the %recoveries were presented in the raw data and did not provide forms.

2.0 CHAIN OF CUSTODY DOCUMENTATION

All chain of custody documentation was complete.

3.0 HOLDING TIMES

All criteria were met. No qualifiers were applied.

4.0 INITIAL AND CONTINUING CALIBRATIONS

All criteria were met. No qualifiers were applied.

5.0 ICP INTERFERENCE CHECK SAMPLE RESULTS

All criteria were met. No qualifiers were applied.

6.0 LABORATORY AND FIELD BLANK ANALYSIS RESULTS

Positive results reported in the associated continuing calibration blanks and/or preparation blanks have been presented in Table 2. The analytes were detected in the associated continuing calibration blanks and/or preparation blanks at levels less than the quantitation limit, indicating the possibility of a false positive at this level. However, all results are greater than the reporting limit and no qualification is necessary.

Positive results reported in the associated equipment blanks and/or field blanks have been presented in Table 2. The analytes were detected in the associated equipment blanks and/or field blanks at levels greater than the quantitation limit. However, all results are greater than the ten times the blank concentration and no qualification is necessary.

7.0 *MATRIX SPIKE/MATRIX SPIKE DUPLICATE RECOVERIES AND REPRODUCIBILITY*

The quantitation limits and/or positive results reported for copper, lead, antimony, tin, zinc, and nickel for all samples should be considered biased low quantitative estimates, and may be higher than reported. Low recoveries for these analytes were obtained for the associated matrix spike analyses. The low recoveries indicate the presence of interferences in samples of similar matrix. The positive results for these analytes have been marked with "J" qualifiers to indicate that they are biased low quantitative estimates. Quantitation limits have been marked "UJ".

8.0 *LABORATORY DUPLICATE RESULTS*

Laboratory duplicate analysis was not performed for the samples in this SDG. Therefore, the sample data cannot be evaluated based on this parameter.

9.0 *ICP SERIAL DILUTION RESULTS*

All criteria were met. No qualifiers were applied.

10.0 *FIELD DUPLICATE RESULTS*

Duplicate samples, IB-REF-SS04 and IB-REF-SS04A and IB-SS04 and IB-SS04D, were submitted to the laboratory to evaluate sampling and analytical precision for those analytes determined to be present. Results for these duplicate samples are presented in Tables 3 and 4, respectively. The Region II criteria were met for the field duplicate samples.

11.0 LABORATORY CONTROL SAMPLE RESULTS

All criteria were met. No qualifiers were applied.

12.0 GFAA POST-DIGESTION SPIKE/DUPLICATE BURN

This parameter is not applicable to the analyses performed.

13.0 QUALITATIVE IDENTIFICATION

All criteria were met. No qualifiers were applied.

14.0 QUANTITATION/REPORTING LIMITS

All criteria were met. No qualifiers were applied.

METHODOLOGY REFERENCES

Analysis	Reference
Metals	Method 6020, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997
Mercury	Method 7471A, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997

Table 1 Samples For Data Validation Review
Aquatic BERA SWMU 1 and 2 (CTO-108)
Soil Samples Collected April 2007
Severn Trent Sample Delivery Group C7E010111

SAMPLE I.D.	LABORATORY I.D	DATE COLLECTED	MATRIX	ANALYSES PERFORMED		
				PEST	TMET1	TMET2
1B-REF-SS01	C7E010111 1	4/29/2007	Soil	X	X	
1B-REF-SS02	C7E010111 2	4/29/2007	Soil	X	X	
1B-REF-SS03	C7E010111 3	4/29/2007	Soil	X	X	X
1B-REF-SS04	C7E010111 4	4/29/2007	Soil	X	X	X
1B-REF-SS04D	C7E010111 5	4/29/2007	Soil	X	X	X
1B-REF-SS05	C7E010111 6	4/29/2007	Soil	X	X	X
1B-REF-SS06	C7E010111 7	4/29/2007	Soil	X	X	X
1B-SS01	C7E010111 8	4/28/2007	Soil	X	X	
1B-SS02	C7E010111 9	4/28/2007	Soil	X	X	
1B-SS03	C7E010111 10	4/28/2007	Soil	X	X	
1B-SS04	C7E010111 11	4/28/2007	Soil	X	X	
1B-SS04D	C7E010111 12	4/28/2007	Soil	X	X	
1B-SS05	C7E010111 13	4/28/2007	Soil	X	X	
1B-SS06	C7E010111 14	4/28/2007	Soil	X	X	
1B-SS07	C7E010111 15	4/28/2007	Soil	X	X	
1B-SS08	C7E010111 16	4/28/2007	Soil	X	X	
1B-SS09	C7E010111 17	4/28/2007	Soil	X	X	
1B-SS10	C7E010111 18	4/28/2007	Soil	X	X	
1B-SS11	C7E010111 19	4/28/2007	Soil	X	X	
1B-SS12	C7E010111 20	4/28/2007	Soil	X	X	

PEST 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT
TMET1 Total Metals: Antimony, Cadmium, Copper, Lead, Mercury, Tin, and Zinc
TMET2 Total Nickel

Table 2 **Blank Results for Inorganic Analyses**

BLANK	ANALYTE	CONCENTRATION /UNITS		ASSOC. SAMPLES
PB1	Copper	0.021	mg/L	All Samples
CCB1	Lead	0.00005	mg/L	IB-SS08, IBSS09, IBSS10, IB-SS11, IB-SS12
	Zinc	0.00012	mg/L	
IB-FB01	Copper	3.4	µg/L	All Samples

Table 3 Field Duplicate Sample Results for Inorganic Parameters
Duplicate Samples 1B-REF-SS04 and 1B-REF-SS04D

Analyte	1B-REF-SS04 (mg/Kg)		1B-REF-SS04 (mg/Kg)		RPD	FOOT NOTES
Mercury	0.027	J	0.032	J	16.9	
Cadmium	0.10	J	0.11	J	9.5	
Copper	78.3	B	78.2	B	0.1	
Nickel	17.8		18.1		1.7	
Lead	3.6		4.1		13.0	
Antimony	0.017	J	0.034	J	66.7	<5xRL
Tin	0.22	J	0.36	J	48.3	<5xRL
Zinc	40.3	E	42.6		5.5	

Table 4 Field Duplicate Sample Results for Inorganic Parameters
Duplicate Samples 1B-SS04 and 1B-SS04D

Analyte	1B-SS04 (mg/Kg)		1B-SS04D (mg/Kg)		RPD	FOOT NOTES
Mercury	0.028	J	0.028		0.0	
Cadmium	0.026	J	0.020	J	26.1	
Copper	89.9	B	86.9	B	3.4	
Lead	0.78		0.70		10.8	
Antimony	ND		ND		NC	
Tin	ND		ND		NC	
Zinc	20.4		19.2		6.1	

Project: Aquatic BERA, SWMU 1 and 2, CTO-108
Laboratory: Severn Trent Laboratories
Sample Delivery Group: C7E010111
Fraction: Organic
Matrix: Soil
Report Date: 6/21/2007

This analytical quality assurance report is based upon a review of analytical data generated for soil samples. Two field duplicate samples and one matrix spike sample were submitted with the samples for this Sample Delivery Group. The sample locations, laboratory identification numbers, sample collection dates, sample matrix, and analyses performed are presented in Table 1.

The samples were analyzed for pesticide constituents: 4,4'DDE, 4,4'-DDD, and 4,4'-DDT. The sample analyses were performed in accordance with the procedures outlined in the method referenced at the end of this report.

All sample analyses have undergone an analytical quality assurance review to ensure adherence to the required protocols. Results have been validated or qualified according to Region II "SW-846 Method 8080A/8000A", SOP HW-23, Revision 0, April 1995. The parameters presented on the following page were evaluated.

X	•	Data Completeness
X	•	Chain of Custody Documentation
X	•	Holding Times
	•	Instrument Performance
X	•	Initial and Continuing Calibrations
X	•	Laboratory and Field Blank Analysis Results
X	•	Surrogate Compound Recoveries
X	•	Matrix Spike/Matrix Spike Duplicate Recoveries and Reproducibility
X	•	Field Duplicate Analysis Results
X	•	Laboratory Control Sample Results
	•	Internal Standard Performance
X	•	Qualitative Identification
X	•	Quantitation/Reporting Limits

X - Denotes parameter evaluated.

It is recommended that the data only be used according to the qualifiers presented, and discussed in this report. All other data should be considered qualitatively and quantitatively valid as reported by the laboratory, based on the items evaluated.

Report Approved By:

Shawne M. Rodgers
President

6/24/2007

Date

1.0 *DATA COMPLETENESS*

GC columns descriptions were not presented in the case narrative. The laboratory was contacted and provided the missing information.

Pesticide extract clean-up descriptions were not presented in the case narrative. The laboratory was contacted and provided the missing information.

2.0 *CHAIN OF CUSTODY DOCUMENTATION*

The chain of custody documentation was complete.

3.0 *HOLDING TIMES*

All criteria were met. No qualifiers were applied.

4.0 *INSTRUMENT PERFORMANCE*

This parameter is not applicable to the analyses performed.

5.0 *INITIAL AND CONTINUING CALIBRATIONS*

All criteria were met. No qualifiers were applied.

6.0 *LABORATORY AND FIELD BLANK ANALYSIS RESULTS*

All criteria were met. No qualifiers were applied.

7.0 SURROGATE COMPOUND RECOVERIES

All criteria were met. No qualifiers were applied.

8.0 MATRIX SPIKE/MATRIX SPIKE DUPLICATE RECOVERIES AND REPRODUCIBILITY

All criteria were met. No qualifiers were applied.

9.0 FIELD DUPLICATE RESULTS

Duplicate samples, IB-REF-SS04 and IB-REF-SS04A and IB-SS04 and IB-SS04D, were submitted to the laboratory to evaluate sampling and analytical precision for those analytes determined to be present. Duplicate samples, IB-REF-SS04 and IB-REF-SS04A, did not have any positive results reported. Results for the field duplicate samples IB-SS04 and IB-SS04D are presented in Table 2. The Region II criteria were met for the field duplicate samples.

10.0 LABORATORY CONTROL SAMPLE RESULTS

All criteria were met. No qualifiers were applied.

11.0 INTERNAL STANDARD PERFORMANCE

All criteria were met. No qualifiers were applied.

12.0 QUALITATIVE IDENTIFICATION

All criteria were met. No qualifiers were applied.

13.0 *QUANTITATION/REPORTING LIMITS*

The positive result reported for 4,4'-DDD for sample IB-SS11 was reported by the laboratory at a concentration greater than the quantitation limit. Poor precision (greater than 100% difference between results) was observed for this analyte on the dual chromatographic columns used for sample analysis. The positive 4,4'-DDD result has been rejected and should be considered suspect. The result has been marked "R" to indicate this.

The following pesticide constituents were reported by the laboratory at concentrations less than the quantitation limit. Poor precision (greater than 50 % difference between results) was observed for these analytes on the dual chromatographic columns used for sample analysis. The positive pesticide constituent results should be considered non-detected at the quantitation limit. The results have been replaced with the quantitation limit and marked "U".

Sample	Affected Compound
IB-SS04	4,4'-DDD
IB-SS06	4,4'-DDD

The following pesticide constituents were reported by the laboratory at concentrations greater than the quantitation limit. Poor precision (greater than 26% difference, but less than 70% difference between results) was observed for these analytes on the dual chromatographic columns used for sample analysis. The positive pesticide/PCB constituent results should be considered quantitative estimates. The results have been marked "J" to indicate this.

Sample	Affected Compound
IB-SS09	4,4'-DDD
IB-SS11	4,4'-DDT
IB-SS12	4,4'-DDT

The following pesticide constituents were reported by the laboratory at concentrations greater than the quantitation limit. Poor precision (greater than 70% difference, but less than 100% difference between results) was observed for these analytes on the dual chromatographic columns used for sample analysis. The positive pesticide/PCB constituent results should be considered quantitative estimates. The results have been marked "NJ" to indicate this.

Sample	Affected Compound
IB-SS12	4,4'-DDD

All samples were analyzed at a five-fold dilution, except for IB-SS06, which was analyzed at a ten-fold dilution, for pesticide constituents. The dilution analyses were performed because of the suspected presence of high levels of target compounds and/or interferences. Reporting limits are elevated by the dilution factor for these samples for target compounds that were not detected. The elevated reporting limits should be noted when assessing the data for these samples.

As required by USEPA protocol, all compounds, which were qualitatively identified at concentrations below their respective Reporting Limits (RLs), have been marked with "J" qualifiers to indicate that they are quantitative estimates.

METHODOLOGY REFERENCES

Analysis	Reference
Pesticide Constituents	Method 8081A, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997

Table 1 Samples For Data Validation Review
Aquatic BERA SWMU 1 and 2 (CTO-108)
Soil Samples Collected April 2007
Severn Trent Sample Delivery Group C7E010111

SAMPLE I.D.	LABORATORY I.D		DATE COLLECTED	MATRIX	ANALYSES PERFORMED		
					PEST	TMET1	TMET2
1B-REF-SS01	C7E010111	1	4/29/2007	Soil	X	X	
1B-REF-SS02	C7E010111	2	4/29/2007	Soil	X	X	
1B-REF-SS03	C7E010111	3	4/29/2007	Soil	X	X	X
1B-REF-SS04	C7E010111	4	4/29/2007	Soil	X	X	X
1B-REF-SS04D	C7E010111	5	4/29/2007	Soil	X	X	X
1B-REF-SS05	C7E010111	6	4/29/2007	Soil	X	X	X
1B-REF-SS06	C7E010111	7	4/29/2007	Soil	X	X	X
1B-SS01	C7E010111	8	4/28/2007	Soil	X	X	
1B-SS02	C7E010111	9	4/28/2007	Soil	X	X	
1B-SS03	C7E010111	10	4/28/2007	Soil	X	X	
1B-SS04	C7E010111	11	4/28/2007	Soil	X	X	
1B-SS04D	C7E010111	12	4/28/2007	Soil	X	X	
1B-SS05	C7E010111	13	4/28/2007	Soil	X	X	
1B-SS06	C7E010111	14	4/28/2007	Soil	X	X	
1B-SS07	C7E010111	15	4/28/2007	Soil	X	X	
1B-SS08	C7E010111	16	4/28/2007	Soil	X	X	
1B-SS09	C7E010111	17	4/28/2007	Soil	X	X	
1B-SS10	C7E010111	18	4/28/2007	Soil	X	X	
1B-SS11	C7E010111	19	4/28/2007	Soil	X	X	
1B-SS12	C7E010111	20	4/28/2007	Soil	X	X	

PEST 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT

TMET1 Total Metals: Antimony, Cadmium, Copper, Lead, Mercury, Tin, and Zinc

TMET2 Total Nickel

Table 2 **Field Duplicate Sample Results for Organic Results**
Soil Duplicate Samples 1B-SS04 and 1B-SS04D

Compound	Sample Results (µg/Kg)		Field Duplicate Results (µg/Kg)	RPD	FOOT NOTES
	1B-SS04		1B-SS04D		
4,4'-DDD	4.1	J	ND	NC	
4,4'-DDE	2.9	J	ND	NC	
4,4'-DDT	6.9	J	ND	NC	

* Precision criteria exceeded

NC Results not calculated due to already considered estimated or one results was not detected (ND).

ND Not detected.

SEVERN TRENT - BURLINGTON SDG 119805

Project: Aquatic BERA, SWMU 1 and 2, CTO-108
Laboratory: Severn Trent Laboratories
Sample Delivery Group: 119805
Fraction: Inorganic
Matrix: Soil
Report Date: 7/6/2007

This analytical quality assurance report is based upon a review of analytical data generated for soil samples. One field duplicate sample and one matrix spike sample were submitted with the samples for this Sample Delivery Group. The sample locations, laboratory identification numbers, sample collection dates, sample matrix, and analyses performed are presented in Table 1.

The samples were analyzed for total metals: cadmium, copper, lead, antimony, tin, zinc, and nickel, and mercury. The sample analyses were performed in accordance with the procedures outlined in the method referenced at the end of this report.

All sample analyses have undergone an analytical quality assurance review to ensure adherence to the required protocols. Results have been validated or qualified according to general guidance provided in "Evaluation of Metals Data for the CLP Program", SOP HW-2, Revision 13, September 2005. The parameters presented on the following page were evaluated.

X	•	Data Completeness
X	•	Chain of Custody Documentation
X	•	Holding Times
X	•	Initial and Continuing Calibrations
X	•	ICP Interference Check Sample Results
X	•	Laboratory and Field Blank Analysis Results
X	•	Matrix Spike Recoveries and Reproducibility
X	•	Laboratory Duplicate Analysis Results
X	•	ICP Serial Dilution Results
X	•	Field Duplicate Analysis Results
X	•	Laboratory Control Sample Results
	•	GFAA Post-Digestion Spike Recovery/Duplicate Burn Precision
X	•	Qualitative Identification
X	•	Quantitation/Reporting Limits

X - Denotes parameter evaluated.

It is recommended that the data only be used according to the qualifiers presented, and discussed in this report. All other data should be considered qualitatively and quantitatively valid as reported by the laboratory, based on the items evaluated.

Report Approved By:

Shawne M Rodgers

Shawne M. Rodgers
President

7/6/2007 Rev 1/6/2009
Date

1.0 DATA COMPLETENESS

The data package was complete.

2.0 CHAIN OF CUSTODY DOCUMENTATION

All chain of custody documentation was complete.

3.0 HOLDING TIMES

All criteria were met. No qualifiers were applied.

4.0 INITIAL AND CONTINUING CALIBRATIONS

All criteria were met. No qualifiers were applied.

5.0 ICP INTERFERENCE CHECK SAMPLE RESULTS

All criteria were met. No qualifiers were applied.

6.0 LABORATORY AND FIELD BLANK ANALYSIS RESULTS

The antimony result reported for sample 1B-SS17 is considered to be a nondetect due to the presence of this analytes in the associated preparation blanks. This analytes was detected in the associated blank at a level less than the quantitation limit, indicating the possibility of a false positive at this level. The affected result is less than the quantitation limit. Replacing the sample result with the quantitation limit and marking it "U" has indicated this.

7.0 *MATRIX SPIKE/MATRIX SPIKE DUPLICATE RECOVERIES AND REPRODUCIBILITY*

The positive results reported for cadmium and tin for the samples should be considered biased high quantitative estimates, and may be lower than reported. High recoveries for these analytes were obtained for the associated matrix spike analyses. The high recoveries indicate the presence of interferences in samples of similar matrix. The positive results for these analytes have been marked with "J" qualifiers to indicate that they are biased high quantitative estimates.

The positive results reported for antimony for all samples, except 1B-SS16, 1B-SS17, 1B-SS22, 1B-SS23, 1B-SS24, 1B-SS24D, 1B-SS26, 1B-SS27, 1B-SS29, and 1B-SS30 should be considered biased low quantitative estimates, and may be higher than reported. A low recovery for this analyte was obtained for the associated matrix spike analysis. The low recovery indicates the presence of interferences in samples of similar matrix. The positive results for antimony have been marked with "J" qualifiers to indicate that they are biased low quantitative estimates.

8.0 *LABORATORY DUPLICATE RESULTS*

All criteria were met. No qualifiers were applied.

9.0 *ICP SERIAL DILUTION RESULTS*

All criteria were met. No qualifiers were applied.

10.0 *FIELD DUPLICATE RESULTS*

Duplicate samples 1B-SS14 and 1B-SS14D, and 1B-SS24 and 1B-SS24D were submitted to the laboratory to evaluate sampling and analytical precision for those analytes determined to be present. Results for these duplicate samples are presented in Tables 2 and 3, respectively. The Region II criteria were met for the field duplicate samples, except for copper for samples 1B-SS14 and 1B-SS14D (% RPD of 182.3), and lead for samples 1B-SS24 and 1B-SS24D (% RPD of 176.7). The lack of homogeneity for the duplicate samples indicates presence of severe interferences. The results for copper for samples 1B-SS14 and 1B-SS14D, and lead for samples 1B-SS24 and 1B-SS24D have been rejected and should be considered suspect. These results have been marked "R".

11.0 LABORATORY CONTROL SAMPLE RESULTS

All criteria were met. No qualifiers were applied.

12.0 GFAA POST-DIGESTION SPIKE/DUPLICATE BURN

This parameter is not applicable to the analyses performed.

13.0 QUALITATIVE IDENTIFICATION

All criteria were met. No qualifiers were applied.

14.0 QUANTITATION/REPORTING LIMITS

All criteria were met. No qualifiers were applied.

METHODOLOGY REFERENCES

Analysis	Reference
Metals	Method 6010B, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997
Metals	Method 6020, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997
Mercury	Method 7471A, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997

Table 1 Samples For Data Validation Review
Aquatic BERA SWMU 1 and 2 (CTO-108)
Soil Samples Collected April 2007
Severn Trent Sample Delivery Group 119805

SAMPLE I.D.	LABORATORY I.D	DATE COLLECTED	MATRIX	ANALYSES PERFORMED PEST	TMET1
1B-SS13	708843	4/28/2007	Soil	X	X
1B-SS14	708844	4/28/2007	Soil	X	X
1B-SS14D	708845	4/28/2007	Soil	X	X
1B-SS15	708846	4/28/2007	Soil	X	X
1B-SS16	708847	4/28/2007	Soil	X	X
1B-SS17	708848	4/28/2007	Soil	X	X
1B-SS18	708849	4/28/2007	Soil	X	X
1B-SS19	708850	4/28/2007	Soil	X	X
1B-SS20	708851	4/28/2007	Soil	X	X
1B-SS21	708852	4/28/2007	Soil	X	X
1B-SS22	708853	4/28/2007	Soil	X	X
1B-SS23	708854	4/28/2007	Soil	X	X
1B-SS24	708855	4/28/2007	Soil	X	X
1B-SS24D	708856	4/28/2007	Soil	X	X
1B-SS25	708857	4/28/2007	Soil	X	X
1B-SS26	708858	4/28/2007	Soil	X	X
1B-SS27	708859	4/28/2007	Soil	X	X
1B-SS28	708860	4/28/2007	Soil	X	X
1B-SS29	708861	4/28/2007	Soil	X	X
1B-SS30	708862	4/28/2007	Soil	X	X

PEST 4,4'-DDD, 4,4'-DDE, 4,4'-DDT

TMET1 Total Metals: Antimony, Cadmium, Copper, Lead, Mercury, Tin, Zinc

Table 2 Field Duplicate Sample Results for Inorganic Parameters
Duplicate Samples 1B-SS14 and 1B-SS14D

Analyte	1B-SS14 (mg/Kg)		1B-SS14D (mg/Kg)		RPD	FOOT NOTES
Antimony	35.4	J	37.9	J	6.8	
Cadmium	7.7	J	11.4	J	38.7	Already Qualified
Copper	1030		22300		182.3	*
Lead	1330		929		35.5	
Mercury	0.87		0.82		5.9	
Tin	148	J	119	J	21.7	
Zinc	2940		2710		8.1	

* Precision criteria exceeded

NC Results not calculated due to already considered estimated or one results was not detected (ND).

NE Not detected.

Table 3 Field Duplicate Sample Results for Inorganic Parameters
Duplicate Samples 1B-SS24 and 1B-SS24D

Analyte	1B-SS24 (mg/Kg)		1B-SS24D (mg/Kg)		RPD	FOOT NOTES
Antimony	11.2	J	3.6		102.7	Already Qualified
Cadmium	1.1	J	1.3	J	16.7	
Copper	78.0		80.1		2.7	
Lead	929		57.4		176.7	*
Mercury	0.084		0.087		3.5	
Tin	223	J	6.3	J	189.0	Already Qualified
Zinc	116		106		9.0	

* Precision criteria exceeded

NC Results not calculated due to already considered estimated or one results was not detected (ND).

ND Not detected.

Project: Aquatic BERA, SWMU 1 and 2, CTO-108
Laboratory: Severn Trent Laboratories
Sample Delivery Group: 119805
Fraction: Organic
Matrix: Soil
Report Date: 7/6/2007 (Revised 1/5/2009)

This analytical quality assurance report is based upon a review of analytical data generated for soil samples. One field duplicate sample and one matrix spike/matrix spike duplicate sample were submitted with the samples for this Sample Delivery Group. The sample locations, laboratory identification numbers, sample collection dates, sample matrix, and analyses performed are presented in Table 1.

The samples were analyzed for pesticide compounds: 4, 4'DDE, 4, 4'-DDD, and 4, 4'-DDT. The sample analyses were performed in accordance with the procedures outlined in the method referenced at the end of this report.

All sample analyses have undergone an analytical quality assurance review to ensure adherence to the required protocols. Results have been validated or qualified according to Region II "SW-846 Method 8080A/8000A", SOP HW-23, Revision 0, April 1995. The parameters presented on the following page were evaluated.

X	•	Data Completeness
X	•	Chain of Custody Documentation
X	•	Holding Times
	•	Instrument Performance
X	•	Initial and Continuing Calibrations
X	•	Laboratory and Field Blank Analysis Results
X	•	Surrogate Compound Recoveries
X	•	Matrix Spike/Matrix Spike Duplicate Recoveries and Reproducibility
X	•	Field Duplicate Analysis Results
X	•	Laboratory Control Sample Results
	•	Internal Standard Performance
X	•	Qualitative Identification
X	•	Quantitation/Reporting Limits

X - Denotes parameter evaluated.

It is recommended that the data only be used according to the qualifiers presented, and discussed in this report. All other data should be considered qualitatively and quantitatively valid as reported by the laboratory, based on the items evaluated.

Report Approved By:

Shawne M. Rodgers
President

7/ 6 /2007
Revised 1/6/2009
Date

1.0 DATA COMPLETENESS

The data package was complete.

2.0 CHAIN OF CUSTODY DOCUMENTATION

The chain of custody documentation was complete.

3.0 HOLDING TIMES

All criteria were met. No qualifiers were applied.

4.0 INSTRUMENT PERFORMANCE

This parameter is not applicable to the analyses performed.

5.0 INITIAL AND CONTINUING CALIBRATIONS

The laboratory evaluated the samples using guidance given in the DOD QSM Final Version 3, which allows for 20% difference as the continuing calibration verification criteria. This is a deviation from Method 8081A, which allows for a 15% difference. This has been noted in the case narrative.

6.0 LABORATORY AND FIELD BLANK ANALYSIS RESULTS

All criteria were met. No qualifiers were applied.

7.0 SURROGATE COMPOUND RECOVERIES

All criteria were met. No qualifiers were applied.

8.0 MATRIX SPIKE/MATRIX SPIKE DUPLICATE RECOVERIES AND REPRODUCIBILITY

All criteria were met. No qualifiers were applied.

9.0 FIELD DUPLICATE RESULTS

Duplicate samples 1B-SS14 and 1B-SS14D, and 1B-SS24 and 1B-SS24Dwere submitted to the laboratory to evaluate sampling and analytical precision for those analytes determined to be present. Results for these duplicate samples are presented in Tables 2 and 3. Precision is evaluated by calculating the relative percent difference (%RPD) between duplicate pair results. There are no USEPA-established acceptance criteria for field duplicate samples. EDQ uses internal acceptance criteria of forty percent for extractable compounds to evaluate soil field duplicate samples.

10.0 LABORATORY CONTROL SAMPLE RESULTS

All criteria were met. No qualifiers were applied.

11.0 INTERNAL STANDARD PERFORMANCE

All criteria were met. No qualifiers were applied.

12.0 *QUALITATIVE IDENTIFICATION*

All criteria were met. No qualifiers were applied.

13.0 *QUANTITATION/REPORTING LIMITS*

The following pesticide/PCB constituents were reported by the laboratory at concentrations greater than the quantitation limit. Poor precision (greater than 70 % difference between results) was observed for these analytes on the dual chromatographic columns used for sample analysis. The laboratory for reporting purposes used the higher concentration for these compounds. The result has been marked with "NJ" qualifiers to indicate that they are tentative identifications.

Sample	Affected Compound
1B-SS13	4,4'-DDT
1B-SS14	4,4'-DDT
1B-SS15	4,4'-DDT

For the following samples, a lack of precision (greater than 25 % difference between results) was observed for this analyte on the dual chromatographic columns used for sample analysis. The laboratory for reporting purposes used the higher concentration for these compounds. The result has been marked with "J" qualifiers to indicate that they are quantitative estimates.

Sample	Affected Compound
1B-SS29	4,4'-DDT
1B-SS14D	4,4'-DDT
1B-SS22	4,4'-DDT
1B-SS25	4,4'-DDE

The samples presented in the following table were analyzed at dilutions for pesticide constituents. The dilution analyses were performed because of the suspected presence of high levels of target compounds and/or interferences. Reporting limits are elevated by the dilution factor for these samples for target compounds that were not detected. The elevated reporting limits should be noted when assessing the data for these samples.

Sample	Dilution Factor
1B-SS13	5.0
1B-SS14	10.0
1B-SS14D	3.0
1B-SS16	10.0
1B-SS18	10.0
1B-SS19	200
1B-SS26	5.0
1B-SS27	3.0
1B-SS28	10.0
1B-SS29	5.0
1B-SS30	50.0

The samples presented below were re-analyzed at dilutions for pesticide constituents. The samples were re-analyzed because the responses for compounds exceeded the linear range of the GC instrument. The results for these compounds have been reported from the dilution analyses. All other results are reported from the initial analyses.

Sample	Dilution Factor	Results Exceeding the Linear Range
1B-SS14	30.0	4,4'-DDE
1B-SS14D	50.0	4,4'-DDE
1B-SS15	10.0	4,4'-DDE, 4,4'-DDT
1B-SS16	20.0	4,4'-DDE
1B-SS18	100	4,4'-DDE
1B-SS19	300	4,4'-DDT
1B-SS21	5.0	4,4'-DDE, 4,4'-DDT
1B-SS24	4.0	4,4'-DDE, 4,4'-DDT

As required by USEPA protocol, all compounds, which were qualitatively identified at concentrations below their respective Reporting Limits (RLs), have been marked with "J" qualifiers to indicate that they are quantitative estimates.

Methodology References

Analysis	Reference
Pesticide Constituents	Method 8081A, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997

Table 1 Samples For Data Validation Review
Aquatic BERA SWMU 1 and 2 (CTO-108)
Soil Samples Collected April 2007
Severn Trent Sample Delivery Group 119805

SAMPLE I.D.	LABORATORY I.D	DATE COLLECTED	MATRIX	ANALYSES PERFORMED PEST	ANALYSES PERFORMED TMET1
1B-SS13	708843	4/28/2007	Soil	X	X
1B-SS14	708844	4/28/2007	Soil	X	X
1B-SS14D	708845	4/28/2007	Soil	X	X
1B-SS15	708846	4/28/2007	Soil	X	X
1B-SS16	708847	4/28/2007	Soil	X	X
1B-SS17	708848	4/28/2007	Soil	X	X
1B-SS18	708849	4/28/2007	Soil	X	X
1B-SS19	708850	4/28/2007	Soil	X	X
1B-SS20	708851	4/28/2007	Soil	X	X
1B-SS21	708852	4/28/2007	Soil	X	X
1B-SS22	708853	4/28/2007	Soil	X	X
1B-SS23	708854	4/28/2007	Soil	X	X
1B-SS24	708855	4/28/2007	Soil	X	X
1B-SS24D	708856	4/28/2007	Soil	X	X
1B-SS25	708857	4/28/2007	Soil	X	X
1B-SS26	708858	4/28/2007	Soil	X	X
1B-SS27	708859	4/28/2007	Soil	X	X
1B-SS28	708860	4/28/2007	Soil	X	X
1B-SS29	708861	4/28/2007	Soil	X	X
1B-SS30	708862	4/28/2007	Soil	X	X

PEST 4,4'-DDD, 4,4'-DDE, 4,4'-DDT

TMET1 Total Metals: Antimony, Cadmium, Copper, Lead, Mercury, Tin, Zinc

SEVERN TRENT - SAVANNAH SDG SWMU26275-1

Project: Aquatic BERA, SWMU 1 and 2, CTO-108
Laboratory: Severn Trent Laboratories
Sample Delivery Group: SWMU26275-1
Fraction: Inorganic
Matrix: Soil
Report Date: 6/27/2007

This analytical quality assurance report is based upon a review of analytical data generated for soil samples. Two field duplicate samples and one matrix spike sample were submitted with the samples for this Sample Delivery Group. The sample locations, laboratory identification numbers, sample collection dates, sample matrix, and analyses performed are presented in Table 1.

The samples were analyzed for total metals: cadmium, copper, lead, antimony, tin, zinc, and nickel, and mercury. The sample analyses were performed in accordance with the procedures outlined in the method referenced at the end of this report.

All sample analyses have undergone an analytical quality assurance review to ensure adherence to the required protocols. Results have been validated or qualified according to general guidance provided in "Evaluation of Metals Data for the CLP Program", SOP HW-2, Revision 13, September 2005. The parameters presented on the following page were evaluated.

X	•	Data Completeness
X	•	Chain of Custody Documentation
X	•	Holding Times
X	•	Initial and Continuing Calibrations
X	•	ICP Interference Check Sample Results
X	•	Laboratory and Field Blank Analysis Results
X	•	Matrix Spike Recoveries and Reproducibility
X	•	Laboratory Duplicate Analysis Results
X	•	ICP Serial Dilution Results
X	•	Field Duplicate Analysis Results
X	•	Laboratory Control Sample Results
	•	GFAA Post-Digestion Spike Recovery/Duplicate Burn Precision
X	•	Qualitative Identification
X	•	Quantitation/Reporting Limits

X - Denotes parameter evaluated.

It is recommended that the data only be used according to the qualifiers presented, and discussed in this report. All other data should be considered qualitatively and quantitatively valid as reported by the laboratory, based on the items evaluated.

Report Approved By:

Shawne M. Rodgers
President

6/28/2007

Date

1.0 DATA COMPLETENESS

Zinc exceeded percent recovery criteria for the interference check standard analysis; however, this was not noted in the case narrative. The laboratory was contacted and provided the revised case narrative indicating that there was trace zinc contamination as determined by the vendor in the interference check standard solution resulting in the criteria exceedance.

2.0 CHAIN OF CUSTODY DOCUMENTATION

All chain of custody documentation was complete.

3.0 HOLDING TIMES

All criteria were met. No qualifiers were applied.

4.0 INITIAL AND CONTINUING CALIBRATIONS

All criteria were met. No qualifiers were applied.

5.0 ICP INTERFERENCE CHECK SAMPLE RESULTS

All criteria were met. No qualifiers were applied.

6.0 LABORATORY AND FIELD BLANK ANALYSIS RESULTS

Positive results reported in the associated continuing calibration blanks and/or preparation blanks have been presented in Table 2. The analytes were detected in the associated continuing calibration blanks and/or preparation blanks at levels less than the quantitation limit, indicating the possibility of a false positive at this level. However, all results are greater than the reporting limit and no qualification is necessary.

Positive results reported in the associated equipment blanks and/or field blanks have been presented in Table 2. The analytes were detected in the associated equipment blanks and/or field blanks at levels greater than the quantitation limit. The results for copper for samples 1B-SS43, IB-SS44, and IB-SS44D are greater than the field blank value, but less that ten times the field blank value. The positive results for copper for these samples have been marked with "J" qualifiers to indicate that they are quantitative estimates.

7.0 *MATRIX SPIKE/MATRIX SPIKE DUPLICATE RECOVERIES AND REPRODUCIBILITY*

The positive results reported for tin for samples IB-SS31, IB-SS32, IB-SS33, IB-SS34, IB-SS34D, IB-SS35, IB-SS36, IB-SS37, IB-SS38, IB-SS39, and IB-SS40 have been rejected and should be considered suspect. Extremely high recoveries (>200% Recovery) for this analyte were obtained for the associated matrix spike analyses. The high recoveries indicate the presence of interferences in samples of similar matrix. The positive results for these analytes have been marked with "R" qualifiers to indicate that they are suspect.

The positive results reported for copper and tin for samples IB-SS45, IB-SS46, IB-SS47, and IB-SS48 should be considered biased high quantitative estimates, and may be lower than reported. High recoveries for these analytes were obtained for the associated matrix spike analyses. The high recoveries indicate the presence of interferences in samples of similar matrix. The positive results for these analytes have been marked with "J" qualifiers to indicate that they are biased high quantitative estimates.

The positive results reported for lead for samples IB-SS45, IB-SS46, IB-SS47, and IB-SS48 should be considered biased low quantitative estimates, and may be higher than reported. A low recovery for this analyte was obtained for the associated matrix spike analysis. The low recovery indicates the presence of interferences in samples of similar matrix. The positive results for lead have been marked with "J" qualifiers to indicate that they are biased low quantitative estimates.

8.0 *LABORATORY DUPLICATE RESULTS*

The quantitation limits reported for tin for samples IB-SS41, IB-SS42, IB-SS43, IB-SS44, and IB-SS44D have been rejected and should be considered suspect. The laboratory duplicate precision criterion of 35 percent for values greater than five times the CRQL (or ± four times the CRQL for results less than five times the CRQL) was exceeded for this analyte. The lack of precision may be due to heterogeneity of samples of similar matrix. These quantitation limits have been marked "R" to indicate that they are suspect.

9.0 *ICP SERIAL DILUTION RESULTS*

All criteria were met. No qualifiers were applied.

10.0 *FIELD DUPLICATE RESULTS*

Duplicate samples, IB-SS34 and IB-SS34D and IB-SS44 and IB-SS44D, were submitted to the laboratory to evaluate sampling and analytical precision for those analytes determined to be present. Results for these duplicate samples are presented in Tables 3 and 4, respectively. The Region II criteria were met for the field duplicate samples, with the exception of mercury and lead. The results for mercury for samples IB-SS34 and IB-SS34D and for lead for samples IB-SS44 and IB-SS44D have been marked with "J" qualifiers to indicate that they are quantitative estimates.

11.0 *LABORATORY CONTROL SAMPLE RESULTS*

All criteria were met. No qualifiers were applied.

12.0 GFAA POST-DIGESTION SPIKE/DUPLICATE BURN

This parameter is not applicable to the analyses performed.

13.0 QUALITATIVE IDENTIFICATION

All criteria were met. No qualifiers were applied.

14.0 QUANTITATION/REPORTING LIMITS

All criteria were met. No qualifiers were applied.

METHODOLOGY REFERENCES

Analysis	Reference
Metals	Method 6020, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997
Mercury	Method 7471A, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997

Table 1 Samples For Data Validation Review
Aquatic BERA SWMU 1 and 2 (CTO-108)
Soil Samples Collected April 2007
Severn Trent Sample Delivery Group SWMU26275-1

SAMPLE I.D.	LABORATORY I.D		DATE COLLECTED	MATRIX	ANALYSES PERFORMED PEST	TMET
IB-SS31	680-26275	1	4/28/2007	Soil	X	X
IB-SS32	680-26275	2	4/28/2007	Soil	X	X
IB-SS33	680-26275	3	4/28/2007	Soil	X	X
IB-SS34	680-26275	4	4/28/2007	Soil	X	X
IB-SS34D	680-26275	5	4/28/2007	Soil	X	X
IB-SS35	680-26275	6	4/28/2007	Soil	X	X
IB-SS36	680-26275	7	4/28/2007	Soil	X	X
IB-SS37	680-26275	8	4/28/2007	Soil	X	X
IB-SS38	680-26275	9	4/28/2007	Soil	X	X
IB-SS39	680-26275	10	4/28/2007	Soil	X	X
IB-SS40	680-26275	11	4/28/2007	Soil	X	X
IB-SS41	680-26275	12	4/28/2007	Soil	X	X
IB-SS42	680-26275	13	4/28/2007	Soil	X	X
IB-SS43	680-26275	14	4/28/2007	Soil	X	X
IB-SS44	680-26275	15	4/28/2007	Soil	X	X
IB-SS44D	680-26275	16	4/28/2007	Soil	X	X
IB-SS45	680-26275	17	4/28/2007	Soil	X	X
IB-SS46	680-26275	18	4/28/2007	Soil	X	X
IB-SS47	680-26275	19	4/28/2007	Soil	X	X
IB-SS48	680-26275	20	4/28/2007	Soil	X	X

PEST Pesticides: 4,4'-DDD, 4,4'-DDE, 4,4'-DDT
TMET Total Metals: Antimony, Cadmium, Copper, Lead, Mercury, Tin, Zinc

Table 2 **Blank Results for Inorganic Analyses**

BLANK	ANALYTE	CONCENTRATION /UNITS	ASSOC. SAMPLES
PB1	Copper	0.1177 mg/Kg	All Samples, except for IB-SS45, IB-SS46, IB-SS47, IB-SS48
	Zinc	0.4632 mg/Kg	
PB2	Zinc	0.7447 mg/Kg	IB-SS45, IB-SS46, IB-SS47, IB-SS48
CCB10	Lead	0.129 µg/L	IB-SS45, IB-SS47, IB-SS48
CCB2	Mercury	0.0814 µg/L	IB-SS31, IB-SS32, IB-SS33, IB-SS34D, IB-SS41, IB-SS42
CCB6	Mercury	0.1542 µg/L	IB-SS34, IB-SS35, IB-SS36, IB-SS37, IB-SS38, IB-SS39, IB-SS40, IB-SS46, IB-SS47, IB-SS48
IB-FB01	Copper	3.4 µg/L	All Samples

Table 3 Field Duplicate Sample Results for Inorganic Parameters
Duplicate Samples IB-SS34 and IB-SS34D

Analyte	IB-SS34 (mg/Kg)	IB-SS34D (mg/Kg)	RPD	FOOT NOTES
Antimony	32	41.0	24.7	
Cadmium	3.2	3.0	6.5	
Copper	210	210	0.0	
Lead	210	250	17.4	
Tin	25	37	38.7	previously rejected
Zinc	470	420	11.2	
Mercury	0.28	0.13	73.2	"J" qualified in duplicate samples

* Precision criteria exceeded

NC Results not calculated due to already considered estimated or one results was not detected (ND).

NE Not detected.

Table 4 Field Duplicate Sample Results for Inorganic Parameters
Duplicate Samples IB-SS44 and IB-SS44D

Analyte	IB-SS44 (mg/Kg)		IB-SS44D (mg/Kg)		RPD	FOOT NOTES
Cadmium	0.080	J	0.076	J	5.1	
Copper	35		38		8.2	
Lead	9.5		6.0		45.2	"J" qualified in duplicate samples
Tin	7.1		7.3		2.8	
Zinc	37		37		0.0	
Mercury	0.023	J	0.037		46.7	

* Precision criteria exceeded

NC Results not calculated due to already considered estimated or one results was not detected (ND).

NE Not detected.

Project: Aquatic BERA, SWMU 1 and 2, CTO-108
Laboratory: Severn Trent Laboratories
Sample Delivery Group: SWMU26275-1
Fraction: Organic
Matrix: Soil
Report Date: 6/29/2007

This analytical quality assurance report is based upon a review of analytical data generated for soil samples. Two field duplicate samples and one matrix spike/matrix spike duplicate sample were submitted with the samples for this Sample Delivery Group. The sample locations, laboratory identification numbers, sample collection dates, sample matrix, and analyses performed are presented in Table 1.

The samples were analyzed for pesticide compounds: 4, 4'DDE, 4, 4'-DDD, and 4, 4'-DDT. The sample analyses were performed in accordance with the procedures outlined in the method referenced at the end of this report.

All sample analyses have undergone an analytical quality assurance review to ensure adherence to the required protocols. Results have been validated or qualified according to Region II "SW-846 Method 8080A/8000A", SOP HW-23, Revision 0, April 1995. The parameters presented on the following page were evaluated.

X	•	Data Completeness
X	•	Chain of Custody Documentation
X	•	Holding Times
	•	Instrument Performance
X	•	Initial and Continuing Calibrations
X	•	Laboratory and Field Blank Analysis Results
X	•	Surrogate Compound Recoveries
X	•	Matrix Spike/Matrix Spike Duplicate Recoveries and Reproducibility
X	•	Field Duplicate Analysis Results
X	•	Laboratory Control Sample Results
	•	Internal Standard Performance
X	•	Qualitative Identification
X	•	Quantitation/Reporting Limits

X - Denotes parameter evaluated.

It is recommended that the data only be used according to the qualifiers presented, and discussed in this report. All other data should be considered qualitatively and quantitatively valid as reported by the laboratory, based on the items evaluated.

Report Approved By:

Shawne M. Rodgers
President

6/29/2007

Date

1.0 *DATA COMPLETENESS*

GC columns descriptions were not presented in the case narrative. The laboratory was contacted and provided the missing information.

The case narrative presented incorrect SDG and project information. The laboratory was contacted and provided the revised case narrative.

The laboratory incorrectly reported the higher concentration of 410 μg/Kg, instead of the lower concentration of 270 μg/Kg, since an RPD greater than 40% was observed for the dual column analysis of sample IB-SS34. The laboratory was contacted and provided the revised analysis result form.

The GC columns presented on several of the summary forms were incorrectly presented as "Equity", instead of "CLP I" or "CLP II". The laboratory was contacted and provided the revised forms.

2.0 *CHAIN OF CUSTODY DOCUMENTATION*

The chain of custody documentation was complete.

3.0 *HOLDING TIMES*

All criteria were met. No qualifiers were applied.

4.0 *INSTRUMENT PERFORMANCE*

This parameter is not applicable to the analyses performed.

5.0 *INITIAL AND CONTINUING CALIBRATIONS*

The laboratory evaluated the samples using guidance given in the DOD QSM Final Version 3, which allows for 20% difference as the continuing calibration verification criteria. This is a deviation from Method 8081A, which allows for a 15% difference. This has been noted in the case narrative.

6.0 *LABORATORY AND FIELD BLANK ANALYSIS RESULTS*

All criteria were met. No qualifiers were applied.

7.0 *SURROGATE COMPOUND RECOVERIES*

All criteria were met. No qualifiers were applied.

8.0 *MATRIX SPIKE/MATRIX SPIKE DUPLICATE RECOVERIES AND REPRODUCIBILITY*

All criteria were met. No qualifiers were applied.

9.0 *FIELD DUPLICATE RESULTS*

Duplicate samples IB- SS34 and IB-SS34D, and IB-SS44 and IB-SS44D were submitted to the laboratory to evaluate sampling and analytical precision for those analytes determined to be present. Results for the field duplicate samples are presented in Tables 2 and 3, respectively. The Region II criteria were met for the field duplicate samples.

10.0 *LABORATORY CONTROL SAMPLE RESULTS*

All criteria were met. No qualifiers were applied.

11.0 *INTERNAL STANDARD PERFORMANCE*

All criteria were met. No qualifiers were applied.

12.0 *QUALITATIVE IDENTIFICATION*

All criteria were met. No qualifiers were applied.

13.0 *QUANTITATION/REPORTING LIMITS*

The positive result reported for 4, 4'-DDD for sample IB-SS37 was reported by the laboratory at a concentration greater than the quantitation limit. Poor precision (greater than 25% difference, but less than 70% difference between results) was observed for this analyte on the dual chromatographic columns used for sample analysis. The positive 4, 4'-DDD result should be considered a quantitative estimate. The result has been marked "J" to indicate this.

The samples presented in the following table were analyzed at dilutions for pesticide constituents. The dilution analyses were performed because of the suspected presence of high levels of target compounds and/or interferences. Reporting limits are elevated by the dilution factor for these samples for target compounds that were not detected. The elevated reporting limits should be noted when assessing the data for these samples.

Sample	Dilution Factor
IB-SS31	2.0
IB-SS33	10.0
IB-SS34	4.0
IB-SS34D	4.0
IB-SS35	2.0
IB-SS36	2.0
IB-SS37	10.0
IB-SS38	10.0
IB-SS39	4.0
IB-SS40	5.0
IB-SS46	10.0
IB-SS47	5.0
IB-SS48	20.0

The samples presented below were re-analyzed at dilutions for pesticide constituents. The samples were re-analyzed because the responses for compounds exceeded the linear range of the GC instrument. The results for these compounds have been reported from the dilution analyses. All other results are reported from the initial analyses.

Sample	Dilution Factor	Results Exceeding the Linear Range
IB-SS33	100	4,4'-DDE, 4,4'-DDT
IB-SS34	10.0	4,4'-DDE
IB-SS34D	10.0	4,4'-DDE
IB-SS46	200	4,4'-DDE, 4,4'-DDT
IB-SS47	20.0	4,4'-DDE, 4,4'-DDT
IB-SS48	200	4,4'-DDE

As required by USEPA protocol, all compounds, which were qualitatively identified at concentrations below their respective Reporting Limits (RLs), have been marked with "J" qualifiers to indicate that they are quantitative estimates.

METHODOLOGY REFERENCES

Analysis	Reference
Pesticide Constituents	Method 8081A, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997

Table 1 Samples For Data Validation Review
Aquatic BERA SWMU 1 and 2 (CTO-108)
Soil Samples Collected April 2007
Severn Trent Sample Delivery Group SWMU26275-1

SAMPLE I.D.	LABORATORY I.D		DATE COLLECTED	MATRIX	ANALYSES PERFORMED PEST	TMET
IB-SS31	680-26275	1	4/28/2007	Soil	X	X
IB-SS32	680-26275	2	4/28/2007	Soil	X	X
IB-SS33	680-26275	3	4/28/2007	Soil	X	X
IB-SS34	680-26275	4	4/28/2007	Soil	X	X
IB-SS34D	680-26275	5	4/28/2007	Soil	X	X
IB-SS35	680-26275	6	4/28/2007	Soil	X	X
IB-SS36	680-26275	7	4/28/2007	Soil	X	X
IB-SS37	680-26275	8	4/28/2007	Soil	X	X
IB-SS38	680-26275	9	4/28/2007	Soil	X	X
IB-SS39	680-26275	10	4/28/2007	Soil	X	X
IB-SS40	680-26275	11	4/28/2007	Soil	X	X
IB-SS41	680-26275	12	4/28/2007	Soil	X	X
IB-SS42	680-26275	13	4/28/2007	Soil	X	X
IB-SS43	680-26275	14	4/28/2007	Soil	X	X
IB-SS44	680-26275	15	4/28/2007	Soil	X	X
IB-SS44D	680-26275	16	4/28/2007	Soil	X	X
IB-SS45	680-26275	17	4/28/2007	Soil	X	X
IB-SS46	680-26275	18	4/28/2007	Soil	X	X
IB-SS47	680-26275	19	4/28/2007	Soil	X	X
IB-SS48	680-26275	20	4/28/2007	Soil	X	X

PEST Pesticides: 4,4'-DDD, 4,4'-DDE, 4,4'-DDT
TMET Total Metals: Antimony, Cadmium, Copper, Lead, Mercury, Tin, Zinc

Table 2 **Field Duplicate Sample Results for Organic Results**
Soil Duplicate Samples IB-SS34 and IB-SS34D

Compound	Sample Results (µg/Kg)	Field Duplicate Results (µg/Kg)	RPD	FOOT NOTES
	IB-SS34	IB-SS34D		
4,4'-DDD	29	45	43	
4,4'-DDE	400	590	38	
4,4'-DDT	230	320	33	

* Precision criteria exceeded
NC Results not calculated due to already considered estimated or one results was not detected (ND).
ND Not detected.

Table 3 Field Duplicate Sample Results for Organic Results
Soil Duplicate Samples IB-SS44 and IB-SS44D

Compound	Sample Results (µg/Kg)		Field Duplicate Results (µg/Kg)		RPD	FOOT NOTES
	IB-SS44		IB-SS44D			
4,4'-DDE	0.78	J	2.2	J	95	
4,4'-DDT	0.41	U	1.4	J	NC	

* Precision criteria exceeded

NC Results not calculated due to already considered estimated or one results was not detected (ND).

ND Not detected.

SEVERN TRENT - SAVANNAH SDG SWMU26275-2

Project: Aquatic BERA, SWMU 1 and 2, CTO-108
Laboratory: Severn Trent Laboratories
Sample Delivery Group: SWMU26275-2
Fraction: Inorganic
Matrix: Soil
Report Date: 6/30/2007

This analytical quality assurance report is based upon a review of analytical data generated for soil samples. One field duplicate sample and one matrix spike sample were submitted with the samples for this Sample Delivery Group. The sample locations, laboratory identification numbers, sample collection dates, sample matrix, and analyses performed are presented in Table 1.

The samples were analyzed for total metals: cadmium, copper, lead, antimony, tin, zinc, and nickel, and mercury. The sample analyses were performed in accordance with the procedures outlined in the method referenced at the end of this report.

All sample analyses have undergone an analytical quality assurance review to ensure adherence to the required protocols. Results have been validated or qualified according to general guidance provided in "Evaluation of Metals Data for the CLP Program", SOP HW-2, Revision 13, September 2005. The parameters presented on the following page were evaluated.

X	•	Data Completeness
X	•	Chain of Custody Documentation
X	•	Holding Times
X	•	Initial and Continuing Calibrations
X	•	ICP Interference Check Sample Results
X	•	Laboratory and Field Blank Analysis Results
X	•	Matrix Spike Recoveries and Reproducibility
X	•	Laboratory Duplicate Analysis Results
X	•	ICP Serial Dilution Results
X	•	Field Duplicate Analysis Results
X	•	Laboratory Control Sample Results
	•	GFAA Post-Digestion Spike Recovery/Duplicate Burn Precision
X	•	Qualitative Identification
X	•	Quantitation/Reporting Limits

X - Denotes parameter evaluated.

It is recommended that the data only be used according to the qualifiers presented, and discussed in this report. All other data should be considered qualitatively and quantitatively valid as reported by the laboratory, based on the items evaluated.

Report Approved By:

Shawne M. Rodgers
President

6/30/2007
Date

1.0 DATA COMPLETENESS

Zinc exceeded percent recovery criteria for the interference check standard analysis; however, this was not noted in the case narrative. The laboratory was contacted and provided the revised case narrative indicating that there was trace zinc contamination as determined by the vendor in the interference check standard solution resulting in the criteria exceedance.

2.0 CHAIN OF CUSTODY DOCUMENTATION

All chain of custody documentation was complete.

3.0 HOLDING TIMES

All criteria were met. No qualifiers were applied.

4.0 INITIAL AND CONTINUING CALIBRATIONS

All criteria were met. No qualifiers were applied.

5.0 ICP INTERFERENCE CHECK SAMPLE RESULTS

All criteria were met. No qualifiers were applied.

6.0 LABORATORY AND FIELD BLANK ANALYSIS RESULTS

All criteria were met. No qualifiers were applied.

7.0 MATRIX SPIKE/MATRIX SPIKE DUPLICATE RECOVERIES AND REPRODUCIBILITY

The positive results reported for copper, mercury, and tin for the samples should be considered biased high quantitative estimates, and may be lower than reported. High recoveries for these analytes were obtained for the associated matrix spike analyses. The high recoveries indicate the presence of interferences in samples of similar matrix. The positive results for these analytes have been marked with "J" qualifiers to indicate that they are biased high quantitative estimates.

The positive results reported for lead for the samples should be considered biased low quantitative estimates, and may be higher than reported. A low recovery for this analyte was obtained for the associated matrix spike analysis. The low recovery indicates the presence of interferences in samples of similar matrix. The positive results for lead have been marked with "J" qualifiers to indicate that they are biased low quantitative estimates.

8.0 LABORATORY DUPLICATE RESULTS

All criteria were met. No qualifiers were applied.

9.0 ICP SERIAL DILUTION RESULTS

All criteria were met. No qualifiers were applied.

10.0 FIELD DUPLICATE RESULTS

Duplicate samples IB-SS54 and IB-SS54D were submitted to the laboratory to evaluate sampling and analytical precision for those analytes determined to be present. Results for these duplicate samples are presented in Table 2. The Region II criteria were met for the field duplicate samples.

11.0 LABORATORY CONTROL SAMPLE RESULTS

All criteria were met. No qualifiers were applied.

12.0 GFAA POST-DIGESTION SPIKE/DUPLICATE BURN

This parameter is not applicable to the analyses performed.

13.0 QUALITATIVE IDENTIFICATION

All criteria were met. No qualifiers were applied.

14.0 QUANTITATION/REPORTING LIMITS

All criteria were met. No qualifiers were applied.

METHODOLOGY REFERENCES

Analysis	Reference
Metals	Method 6020, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997
Mercury	Method 7471A, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997

Table 1 Samples For Data Validation Review
Aquatic BERA SWMU 1 and 2 (CTO-108)
Soil Samples Collected April 2007
Severn Trent Sample Delivery Group SWMU26275-2

SAMPLE I.D.	LABORATORY I.D		DATE COLLECTED	MATRIX	ANALYSES PERFORMED	
					PEST	TMET
IB-SS49	680-26275	21	4/28/2007	Soil	X	X
IB-SS50	680-26275	22	4/28/2007	Soil	X	X
IB-SS51	680-26275	23	4/28/2007	Soil	X	X
IB-SS52	680-26275	24	4/28/2007	Soil	X	X
IB-SS53	680-26275	25	4/28/2007	Soil	X	X
IB-SS54	680-26275	26	4/28/2007	Soil	X	X
IB-SS54D	680-26275	27	4/28/2007	Soil	X	X
IB-SS55	680-26275	28	4/28/2007	Soil	X	X

PEST Pesticides: 4,4-DDD, 4,4-DDE, 4,4-DDT

TMET Total Metals: Antimony, Cadmium, Copper, Lead, Mercury, Tin, Zinc

Table 2 Field Duplicate Sample Results for Inorganic Parameters
Duplicate Samples 1B-SS54 and 1B-SS54D

Analyte	1B-SS54 (mg/Kg)		1B-SS54D (mg/Kg)		RPD	FOOT NOTES
Antimony	0.27		0.24		11.8	
Cadmium	0.19		0.16		17.1	
Copper	34	J	32	J	6.1	
Lead	8.0	J	7.6	J	5.1	
Zinc	38		36		5.4	
Mercury	0.069		0.066		4.4	

* Precision criteria exceeded

NC Results not calculated due to already considered estimated or one results was not detected (ND).

ND Not detected.

Project: Aquatic BERA, SWMU 1 and 2, CTO-108
Laboratory: Severn Trent Laboratories
Sample Delivery Group: SWMU26275-2
Fraction: Organic
Matrix: Soil
Report Date: 6/30/2007

This analytical quality assurance report is based upon a review of analytical data generated for soil samples. One field duplicate sample and one matrix spike/matrix spike duplicate sample were submitted with the samples for this Sample Delivery Group. The sample locations, laboratory identification numbers, sample collection dates, sample matrix, and analyses performed are presented in Table 1.

The samples were analyzed for pesticide compounds: 4, 4'DDE, 4, 4'-DDD, and 4, 4'-DDT. The sample analyses were performed in accordance with the procedures outlined in the method referenced at the end of this report.

All sample analyses have undergone an analytical quality assurance review to ensure adherence to the required protocols. Results have been validated or qualified according to Region II "SW-846 Method 8080A/8000A", SOP HW-23, Revision 0, April 1995. The parameters presented on the following page were evaluated.

X	•	Data Completeness
X	•	Chain of Custody Documentation
X	•	Holding Times
	•	Instrument Performance
X	•	Initial and Continuing Calibrations
X	•	Laboratory and Field Blank Analysis Results
X	•	Surrogate Compound Recoveries
X	•	Matrix Spike/Matrix Spike Duplicate Recoveries and Reproducibility
X	•	Field Duplicate Analysis Results
X	•	Laboratory Control Sample Results
	•	Internal Standard Performance
X	•	Qualitative Identification
X	•	Quantitation/Reporting Limits

X - Denotes parameter evaluated.

It is recommended that the data only be used according to the qualifiers presented, and discussed in this report. All other data should be considered qualitatively and quantitatively valid as reported by the laboratory, based on the items evaluated.

Report Approved By:

Shawne M. Rodgers
President

6/30/2007

Date

1.0 DATA COMPLETENESS

The data package was complete.

2.0 CHAIN OF CUSTODY DOCUMENTATION

The chain of custody documentation was complete.

3.0 HOLDING TIMES

All criteria were met. No qualifiers were applied.

4.0 INSTRUMENT PERFORMANCE

This parameter is not applicable to the analyses performed.

5.0 INITIAL AND CONTINUING CALIBRATIONS

The laboratory evaluated the samples using guidance given in the DOD QSM Final Version 3, which allows for 20% difference as the continuing calibration verification criteria. This is a deviation from Method 8081A, which allows for a 15% difference. This has been noted in the case narrative.

6.0 LABORATORY AND FIELD BLANK ANALYSIS RESULTS

All criteria were met. No qualifiers were applied.

7.0 *SURROGATE COMPOUND RECOVERIES*

All criteria were met. No qualifiers were applied.

8.0 *MATRIX SPIKE/MATRIX SPIKE DUPLICATE RECOVERIES AND REPRODUCIBILITY*

All criteria were met. No qualifiers were applied.

9.0 *FIELD DUPLICATE RESULTS*

Duplicate samples IB-SS54 and IB-SS54D were submitted to the laboratory to evaluate sampling and analytical precision for those analytes determined to be present. There were no positive results for the field duplicate samples.

10.0 *LABORATORY CONTROL SAMPLE RESULTS*

All criteria were met. No qualifiers were applied.

11.0 *INTERNAL STANDARD PERFORMANCE*

All criteria were met. No qualifiers were applied.

12.0 *QUALITATIVE IDENTIFICATION*

All criteria were met. No qualifiers were applied.

13.0 *QUANTITATION/REPORTING LIMITS*

The samples presented in the following table were analyzed at dilutions for pesticide constituents. The dilution analyses were performed because of the suspected presence of high levels of target compounds and/or interferences. Reporting limits are elevated by the dilution factor for these samples for target compounds that were not detected. The elevated reporting limits should be noted when assessing the data for these samples.

Sample	Dilution Factor
IB-SS49	4.0

The samples presented below were re-analyzed at dilutions for pesticide constituents. The samples were re-analyzed because the responses for compounds exceeded the linear range of the GC instrument. The results for these compounds have been reported from the dilution analyses. All other results are reported from the initial analyses.

Sample	Dilution Factor	Results Exceeding the Linear Range
IB-SS49	20.0	4,4'-DDd
IB-SS50	20.0	4,4'-DDE, 4,4'-DDT

As required by USEPA protocol, all compounds, which were qualitatively identified at concentrations below their respective Reporting Limits (RLs), have been marked with "J" qualifiers to indicate that they are quantitative estimates.

METHODOLOGY REFERENCES

Analysis	Reference
Pesticide Constituents	Method 8081A, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997

Table 1 Samples For Data Validation Review
Aquatic BERA SWMU 1 and 2 (CTO-108)
Soil Samples Collected April 2007
Severn Trent Sample Delivery Group SWMU26275-2

SAMPLE I.D.	LABORATORY I.D		DATE COLLECTED	MATRIX	ANALYSES PERFORMED	
					PEST	TMET
IB-SS49	680-26275	21	4/28/2007	Soil	X	X
IB-SS50	680-26275	22	4/28/2007	Soil	X	X
IB-SS51	680-26275	23	4/28/2007	Soil	X	X
IB-SS52	680-26275	24	4/28/2007	Soil	X	X
IB-SS53	680-26275	25	4/28/2007	Soil	X	X
IB-SS54	680-26275	26	4/28/2007	Soil	X	X
IB-SS54D	680-26275	27	4/28/2007	Soil	X	X
IB-SS55	680-26275	28	4/28/2007	Soil	X	X

PEST Pesticides: 4,4-DDD, 4,4-DDE, 4,4-DDT
TMET Total Metals: Antimony, Cadmium, Copper, Lead, Mercury, Tin, Zinc

SEVERN TRENT - SAVANNAH SDG SWMU26275-3

Project: Aquatic BERA, SWMU 1 and 2, CTO-108
Laboratory: Severn Trent Laboratories
Sample Delivery Group: SWMU26275-3
Fraction: Inorganic
Matrix: Soil
Report Date: 7/2/2007

This analytical quality assurance report is based upon a review of analytical data generated for three field blanks. The sample locations, laboratory identification numbers, sample collection dates, sample matrix, and analyses performed are presented in Table 1.

The samples were analyzed for total metals: cadmium, copper, lead, antimony, selenium, tin, zinc, and nickel, and mercury. The sample analyses were performed in accordance with the procedures outlined in the method referenced at the end of this report.

All sample analyses have undergone an analytical quality assurance review to ensure adherence to the required protocols. Results have been validated or qualified according to general guidance provided in "Evaluation of Metals Data for the CLP Program", SOP HW-2, Revision 13, September 2005. The parameters presented on the following page were evaluated.

X	•	Data Completeness
X	•	Chain of Custody Documentation
X	•	Holding Times
X	•	Initial and Continuing Calibrations
X	•	ICP Interference Check Sample Results
X	•	Laboratory and Field Blank Analysis Results
X	•	Matrix Spike Recoveries and Reproducibility
X	•	Laboratory Duplicate Analysis Results
X	•	ICP Serial Dilution Results
X	•	Field Duplicate Analysis Results
X	•	Laboratory Control Sample Results
	•	GFAA Post-Digestion Spike Recovery/Duplicate Burn Precision
X	•	Qualitative Identification
X	•	Quantitation/Reporting Limits

X - Denotes parameter evaluated.

It is recommended that the data only be used according to the qualifiers presented, and discussed in this report. All other data should be considered qualitatively and quantitatively valid as reported by the laboratory, based on the items evaluated.

Report Approved By:

Shawne M. Rodgers
President

7/1/2007

Date

1.0 DATA COMPLETENESS

Zinc exceeded percent recovery criteria for the interference check standard analysis; however, this was not noted in the case narrative. The laboratory was contacted and provided the revised case narrative indicating that there was trace zinc contamination as determined by the vendor in the interference check standard solution resulting in the criteria exceedance.

2.0 CHAIN OF CUSTODY DOCUMENTATION

All chain of custody documentation was complete.

3.0 HOLDING TIMES

All criteria were met. No qualifiers were applied.

4.0 INITIAL AND CONTINUING CALIBRATIONS

All criteria were met. No qualifiers were applied.

5.0 ICP INTERFERENCE CHECK SAMPLE RESULTS

All criteria were met. No qualifiers were applied.

6.0 LABORATORY AND FIELD BLANK ANALYSIS RESULTS

All criteria were met. No qualifiers were applied.

7.0 MATRIX SPIKE/MATRIX SPIKE DUPLICATE RECOVERIES AND REPRODUCIBILITY

All criteria were met. No qualifiers were applied.

8.0 *LABORATORY DUPLICATE RESULTS*

All criteria were met. No qualifiers were applied.

9.0 *ICP SERIAL DILUTION RESULTS*

All criteria were met. No qualifiers were applied.

10.0 *FIELD DUPLICATE RESULTS*

Duplicate samples 1B-OWSD03 and 1B-OWSD03D were submitted to the laboratory to evaluate sampling and analytical precision for those analytes determined to be present. Results for these duplicate samples are presented in Table 2. The Region II criteria were met for the field duplicate samples.

11.0 *LABORATORY CONTROL SAMPLE RESULTS*

All criteria were met. No qualifiers were applied.

12.0 *GFAA POST-DIGESTION SPIKE/DUPLICATE BURN*

This parameter is not applicable to the analyses performed.

13.0 *QUALITATIVE IDENTIFICATION*

All criteria were met. No qualifiers were applied.

14.0 QUANTITATION/REPORTING LIMITS

Positive results and quantitation limits for all inorganic analytes for all of the sediment samples that were not previously qualified for other criteria, should be considered biased low quantitative estimates, and may be higher than reported. The percent solids for these sediment samples were less than 50 percent. The positive results have been marked with "J" qualifiers to indicate that they are biased low quantitative estimates. The quantitation limits have been marked "UJ".

METHODOLOGY REFERENCES

Analysis	Reference
Metals	Method 6020, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997
Mercury	Method 7471A, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997

Table 1 Samples For Data Validation Review
Aquatic BERA SWMU 1 and 2 (CTO-108)
Soil Samples Collected April 2007
Severn Trent Sample Delivery Group SWMU26275-3

SAMPLE I.D.	LABORATORY I.D		DATE COLLECTED	MATRIX	ANALYSES PERFORMED PEST	TMET1	TMET2	TMET3
IB-ER01	680-26275	29	4/29/2007	EQUIPMENT BLANK	X	X		
IB-FB01	680-26275	30	4/29/2007	FIELD BLANK	X		X	
IB-FB02	680-26275	31		FIELD BLANK				
IB-OWSD01	680-26275	36	4/30/2007	Soil				X
IB-OWSD02	680-26275	33	4/30/2007	Soil				X
IB-OWSD03	680-26275	34	4/30/2007	Soil				X
IB-OWSD03D	680-26275	35	4/30/2007	Soil				X

PEST Pesticides: 4,4-DDD, 4,4-DDE, 4,4-DDT
TMET1 Total Metals: Antimony, Cadmium, Copper, Lead, Mercury, Tin, Zinc
TMET2 Total Metals: Arsenic, Cadmium, Copper, Mercury, Selenium, Zinc, Antimony, Lead, Tin
TMET3 Total Metals: Arsenic, Cadmium, Copper, Mercury, Selenium, Zinc

Table 2 Field Duplicate Sample Results for Inorganic Parameters
Duplicate Samples 1B-OWSD03 and 1B-OWSD03D

Analyte	1B-OWSD03 (mg/Kg)		1B-OWSD03D (mg/Kg)		RPD	FOOT NOTES
Arsenic	7.0	J	7.9	J	12.1	
Cadmium	0.085	J	0.087	J	2.3	
Copper	12	J	14	J	15.4	
Selenium	1.1	J	1.0	J	9.5	
Zinc	9.8	J	15	J	41.9	
Mercury	0.020	J	0.025	J	22.2	

* Precision criteria exceeded

NC Results not calculated due to already considered estimated or one results was not detected (ND).

ND Not detected.

Project: Aquatic BERA, SWMU 1 and 2, CTO-108
Laboratory: Severn Trent Laboratories
Sample Delivery Group: SWMU26275-3
Fraction: Organic
Matrix: Soil
Report Date: 7/1/2007

This analytical quality assurance report is based upon a review of analytical data generated for three field blanks. The sample locations, laboratory identification numbers, sample collection dates, sample matrix, and analyses performed are presented in Table 1.

The samples were analyzed for pesticide compounds: 4, 4'DDE, 4, 4'-DDD, and 4, 4'-DDT. The sample analyses were performed in accordance with the procedures outlined in the method referenced at the end of this report.

All sample analyses have undergone an analytical quality assurance review to ensure adherence to the required protocols. Results have been validated or qualified according to Region II "SW-846 Method 8080A/8000A", SOP HW-23, Revision 0, April 1995. The parameters presented on the following page were evaluated.

X	•	Data Completeness
X	•	Chain of Custody Documentation
X	•	Holding Times
	•	Instrument Performance
X	•	Initial and Continuing Calibrations
	•	Laboratory and Field Blank Analysis Results
X	•	Surrogate Compound Recoveries
	•	Matrix Spike/Matrix Spike Duplicate Recoveries and Reproducibility
	•	Field Duplicate Analysis Results
X	•	Laboratory Control Sample Results
	•	Internal Standard Performance
X	•	Qualitative Identification
X	•	Quantitation/Reporting Limits

X - Denotes parameter evaluated.

It is recommended that the data only be used according to the qualifiers presented, and discussed in this report. All other data should be considered qualitatively and quantitatively valid as reported by the laboratory, based on the items evaluated.

Report Approved By:

Shawne M. Rodgers
President

7/1/2007

Date

1.0 DATA COMPLETENESS

The data package was complete.

2.0 CHAIN OF CUSTODY DOCUMENTATION

The chain of custody documentation was complete.

3.0 HOLDING TIMES

All criteria were met. No qualifiers were applied.

4.0 INSTRUMENT PERFORMANCE

This parameter is not applicable to the analyses performed.

5.0 INITIAL AND CONTINUING CALIBRATIONS

The laboratory evaluated the samples using guidance given in the DOD QSM Final Version 3, which allows for 20% difference as the continuing calibration verification criteria. This is a deviation from Method 8081A, which allows for a 15% difference. This has been noted in the case narrative.

6.0 LABORATORY AND FIELD BLANK ANALYSIS RESULTS

The samples were field blanks; therefore this parameter was not applicable to the analyses performed.

7.0 *SURROGATE COMPOUND RECOVERIES*

All criteria were met. No qualifiers were applied.

8.0 *MATRIX SPIKE/MATRIX SPIKE DUPLICATE RECOVERIES AND REPRODUCIBILITY*

The samples were field blanks; therefore this parameter was not applicable to the analyses performed.

9.0 *FIELD DUPLICATE RESULTS*

There were no field duplicate samples submitted with this SDG.

10.0 *LABORATORY CONTROL SAMPLE RESULTS*

All criteria were met. No qualifiers were applied.

11.0 *INTERNAL STANDARD PERFORMANCE*

All criteria were met. No qualifiers were applied.

12.0 *QUALITATIVE IDENTIFICATION*

All criteria were met. No qualifiers were applied.

13.0 *QUANTITATION/REPORTING LIMITS*

As required by USEPA protocol, all compounds, which were qualitatively identified at concentrations below their respective Reporting Limits (RLs), have been marked with "J" qualifiers to indicate that they are quantitative estimates.

METHODOLOGY REFERENCES

Analysis	Reference
Pesticide Compounds	Method 8081A, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997

Table 1 Samples For Data Validation Review
Aquatic BERA SWMU 1 and 2 (CTO-108)
Soil Samples Collected April 2007
Severn Trent Sample Delivery Group SWMU26275-3

SAMPLE I.D.	LABORATORY I.D		DATE COLLECTED	MATRIX	ANALYSES PERFORMED			
					PEST	TMET1	TMET2	TMET3
IB-ER01	680-26275	29	4/29/2007	EQUIPMENT BLANK	X	X		
IB-FB01	680-26275	30	4/29/2007	FIELD BLANK	X		X	
IB-FB02	680-26275	31		FIELD BLANK				
IB-OWSD01	680-26275	36	4/30/2007	Soil				X
IB-OWSD02	680-26275	33	4/30/2007	Soil				X
IB-OWSD03	680-26275	34	4/30/2007	Soil				X
IB-OWSD03D	680-26275	35	4/30/2007	Soil				X

PEST Pesticides: 4,4-DDD, 4,4-DDE, 4,4-DDT
TMET1 Total Metals: Antimony, Cadmium, Copper, Lead, Mercury, Tin, Zinc
TMET2 Total Metals: Arsenic, Cadmium, Copper, Mercury, Selenium, Zinc, Antimony, Lead, Tin
TMET3 Total Metals: Arsenic, Cadmium, Copper, Mercury, Selenium, Zinc

SEVERN TRENT - SAVANNAH SDG SWMU26318

Project: Aquatic BERA, SWMU 1 and 2, CTO-108
Laboratory: Severn Trent Laboratories
Sample Delivery Group: SWMU26318-1
Fraction: Inorganic
Matrix: Soil
Report Date: 7/3/2007

This analytical quality assurance report is based upon a review of analytical data generated for grass samples. One matrix spike sample/matrix spike duplicate were submitted with the samples for this Sample Delivery Group. The sample locations, laboratory identification numbers, sample collection dates, sample matrix, and analyses performed are presented in Table 1.

The samples were analyzed for total metals: arsenic cadmium, copper, selenium, zinc, and mercury. The sample analyses were performed in accordance with the procedures outlined in the method referenced at the end of this report.

All sample analyses have undergone an analytical quality assurance review to ensure adherence to the required protocols. Results have been validated or qualified according to general guidance provided in "Evaluation of Metals Data for the CLP Program", SOP HW-2, Revision 13, September 2005. The parameters presented on the following page were evaluated.

X	•	Data Completeness
X	•	Chain of Custody Documentation
X	•	Holding Times
X	•	Initial and Continuing Calibrations
X	•	ICP Interference Check Sample Results
X	•	Laboratory and Field Blank Analysis Results
X	•	Matrix Spike Recoveries and Reproducibility
X	•	Laboratory Duplicate Analysis Results
X	•	ICP Serial Dilution Results
X	•	Field Duplicate Analysis Results
X	•	Laboratory Control Sample Results
	•	GFAA Post-Digestion Spike Recovery/Duplicate Burn Precision
X	•	Qualitative Identification
X	•	Quantitation/Reporting Limits

X - Denotes parameter evaluated.

It is recommended that the data only be used according to the qualifiers presented, and discussed in this report. All other data should be considered qualitatively and quantitatively valid as reported by the laboratory, based on the items evaluated.

Report Approved By:

Shawne M. Rodgers
President

7/3/2007

Date

1.0 *DATA COMPLETENESS*

All criteria were met. No qualifiers were applied.

2.0 *CHAIN OF CUSTODY DOCUMENTATION*

All chain of custody documentation was complete.

3.0 *HOLDING TIMES*

All criteria were met. No qualifiers were applied.

4.0 *INITIAL AND CONTINUING CALIBRATIONS*

All criteria were met. No qualifiers were applied.

5.0 *ICP INTERFERENCE CHECK SAMPLE RESULTS*

All criteria were met. No qualifiers were applied.

6.0 *LABORATORY AND FIELD BLANK ANALYSIS RESULTS*

All criteria were met. No qualifiers were applied.

7.0 *MATRIX SPIKE/MATRIX SPIKE DUPLICATE RECOVERIES AND REPRODUCIBILITY*

All criteria were met. No qualifiers were applied.

8.0 *LABORATORY DUPLICATE RESULTS*

All criteria were met. No qualifiers were applied.

9.0 *ICP SERIAL DILUTION RESULTS*

All criteria were met. No qualifiers were applied.

10.0 *FIELD DUPLICATE RESULTS*

There were no field duplicate samples submitted with this SDG.

11.0 *LABORATORY CONTROL SAMPLE RESULTS*

All criteria were met. No qualifiers were applied.

12.0 *GFAA POST-DIGESTION SPIKE/DUPLICATE BURN*

This parameter is not applicable to the analyses performed.

13.0 *QUALITATIVE IDENTIFICATION*

All criteria were met. No qualifiers were applied.

14.0 *QUANTITATION/REPORTING LIMITS*

All criteria were met. No qualifiers were applied.

METHODOLOGY REFERENCES

Analysis	Reference
Metals	Method 6020, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997
Mercury	Method 7471A, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997

Table 1 Samples For Data Validation Review
Aquatic BERA SWMU 1 and 2 (CTO-108)
Grass Samples Collected April 2007
Severn Trent Sample Delivery Group SWMU2638-1

SAMPLE I.D.	LABORATORY I.D	DATE COLLECTED	MATRIX	ANALYSES PERFORMED TMET
1B-SG01-AG	680-26138-1	4/30/2007	Above Grnd. Sea Grass	X
1B-SG01-WP	680-26138-2	4/30/2007	Whole Plant Sea Grass	X
1B-SG02-AG	680-26138-3	4/30/2007	Above Grnd. Sea Grass	X
1B-SG02-WP	680-26138-4	4/30/2007	Whole Plant Sea Grass	X
1B-SG03-AG	680-26138-5	4/30/2007	Above Grnd. Sea Grass	X
1B-SG03-WP	680-26138-6	4/30/2007	Whole Plant Sea Grass	X

TMET Total Metals: Arsenic, Cadmium, Copper, Mercury, Selenium, Zinc

SEVERN TRENT - SAVANNAH SDG SWMU28224-2

Project: NAPR - SWMUs 1 and 2 (CTO-108)
Laboratory: Test America
Sample Delivery Group: SWMU28224-2
Fraction: Inorganic
Matrix: Soil
Report Date: 5/6/2008

This analytical quality assurance report is based upon a review of analytical data generated for earthworm tissue samples. The sample locations, laboratory identification numbers, sample collection dates, sample matrix, and analyses performed are presented in Table 1.

The samples were analyzed for total metals: cadmium, copper, lead, antimony, tin, zinc, and nickel, and mercury. The sample analyses were performed in accordance with the procedures outlined in the method referenced at the end of this report.

All sample analyses have undergone an analytical quality assurance review to ensure adherence to the required protocols. Results have been validated or qualified according to general guidance provided in "Evaluation of Metals Data for the CLP Program", SOP HW-2, Revision 13, September 2005. The parameters presented on the following page were evaluated.

X	•	Data Completeness
X	•	Chain of Custody Documentation
X	•	Holding Times
X	•	Initial and Continuing Calibrations
X	•	ICP Interference Check Sample Results
X	•	Laboratory and Field Blank Analysis Results
X	•	Matrix Spike Recoveries and Reproducibility
X	•	Laboratory Duplicate Analysis Results
X	•	ICP Serial Dilution Results
	•	Field Duplicate Analysis Results
X	•	Laboratory Control Sample Results
	•	GFAA Post-Digestion Spike Recovery/Duplicate Burn Precision
X	•	Qualitative Identification
X	•	Quantitation/Reporting Limits

X - Denotes parameter evaluated.

It is recommended that the data only be used according to the qualifiers presented, and discussed in this report. All other data should be considered qualitatively and quantitatively valid as reported by the laboratory, based on the items evaluated.

Report Approved By:

Shawne M. Rodgers
President

5/6/2008

Date

1.0 DATA COMPLETENESS

The data package was complete.

2.0 CHAIN OF CUSTODY DOCUMENTATION

All chain of custody documentation was complete.

3.0 HOLDING TIMES

All criteria were met. No qualifiers were applied.

4.0 INITIAL AND CONTINUING CALIBRATIONS

All criteria were met. No qualifiers were applied.

5.0 ICP INTERFERENCE CHECK SAMPLE RESULTS

All criteria were met. No qualifiers were applied.

6.0 LABORATORY AND FIELD BLANK ANALYSIS RESULTS

Positive results reported in the associated continuing calibration blanks and/or preparation blanks have been presented in Table 2. The analytes were detected in the associated continuing calibration blanks and/or preparation blanks at levels less than the quantitation limit, indicating the possibility of a false positive at this level. However, all results are greater than the reporting limit and no qualification is necessary.

Results for antimony for samples 1B-SS18, 1B-SS19, 1B-SS29, 1B-SS33, 1B-SS37, 1B-SS46, 1B-SS49, and 1B-REF-03 are less than the quantitation limit. These results have been marked "U".

7.0 *MATRIX SPIKE/MATRIX SPIKE DUPLICATE RECOVERIES AND REPRODUCIBILITY*

The positive results reported for tin for all samples, except 1B-SS09 should be considered biased high quantitative estimates, and may be lower than reported. High recoveries for this analyte were obtained for the associated matrix spike/matrix spike analyses. The high recoveries indicate the presence of interferences in samples of similar matrix. The positive tin results for have been marked with "J" qualifiers to indicate that they are biased high quantitative estimates.

The positive results and detection limits reported for mercury for the samples should be considered biased low quantitative estimates, and may be higher than reported. A low recovery for this analyte was obtained for the associated matrix spike analysis. The low recovery indicates the presence of interferences in samples of similar matrix. The positive results for mercury have been marked with "J" qualifiers to indicate that they are biased low quantitative estimates.

8.0 *LABORATORY DUPLICATE RESULTS*

All criteria were met. No qualifiers were applied.

9.0 *ICP SERIAL DILUTION RESULTS*

All criteria were met. No qualifiers were applied.

10.0 *FIELD DUPLICATE RESULTS*

There were no field duplicate samples submitted with this SDG.

11.0 *LABORATORY CONTROL SAMPLE RESULTS*

All criteria were met. No qualifiers were applied.

12.0 *GFAA POST-DIGESTION SPIKE/DUPLICATE BURN*

This parameter is not applicable to the analyses performed.

13.0 *QUALITATIVE IDENTIFICATION*

All criteria were met. No qualifiers were applied.

14.0 *QUANTITATION/REPORTING LIMITS*

All criteria were met. No qualifiers were applied.

METHODOLOGY REFERENCES

Analysis	Reference
Metals	Method 6020, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997
Mercury	Method 7471A, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997

Table 1 Samples For Data Validation Review
NAPR - SWMUs 1 and 2 (CTO-108)
Earthworm Tissue Samples Collected June 2007
Test America Sample Delivery Group SWMU28224-2

SAMPLE I.D.	LABORATORY I.D	DATE COLLECTED	MATRIX	ANALYSES PERFORMED		
				8081A	6020	7471A
1B-REF-03	680-28224-30	6/22/2007	Tissue	X	X	X
1B-REF-05	680-28224-31	6/22/2007	Tissue	X	X	X
1B-REF-06	680-28224-32	6/22/2007	Tissue	X	X	X
1B-SS09	680-28224-16	6/22/2007	Tissue	X	X	X
1B-SS13	680-28224-17	6/22/2007	Tissue	X	X	X
1B-SS15	680-28224-18	6/22/2007	Tissue	X	X	X
1B-SS18	680-28224-19	6/22/2007	Tissue	X	X	X
1B-SS19	680-28224-20	6/22/2007	Tissue	X	X	X
1B-SS29	680-28224-21	6/22/2007	Tissue	X	X	X
1B-SS33	680-28224-22	6/22/2007	Tissue	X	X	X
1B-SS37	680-28224-23	6/22/2007	Tissue	X	X	X
1B-SS39	680-28224-24	6/22/2007	Tissue	X	X	X
1B-SS46	680-28224-25	6/22/2007	Tissue	X	X	X
1B-SS48	680-28224-26	6/22/2007	Tissue	X	X	X
1B-SS49	680-28224-27	6/22/2007	Tissue	X	X	X
1B-SS50	680-28224-28	6/22/2007	Tissue	X	X	X
1B-SS51	680-28224-29	6/22/2007	Tissue	X	X	X

Project: NAPR - SWMUs 1 and 2 (CTO-108)
Laboratory: Test America
Sample Delivery Group: SWMU28224-2
Fraction: Organic
Matrix: Tissue
Report Date: 5/9/2008

This analytical quality assurance report is based upon a review of analytical data generated for earthworm tissue samples. The sample locations, laboratory identification numbers, sample collection dates, sample matrix, and analyses performed are presented in Table 1.

The samples were analyzed for pesticide compounds: 4, 4'DDE, 4, 4'-DDD, and 4, 4'-DDT. The sample analyses were performed in accordance with the procedures outlined in the method referenced at the end of this report.

All sample analyses have undergone an analytical quality assurance review to ensure adherence to the required protocols. Results have been validated or qualified according to Region II "SW-846 Method 8080A/8000A", SOP HW-23, Revision 0, April 1995. The parameters presented on the following page were evaluated.

X	•	Data Completeness
X	•	Chain of Custody Documentation
X	•	Holding Times
	•	Instrument Performance
X	•	Initial and Continuing Calibrations
X	•	Laboratory and Field Blank Analysis Results
X	•	Surrogate Compound Recoveries
	•	Matrix Spike/Matrix Spike Duplicate Recoveries and Reproducibility
	•	Field Duplicate Analysis Results
X	•	Laboratory Control Sample Results
	•	Internal Standard Performance
X	•	Qualitative Identification
X	•	Quantitation/Reporting Limits

X - Denotes parameter evaluated.

It is recommended that the data only be used according to the qualifiers presented, and discussed in this report. All other data should be considered qualitatively and quantitatively valid as reported by the laboratory, based on the items evaluated.

Report Approved By:

Shawne M. Rodgers
President

5/19/2008

Date

1.0 *DATA COMPLETENESS*

The data package was complete.

2.0 *CHAIN OF CUSTODY DOCUMENTATION*

The chain of custody documentation was complete.

3.0 *HOLDING TIMES*

All criteria were met. No qualifiers were applied.

4.0 *INSTRUMENT PERFORMANCE*

This parameter is not applicable to the analyses performed.

5.0 *INITIAL AND CONTINUING CALIBRATIONS*

The laboratory evaluated the samples using guidance given in the DOD QSM Final Version 3, which allows for 20% difference as the continuing calibration verification criteria. This is a deviation from Method 8081A, which allows for a 15% difference. This has been noted in the case narrative.

6.0 *LABORATORY AND FIELD BLANK ANALYSIS RESULTS*

All criteria were met. No qualifiers were applied.

7.0 SURROGATE COMPOUND RECOVERIES

All criteria were met. No qualifiers were applied.

8.0 MATRIX SPIKE/MATRIX SPIKE DUPLICATE RECOVERIES AND REPRODUCIBILITY

The laboratory did not select a site sample to perform matrix spike/ matrix spike duplicate analyses. Therefore, the associated sample data could not be evaluated based on these parameters. This should be noted when assessing the sample data.

9.0 FIELD DUPLICATE RESULTS

There were no field duplicate samples submitted with this SDG.

10.0 LABORATORY CONTROL SAMPLE RESULTS

All criteria were met. No qualifiers were applied.

11.0 INTERNAL STANDARD PERFORMANCE

All criteria were met. No qualifiers were applied.

12.0 QUALITATIVE IDENTIFICATION

All criteria were met. No qualifiers were applied.

13.0 *QUANTITATION/REPORTING LIMITS*

The following positive results reported by the laboratory at a concentration greater than the reporting limit. Poor precision (greater than 25% difference, but less than 70% difference between results) was observed for this analyte on the dual chromatographic columns used for sample analysis. The laboratory for reporting purposes used the lower concentration for these compounds. The positive results should be considered quantitative estimates. The result has been marked "J" to indicate this.

Sample	Affected Compound
1B-SS33	4,4'-DDE
1B-SS48	4,4'-DDE
1B-SS49	4,4'-DDE

The following pesticide/PCB constituents were reported by the laboratory at concentrations less than the reporting limit. Poor precision (greater than 50 % difference between results) was observed for these analytes on the dual chromatographic columns used for sample analysis. The laboratory for reporting purposes used the lower concentration for these compounds. The positive pesticide/PCB constituent results should be considered non-detected at the reporting limit. The results have been marked "U".

Sample	Affected Compound
1B-SS09	4,4'-DDE
1B-SS13	4,4'-DDE
1B-SS15	4,4'-DDE
1B-SS18	4,4'-DDE
1B-SS29	4,4'-DDE
1B-SS39	4,4'-DDE
1B-SS46	4,4'-DDD

The samples presented in the following table were analyzed at dilutions for pesticide constituents. The dilution analyses were performed because of the suspected presence of high levels of target compounds and/or interferences. Reporting limits are elevated by the dilution factor for these samples for target compounds that were not detected. The elevated reporting limits should be noted when assessing the data for these samples.

Sample	Dilution Factor
1B-SS15	2.0
1B-SS18	10.0
1B-SS33	5.0
1B-SS37	5.0
1B-SS39	2.0
1B-SS48	5.0
1B-SS49	5.0
1B-SS50	5.0

The samples presented below were re-analyzed at dilutions for pesticide constituents. The samples were re-analyzed because the responses for compounds exceeded the linear range of the GC instrument. The results for these compounds have been reported from the dilution analyses. All other results are reported from the initial analyses.

Sample	Dilution Factor	Results Exceeding the Linear Range
1B-SS19	200	4,4'-DDE, 4,4'-DDT
1B-SS46	20.0	4,4'-DDE

As required by USEPA protocol, all compounds, which were qualitatively identified at concentrations below their respective Reporting Limits (RLs), have been marked with "J" qualifiers to indicate that they are quantitative estimates.

METHODOLOGY REFERENCES

Analysis	Reference
Pesticide Constituents	Method 8081A, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997

Table 1 Samples For Data Validation Review
NAPR - SWMUs 1 and 2 (CTO-108)
Earthworm Tissue Samples Collected June 2007
Test America Sample Delivery Group SWMU28224-2

SAMPLE I.D.	LABORATORY I.D	DATE COLLECTED	MATRIX	ANALYSES PERFORMED		
				8081A	6020	7471A
1B-REF-03	680-28224-30	6/22/2007	Tissue	X	X	X
1B-REF-05	680-28224-31	6/22/2007	Tissue	X	X	X
1B-REF-06	680-28224-32	6/22/2007	Tissue	X	X	X
1B-SS09	680-28224-16	6/22/2007	Tissue	X	X	X
1B-SS13	680-28224-17	6/22/2007	Tissue	X	X	X
1B-SS15	680-28224-18	6/22/2007	Tissue	X	X	X
1B-SS18	680-28224-19	6/22/2007	Tissue	X	X	X
1B-SS19	680-28224-20	6/22/2007	Tissue	X	X	X
1B-SS29	680-28224-21	6/22/2007	Tissue	X	X	X
1B-SS33	680-28224-22	6/22/2007	Tissue	X	X	X
1B-SS37	680-28224-23	6/22/2007	Tissue	X	X	X
1B-SS39	680-28224-24	6/22/2007	Tissue	X	X	X
1B-SS46	680-28224-25	6/22/2007	Tissue	X	X	X
1B-SS48	680-28224-26	6/22/2007	Tissue	X	X	X
1B-SS49	680-28224-27	6/22/2007	Tissue	X	X	X
1B-SS50	680-28224-28	6/22/2007	Tissue	X	X	X
1B-SS51	680-28224-29	6/22/2007	Tissue	X	X	X

SEVERN TRENT - SAVANNAH SDG 680-23974-1

ENVIRONMENTAL
Data Services, Inc.

METALS

USEPA Region II - Level IV Review

Site: RCRA Facility Investigation, CTO-108, Ceiba, PR SDG #: 680-23974-1

Client: CH2M Hill, Inc./Baker Environmental, Inc. Date: April 18, 2007

Laboratory: Severn Trent Laboratories, Savannah, GA Reviewer: Nancy Weaver

EDS ID	Client Sample ID	Laboratory Sample ID	Matrix
1	REF2-VEG-WB03	680-23974-1	Tissue
2	REF2-VEG-AB03	680-23974-2	Tissue
3	REF2-VEG-WB02	680-23974-3	Tissue
4	REF2-VEG-AB02	680-23974-4	Tissue
5	REF2-VEG-WB01	680-23974-5	Tissue
6	REF2-VEG-AB01	680-23974-6	Tissue

The USEPA Region II SOP No. HW-2, Revision 13, September 2005 for Evaluation of Metals Data for the Contract Laboratory Program was used in evaluating the data in this summary report.

Sample Conditions/Problems - The Traffic Reports/Chain-of-Custody Records, Sampling Report and/or Laboratory Case Narrative did not indicate any problems with sample receipt, condition of samples, analytical problems or special circumstances affecting the quality of the data.

Holding Times - All samples were prepared and analyzed within 28 days for mercury and 180 days for all other metals.

Calibration - The ICV and CCV %R values were acceptable.

CRDL Standard - The CRDL standards exhibited acceptable %R values except those noted below. The associated samples were qualified as indicated.

Method and Calibration Blanks - The method blanks and continuing calibration blanks exhibited contamination for several compounds, however, all sample results are non-detect or greater than 5X the blank concentration.

ICP Interference Check Sample - All %R values were acceptable.

Matrix Spike/Matrix Spike Duplicate - The matrix spike samples exhibited acceptable %R values.

Field Duplicates - Field duplicate samples were not included in this data package.

LCS - The LCS samples exhibited acceptable %R values.

ICP Serial Dilution - The ICP serial dilution sample exhibited acceptable %D values.

Field and Equipment Blank - Field QC samples were not included in this data package.

Compound Quantitation - No discrepancies were identified.

DataQual
Environmental Services, LLC

Michael Baker, Jr., Inc.
Airside Business Park
100 Airside Drive
Moon Township, PA 15108

October 29, 2008
SDG# SWMU23974, Test America-Savannah
NAPR SWMU 45, Step 6 Puerto Rico

Dear Mr. Kimes,

The following Data Validation report is provided as requested for the parameters noted in the table below for SDG # SWMU23974. The data validation was performed in accordance with the SW-846 methods utilized by the laboratory and professional judgment. The method in this SDG does not have an applicable Region II checklist SOP (SW-846 method 6020 for select metals (Cu, Pb & Zn). Therefore alternate worksheets were provided. Specific method requirements, Region II flagging conventions and professional judgment were used to validate the metals results. All areas of concern are discussed in the body of the report and a summary of data qualifications is provided.

Sample ID	Lab ID	Matrix	Metals
REF2-VEG-WB03	680-23974-1	tissue	X
REF2-VEG-AB03	680-23974-2	tissue	X
REF2-VEG-WB02	680-23974-3	tissue	X
REF2-VEG-AB02	680-23974-4	tissue	X
REF2-VEG-WB01	680-23974-5	tissue	X
REF2-VEG-AB01	680-23974-6	tissue	X

There were no quality control samples provided with this SDG.

The samples were evaluated based on the following criteria:

- Data Completeness *
- Technical Holding Times *
- Initial/Continuing Calibrations *
- CRDL Standards *
- ICSA/ICSAB Standards *
- Blanks
- Laboratory Control Samples *
- Matrix Spike Recoveries NA
- Matrix Duplicate RPDs NA
- Serial Dilutions *
- Field Duplicates NA
- Identification/Quantitation *
- Reporting Limits *

* - indicates that qualifications were not required based on this criteria

Overall Evaluation of Data/Potential Usability Issues

A summary of qualifications applied to the sample results are noted below for the fractions validated. Specific details regarding qualification of the data are addressed in the Specific Evaluation section of this narrative. If an issue is not addressed there were no actions required based on unmet quality criteria. When more than one qualifier is associated with a compound/analyte the validator has chosen the qualifier that best indicates possible bias in the results and flagged the data accordingly. However, information regarding all quality control issues is provided in the body of the report and on the qualification summary page.

Metals

Blank contamination was noted and qualification was required in the samples in this SDG.

Specific Evaluation of Data

Data Completeness

The SDG was received complete and intact. Resubmissions were not required.

Technical Holding Times

According to chain of custody records, sampling was performed on 1/31/07 and samples were received at the laboratory 2/2/07. Sample preparation and analysis was performed within Region II and/or method holding time requirements.

Blanks

Metals

Associated blanks exhibited contamination as noted in the following table. The laboratory reported non-detect results to the RL for this project.

Blank ID	Analyte	Concentration	Action Level	Q Flag
PBlk	copper	0.1965J mg/Kg	RL	U at RL
	zinc	1.2990J mg/Kg	RL	U at RL

Associated samples and required qualifications are noted in the following table.

Sample ID	Analyte	Q Flag
all samples >MDL but less than RL	copper	U at RL
all samples >MDL but less than RL	zinc	U at RL

A summary of qualifications required is provided on the following page. Please do not hesitate to contact DataQual ES with any questions regarding this validation report.

Sincerely,

Jacqueline Cleveland
Vice President

Summary of Data Qualifications

Metals

Sample ID	Analyte	Results	Q flag
all samples	copper	+J (all >MDL but less than RL)	U at RL
all samples	zinc		

Glossary of Qualification Flags and Abbreviations

Qualification Flags (Q-Flags)

U	not detected above the reported sample quantitation limit
J	estimated value
UJ	reported quantitation limit is qualified as estimated
-	analyte has been tentatively identified
JN	analyte has been tentatively identified, estimated value
R	result is rejected; the presence or absence of the analyte cannot be verified

Method/Preparation Blank Qualification Flags (Q-Flags)

Organic Methods

NA	The sample result for the blank contaminant is greater than the sample RL and is greater than 5X (10X for common laboratory contaminants) the blank value. The sample result for the blank contaminant is not qualified with any blank qualifiers.
U	The sample result for the blank contaminant is greater than the sample RL and is less than 5X (10X for common laboratory contaminants) the blank value.
CRQL	The sample result for the blank contaminant is less than the sample RL and is less than 5X (10X for common laboratory contaminants) the blank value.

Inorganic Methods

ICB/CCB/PB Action:

No Action -	The sample result is greater than the RL and greater than ten times (10X) the blank value.
U -	The sample result is greater than or equal to the MDL but less than or equal to the RL, result is reported as non-detect at the reporting limit, when the ICB/CCB/PB result is less than the RL.
R -	Sample result is greater than the RL and less than the ICB/CCB value when the ICB/CCB/PB value is greater than the RL.

Glossary of Qualification Flags and Abbreviations

Field QC Blank action:

Note – Use field blanks to qualify data only if field blank results are greater than prep blank results.
Do not use rinsate blank associated with soils to qualify water samples and vice versa.

No Action -	The sample result is greater than the RL and greater than ten times (10X) the blank value.
U -	The sample result is greater than or equal to the MDL but less than or equal to the RL when the field blank result is greater than the RL - result is reported as non-detect at the reporting limit.
R -	Sample result is greater than the RL and less than the field blank value when the field blank result is greater than the RL.
J -	Sample result is greater than the field blank value but less than 10X the field blank value when field blank result is greater than the RL.

General Abbreviations

RL	reporting limit
IDL	instrument detection limit
MDL	method detection limit
CRDL	contract required detection limit
CRQL	contract required quantitation limit
+	positive result
-	non-detect result

SEVERN TRENT - SAVANNAH SDG 680-23902-1

ENVIRONMENTAL
Data Services, Inc.

METALS
USEPA Region II - Level IV Review

Site: RCRA Facility Investigation, CTO-108, Ceiba, PR SDG #: 680-23902-1

Client: CH2M Hill, Inc./Baker Environmental, Inc. Date: April 30, 2007

Laboratory: Severn Trent Laboratories, Savannah, GA Reviewer: Nancy Weaver

EDS ID	Client Sample ID	Laboratory Sample ID	Matrix
1	45B-SD04	680-23902-1	Soil
2	45B-SD04D	680-23902-2	Soil
3	45B-SD06	680-23902-3	Soil
4	45B-SD10	680-23902-4	Soil
5	45B-SD13	680-23902-5	Soil
6	45B-SD15	680-23902-6	Soil
7	45B-SD17	680-23902-7	Soil
8	REF-SD11	680-23902-8	Soil
8 MS	REF-SD11MS	680-23902-8MS	Soil
8MSD	REF-SD11MSD	680-23902-8MSD	Soil
9	REF-SD12	680-23902-9	Soil
10	45B-VEG-SED01	680-23902-10	Tissue
10 MS	45B-VEG-SED01MS	680-23902-10MS	Tissue
10 MSD	45B-VEG-SED01MSD	680-23902-10MSD	Tissue
11	45B-VEG-SED01D	680-23902-11	Tissue
12	45B-VEG-SED02	680-23902-12	Tissue
13	45B-VEG-SED03	680-23902-13	Tissue
14	REF2-VEG-SED01	680-23902-14	Tissue
15	REF2-VEG-SED02	680-23902-15	Tissue
16	REF2-VEG-SED03	680-23902-16	Tissue
17	45-ER01	680-23902-17EB	Water
18	45-FB01	680-23902-18FB	Water
19	45B-VEG-AB01	680-23902-19	Tissue
19 MS	45B-VEG-AB01MS	680-23902-19MS	Tissue
19 MSD	45B-VEG-AB01MSD	680-23902-19MSD	Tissue
20	45B-VEG-WB01	680-23902-20	Tissue
21	45B-VEG-AB02	680-23902-21	Tissue
22	45B-VEG-WB02	680-23902-22	Tissue
23	45B-VEG-AB03	680-23902-23	Tissue
24	45B-VEG-WB03	680-23902-24	Tissue

The USEPA Region II SOP No. HW-2, Revision 13, September 2005 for Evaluation of Metals Data for the Contract Laboratory Program was used in evaluating the data in this summary report.

Sample Conditions/Problems - The Traffic Reports/Chain-of-Custody Records, Sampling Report and/or Laboratory Case Narrative did not indicate any problems with sample receipt, condition of samples, analytical problems or special circumstances affecting the quality of the data.

Holding Times - All samples were prepared and analyzed within 28 days for mercury and 180 days for all other metals.

Calibration - The ICV and CCV %R values were acceptable.

CRDL Standard - The CRDL standards exhibited acceptable %R values except those noted below.

Compound	%R - High/Low	Qualifier	Affected Samples
Cadmium	111% - High	None	ND or already qualified (J)
Copper	145% - High	None	
Arsenic	116% - High	None	ND, already (J) or >2X CRDL
Selenium	115% - High	None	
Mercury	76.0% - Low	None	Already qualified (J) due to MS/MSD
Tin	68% - Low	UL	All Soil Samples

Method and Calibration Blanks - The method blanks and continuing calibration blanks exhibited the following contamination.

Soil

Compound	Conc.	Action Level	Qualifier	Affected Samples
Copper	0.083(PBS) mg/kg	0.415 mg/kg	None	All >5X

Water

Compound	Conc.	Action Level	Qualifier	Affected Samples
Copper	0.093 (ICB) ug/L	0.465 ug/L	None	All >5X

ICP Interference Check Sample - All %R values were acceptable.

Matrix Spike/Matrix Spike Duplicate - The matrix spike samples exhibited acceptable %R values except the following.

MS/MSD Sample ID	Compound	MS/MSD %R	Qualifier	Affected Samples
REF-SD11	Mercury	73.5/77.1	J/UJ	All REF-SED samples
	Tin	190%/189%	None	All ND

Field Duplicates - Field duplicate results are summarized below.

Compound	45B-SD04 mg/kg	45B-SD04D mg/kg	RPD	Qualifier
Arsenic	2.8	3.0	7	None
Cadmium	0.090 J	0.12 J	29	
Copper	18	25	33	
Mercury	0.0098 J	0.016 J	48	

Compound	45B-VEG-SED01 mg/kg	45B-VEG-SED01D mg/kg	RPD	Qualifier
Arsenic	3.9	4.5	14	None
Cadmium	0.057 J	0.075 J	27	
Selenium	0.19 J	0.18 J	5	
Mercury	0.0093 J	0.0089 J	4	

LCS - The LCS samples exhibited acceptable %R values.

ICP Serial Dilution - The ICP serial dilution samples exhibited acceptable %D values.

Field and Equipment Blank - Field QC results are summarized below.

Blank ID	Compound	Conc. ug/L	Action Level ug/L	Qualifier	Affected Samples
45-ER01	Copper	0.89	4.45	None	All >5X
45-FB01	Copper	0.40	2.00	None	

Compound Quantitation - No discrepancies were identified.

DataQual

Environmental Services, LLC

Michael Baker, Jr., Inc.
Airside Business Park
100 Airside Drive
Moon Township, PA 15108

October 29, 2008
SDG# SWMU23902-1, Test America-Savannah
NAPR SWMU 45, Step 6 Puerto Rico

Dear Mr. Kimes,

The following Data Validation report is provided as requested for the parameters noted in the table below for SDG # SWMU23902-1. The data validation was performed in accordance with the SW-846 methods utilized by the laboratory and professional judgment. The method in this SDG does not have an applicable Region II checklist SOP (SW-846 method 6020 for select metals (Cu, Pb & Zn). Therefore alternate worksheets were provided. Specific method requirements, Region II flagging conventions and professional judgment were used to validate the metals results. All areas of concern are discussed in the body of the report and a summary of data qualifications is provided.

Sample ID	Lab ID	Matrix	Metals
REF2-VEG-SED01	680-23902-14	soil	X
REF2-VEG-SED02	680-23902-15	soil	X
REF2-VEG-SED03	680-23902-16	soil	X

There were no quality control samples provided with this SDG.

The samples were evaluated based on the following criteria:

- Data Completeness *
- Technical Holding Times *
- Initial/Continuing Calibrations *
- CRDL Standards
- ICSA/ICSAB Standards *
- Blanks *
- Laboratory Control Samples *
- Matrix Spike Recoveries
- Matrix Duplicate RPDs *
- Serial Dilutions *
- Field Duplicates NA
- Identification/Quantitation
- Reporting Limits *

5830 Amberway Drive • St. Louis, MO 63128 • 314-330-1327 • Fax 314-849-6264

* - indicates that qualifications were not required based on this criteria

Overall Evaluation of Data/Potential Usability Issues

A summary of qualifications applied to the sample results are noted below for the fractions validated. Specific details regarding qualification of the data are addressed in the Specific Evaluation section of this narrative. If an issue is not addressed there were no actions required based on unmet quality criteria. When more than one qualifier is associated with a compound/analyte the validator has chosen the qualifier that best indicates possible bias in the results and flagged the data accordingly. However, information regarding all quality control issues is provided in the body of the report and on the qualification summary page.

Metals

The CRDL standard was high for copper. The analyte required qualification in one sample.

The associated MS/MSD exhibited low recoveries for lead and zinc. The analytes were flagged as estimated J/UJ in all samples.

One sample exhibited a %solids value less than 50%. All analytes in this sample were flagged as estimated J/UJ.

Specific Evaluation of Data

Data Completeness

The SDG was received complete and intact. Resubmissions were not required.

Technical Holding Times

According to chain of custody records, sampling was performed on 1/30/07 and samples were received at the laboratory 2/1/07. Sample preparation and analysis was performed within Region II and/or method holding time requirements.

CRDL Standard

Metals

The associated CRDL standard exhibited a high recovery for the analyte copper (145%). All reported positive results greater than 2X the RL required qualification as estimated J. The reported positive result for copper in sample REF2-VEG-SED03 was qualified as estimated J.

Matrix Spike

Metals

The matrix spikes of sample 45B-VEG-SED01 (an associated sample in the same SDG) exhibited non-compliant recoveries for lead and zinc that required qualification in the field samples. A summary of this non-compliances and affected samples are noted in the following table.

MS/SD	Analytes	Samples	%R	Q Flag
45B-VEG-SED01	lead	all soil samples	45/42	J/UJ
	zinc		29/34	

Identification/Quantitation

Metals

Sample REF2-VEG-SED01 exhibited a % solids value that was less than 50% (49%). All reported results in the sample were qualified as estimated J/UJ.

A summary of qualifications required is provided on the following page. Please do not hesitate to contact DataQual ES with any questions regarding this validation report.

Sincerely,

Jacqueline Cleveland
Vice President

Summary of Data Qualifications

Metals

Sample ID	Analyte	Results	Q flag
REF2-VEG-SED03	copper	+	J
all samples	lead	+/-	J/UJ
	zinc		
REF2-VEG-SED01	all analytes	+/-	J/UJ

Glossary of Qualification Flags and Abbreviations

Qualification Flags (Q-Flags)

U	not detected above the reported sample quantitation limit
J	estimated value
UJ	reported quantitation limit is qualified as estimated
-	analyte has been tentatively identified
JN	analyte has been tentatively identified, estimated value
R	result is rejected; the presence or absence of the analyte cannot be verified

Method/Preparation Blank Qualification Flags (Q-Flags)

Organic Methods

NA	The sample result for the blank contaminant is greater than the sample RL and is greater than 5X (10X for common laboratory contaminants) the blank value. The sample result for the blank contaminant is not qualified with any blank qualifiers.
U	The sample result for the blank contaminant is greater than the sample RL and is less than 5X (10X for common laboratory contaminants) the blank value.
CRQL	The sample result for the blank contaminant is less than the sample RL and is less than 5X (10X for common laboratory contaminants) the blank value.

Inorganic Methods

ICB/CCB/PB Action:

No Action -	The sample result is greater than the RL and greater than ten times (10X) the blank value.
U -	The sample result is greater than or equal to the MDL but less than or equal to the RL, result is reported as non-detect at the reporting limit, when the ICB/CCB/PB result is less than the RL.
R -	Sample result is greater than the RL and less than the ICB/CCB value when the ICB/CCB/PB value is greater than the RL.

Glossary of Qualification Flags and Abbreviations

Field QC Blank action:

Note – Use field blanks to qualify data only if field blank results are greater than prep blank results.
Do not use rinsate blank associated with soils to qualify water samples and vice versa.

No Action -	The sample result is greater than the RL and greater than ten times (10X) the blank value.
U -	The sample result is greater than or equal to the MDL but less than or equal to the RL when the field blank result is greater than the RL - result is reported as non-detect at the reporting limit.
R -	Sample result is greater than the RL and less than the field blank value when the field blank result is greater than the RL.
J -	Sample result is greater than the field blank value but less than 10X the field blank value when field blank result is greater than the RL.

General Abbreviations

RL	reporting limit
IDL	instrument detection limit
MDL	method detection limit
CRDL	contract required detection limit
CRQL	contract required quantitation limit
+	positive result
-	non-detect result

APPENDIX G
95 PERCENT UCL OF THE MEAN ECOLOGICAL COC CONCENTRATIONS IN SWMU 1 SURFACE SOIL

4,4'-DDD
SWMU 1 Surface Soil

General Statistics

Number of Valid Data	88	Number of Detected Data	52
Number of Distinct Detected Data	46	Number of Non-Detect Data	36
Number of Missing Values	2	Percent Non-Detects	40.91%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.9	Minimum Detected	-0.105
Maximum Detected	13000	Maximum Detected	9.473
Mean of Detected	340.2	Mean of Detected	3.482
SD of Detected	1809	SD of Detected	1.735
Minimum Non-Detect	0.37	Minimum Non-Detect	-0.994
Maximum Non-Detect	49	Maximum Non-Detect	3.892

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	65
Number treated as Detected	23
Single DL Non-Detect Percentage	73.86%

UCL Statistics

Normal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.469
5% Lilliefors Critical Value	0.123

Data not Normal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method	
Mean	202.7
SD	1395
95% DL/2 (t) UCL	450
Maximum Likelihood Estimate(MLE) Method	N/A
MLE yields a negative mean	

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.29
Theta Star	1171
nu star	30.21
A-D Test Statistic	6.926
5% A-D Critical Value	0.865
K-S Test Statistic	0.865
5% K-S Critical Value	0.134

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	1.00E-09
Maximum	13000
Mean	222
Median	18
SD	1394
k star	0.0964
Theta star	2303
Nu star	16.96
AppChi2	8.645
95% Gamma Approximate UCL	435.5
95% Adjusted Gamma UCL	440.6

Note: DL/2 is not a recommended method.

Lognormal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.0914
5% Lilliefors Critical Value	0.123

Data appear Lognormal at 5% Significance Level

Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	2.297
SD	2.202
95% H-Stat (DL/2) UCL	195.6
Log ROS Method	
Mean in Log Scale	2.024
SD in Log Scale	2.274
Mean in Original Scale	201.6
SD in Original Scale	1395
95% Percentile Bootstrap UCL	492.2
95% BCA Bootstrap UCL	657.7

Data Distribution Test with Detected Values Only
Data appear Lognormal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	201.8
SD	1387
SE of Mean	149.3
95% KM (t) UCL	450.1
95% KM (z) UCL	447.5
95% KM (jackknife) UCL	449
95% KM (bootstrap t) UCL	4783
95% KM (BCA) UCL	495.6
95% KM (Percentile Bootstrap) UCL	492.9
95% KM (Chebyshev) UCL	852.8
97.5% KM (Chebyshev) UCL	1134
99% KM (Chebyshev) UCL	1688

Potential UCLs to Use
97.5% KM (Chebyshev) UCL (ug/kg): 1134 ug/kg

4,4'-DDE
SWMU 1 Surface Soil

General Statistics

Number of Valid Data	89
Number of Distinct Detected Data	62
Number of Missing Values	1
Number of Detected Data	68
Number of Non-Detect Data	21
Percent Non-Detects	23.60%

Raw Statistics

Minimum Detected	0.62
Maximum Detected	28000
Mean of Detected	1095
SD of Detected	3590
Minimum Non-Detect	0.37
Maximum Non-Detect	12

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

UCL Statistics
Normal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.38
5% Lilliefors Critical Value	0.107

Data not Normal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method	
Mean	837
SD	3167
95% DL/2 (t) UCL	1395
Maximum Likelihood Estimate(MLE) Method	N/A
MLE yields a negative mean	

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.31
Theta Star	3533
nu star	42.14
A-D Test Statistic	1.487
5% A-D Critical Value	0.862
K-S Test Statistic	0.862
5% K-S Critical Value	0.117

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	1.00E-09
Maximum	28000
Mean	836.3
Median	64
SD	3167
k star	0.106
Theta star	7882
Nu star	18.89
AppChi2	10.03
95% Gamma Approximate UCL	1574
95% Adjusted Gamma UCL	1591

Note: DL/2 is not a recommended method.

Log-transformed Statistics

Minimum Detected	-0.478
Maximum Detected	10.24
Mean of Detected	4.817
SD of Detected	2.503
Minimum Non-Detect	-0.994
Maximum Non-Detect	2.485
Number treated as Non-Detect	35
Number treated as Detected	54
Single DL Non-Detect Percentage	39.33%

Lognormal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.0838
5% Lilliefors Critical Value	0.107

Data appear Lognormal at 5% Significance Level

Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	3.757
SD	3.004
95% H-Stat (DL/2) UCL	9614
Log ROS Method	3.691
Mean in Log Scale	3.036
SD in Log Scale	836.7
Mean in Original Scale	3167
SD in Original Scale	1463
95% Percentile Bootstrap UCL	1833
95% BCA Bootstrap UCL	

Data Distribution Test with Detected Values Only
Data appear Lognormal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	836.6
SD	3149
SE of Mean	336.3
95% KM (t) UCL	1396
95% KM (z) UCL	1390
95% KM (jackknife) UCL	1395
95% KM (bootstrap t) UCL	2630
95% KM (BCA) UCL	1442
95% KM (Percentile Bootstrap) UCL	1437
95% KM (Chebyshev) UCL	2303
97.5% KM (Chebyshev) UCL	2937
99% KM (Chebyshev) UCL	4183

Potential UCLs to Use
97.5% KM (Chebyshev) UCL (ug/kg): 2937 ug/kg

4,4'-DDT
SWMU 1 Surface Soil

General Statistics

Number of Valid Data	89	Number of Detected Data	67
Number of Distinct Detected Data	55	Number of Non-Detect Data	22
Number of Missing Values	1	Percent Non-Detects	24.72%

Raw Statistics

Minimum Detected	1.2
Maximum Detected	43000
Mean of Detected	1060
SD of Detected	5516
Minimum Non-Detect	0.33
Maximum Non-Detect	12

Log-transformed Statistics

Minimum Detected	0.182
Maximum Detected	10.67
Mean of Detected	4.27
SD of Detected	2.108
Minimum Non-Detect	-1.109
Maximum Non-Detect	2.485

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	34
Number treated as Detected	55
Single DL Non-Detect Percentage	38.20%

UCL Statistics
Normal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.441
5% Lilliefors Critical Value	0.108

Data not Normal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method	
Mean	798.9
SD	4799
95% DL/2 (t) UCL	1645

Maximum Likelihood Estimate(MLE) Method N/A
MLE yields a negative mean

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.26
Theta Star	4083
nu star	34.8
A-D Test Statistic	7.044
5% A-D Critical Value	0.882
K-S Test Statistic	0.882
5% K-S Critical Value	0.119

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	1.00E-09
Maximum	43000
Mean	798.3
Median	34
SD	4799
k star	0.0994
Theta star	8030
Nu star	17.69
AppChi2	9.171
95% Gamma Approximate UCL	1540
95% Adjusted Gamma UCL	1557

Note: DL/2 is not a recommended method.

Lognormal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.075
5% Lilliefors Critical Value	0.108

Data appear Lognormal at 5% Significance Level

Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	3.226
SD	2.71
95% H-Stat (DL/2) UCL	1687
Log ROS Method	
Mean in Log Scale	3.221
SD in Log Scale	2.623
Mean in Original Scale	798.6
SD in Original Scale	4799
95% Percentile Bootstrap UCL	1757
95% BCA Bootstrap UCL	2412

Data Distribution Test with Detected Values Only
Data appear Lognormal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	798.7
SD	4772
SE of Mean	509.6
95% KM (t) UCL	1646
95% KM (z) UCL	1637
95% KM (jackknife) UCL	1644
95% KM (bootstrap t) UCL	12428
95% KM (BCA) UCL	1728
95% KM (Percentile Bootstrap) UCL	1759
95% KM (Chebyshev) UCL	3020
97.5% KM (Chebyshev) UCL	3981
99% KM (Chebyshev) UCL	5869

Potential UCLs to Use
97.5% KM (Chebyshev) UCL (ug/kg): 3981 ug/kg

Antimony
SWMU 1 Surface Soil

General Statistics

Number of Valid Data	85	Number of Detected Data	64
Number of Distinct Detected Data	57	Number of Non-Detect Data	21
Number of Missing Values	5	Percent Non-Detects	24.71%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.012	Minimum Detected	-4.423
Maximum Detected	220	Maximum Detected	5.394
Mean of Detected	18.59	Mean of Detected	1.577
SD of Detected	34.48	SD of Detected	2.064
Minimum Non-Detect	0.22	Minimum Non-Detect	-1.514
Maximum Non-Detect	1.9	Maximum Non-Detect	0.642

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	34
Number treated as Detected	51
Single DL Non-Detect Percentage	40.00%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Lilliefors Test Statistic	0.295	Lilliefors Test Statistic	0.122
5% Lilliefors Critical Value	0.111	5% Lilliefors Critical Value	0.111
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method			
Mean	14.07	DL/2 Substitution Method	0.797
SD	30.9	Mean	2.29
95% DL/2 (t) UCL	19.64	SD	42.32
		95% H-Stat (DL/2) UCL	
Maximum Likelihood Estimate(MLE) Method			
Mean	0.828	Log ROS Method	0.697
SD	42.9	Mean in Log Scale	2.389
95% MLE (t) UCL	8.567	SD in Log Scale	14.04
95% MLE (Tiku) UCL	9.538	Mean in Original Scale	30.91
		SD in Original Scale	19.72
Gamma Distribution Test with Detected Values Only		95% Percentile Bootstrap UCL	22.22
k star (bias corrected)	0.464	95% BCA Bootstrap UCL	
Theta Star	40.07		
nu star	59.37	Data Distribution Test with Detected Values Only	
		Data appear Gamma Distributed at 5% Significance Level	
A-D Test Statistic	0.569		
5% A-D Critical Value	0.822	Nonparametric Statistics	
K-S Test Statistic	0.822	Kaplan-Meier (KM) Method	
5% K-S Critical Value	0.118	Mean	14.02
Data appear Gamma Distributed at 5% Significance Level		SD	30.74
		SE of Mean	3.36
Assuming Gamma Distribution		95% KM (t) UCL	19.61
Gamma ROS Statistics using Extrapolated Data		95% KM (z) UCL	19.54
Minimum	1.00E-09	95% KM (jackknife) UCL	19.6
Maximum	220	95% KM (bootstrap t) UCL	23.56
Mean	13.99	95% KM (BCA) UCL	19.83
Median	2.8	95% KM (Percentile Bootstrap) UCL	20.08
SD	30.93	95% KM (Chebyshev) UCL	28.67
k star	0.124	97.5% KM (Chebyshev) UCL	35
Theta star	112.7	99% KM (Chebyshev) UCL	47.45
Nu star	21.11		
AppChi2	11.67	**Potential UCLs to Use**	
95% Gamma Approximate UCL	25.3	**95% KM (Chebyshev) UCL (mg/kg):**	**28.67 mg/kg**
95% Adjusted Gamma UCL	25.57		

Note: DL/2 is not a recommended method.

Cadmium
SWMU 1 Surface Soil

General Statistics

Number of Valid Data	85	Number of Detected Data	80
Number of Distinct Detected Data	65	Number of Non-Detect Data	5
Number of Missing Values	5	Percent Non-Detects	5.88%

Raw Statistics

Minimum Detected	0.02
Maximum Detected	83.8
Mean of Detected	3.798
SD of Detected	10.1
Minimum Non-Detect	0.19
Maximum Non-Detect	0.25

Log-transformed Statistics

Minimum Detected	-3.912
Maximum Detected	4.428
Mean of Detected	-0.111
SD of Detected	1.781
Minimum Non-Detect	-1.661
Maximum Non-Detect	-1.386

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	26
Number treated as Detected	59
Single DL Non-Detect Percentage	30.59%

UCL Statistics

Normal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.354
5% Lilliefors Critical Value	0.0991

Data not Normal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean	3.581
SD	9.834
95% DL/2 (t) UCL	5.356

Maximum Likelihood Estimate(MLE) Method

Mean	0.664
SD	12.31
95% MLE (t) UCL	2.886
95% MLE (Tiku) UCL	2.985

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.439
Theta Star	8.659
nu star	70.19
A-D Test Statistic	2.161
5% A-D Critical Value	0.831
K-S Test Statistic	0.831
5% K-S Critical Value	0.106

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	1.00E-09
Maximum	83.8
Mean	3.575
Median	0.77
SD	9.836
k star	0.268
Theta star	13.32
Nu star	45.62
AppChi2	31.13
95% Gamma Approximate UCL	5.24
95% Adjusted Gamma UCL	5.275

Note: DL/2 is not a recommended method.

Lognormal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.0587
5% Lilliefors Critical Value	0.0991

Data appear Lognormal at 5% Significance Level

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean	-0.233
SD	1.796
95% H-Stat (DL/2) UCL	7.61

Log ROS Method

Mean in Log Scale	-0.24
SD in Log Scale	1.806
Mean in Original Scale	3.581
SD in Original Scale	9.834
95% Percentile Bootstrap UCL	5.467
95% BCA Bootstrap UCL	6.598

Data Distribution Test with Detected Values Only
Data appear Lognormal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	3.581
SD	9.776
SE of Mean	1.067
95% KM (t) UCL	5.355
95% KM (z) UCL	5.336
95% KM (jackknife) UCL	5.355
95% KM (bootstrap t) UCL	7.57
95% KM (BCA) UCL	5.703
95% KM (Percentile Bootstrap) UCL	5.468
95% KM (Chebyshev) UCL	8.232
97.5% KM (Chebyshev) UCL	10.24
99% KM (Chebyshev) UCL	14.2

Potential UCLs to Use
97.5% KM (Chebyshev) UCL (mg/kg): 10.24 mg/kg

Copper
SWMU 1 Surface Soil

General Statistics

Number of Valid Data	83	Number of Detected Data	83
Number of Distinct Detected Data	72	Number of Non-Detect Data	0
Number of Missing Values	7	Percent Non-Detects	0.00%

Raw Statistics

Minimum Detected	19.8
Maximum Detected	2340
Mean of Detected	220.5
SD of Detected	339.7
Minimum Non-Detect	N/A
Maximum Non-Detect	N/A

UCL Statistics

Normal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.277
5% Lilliefors Critical Value	0.0973

Data not Normal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method	
Mean	220.5
SD	339.7
95% DL/2 (t) UCL	282.6
Maximum Likelihood Estimate(MLE) Method	N/A
MLE method failed to converge properly	

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.843
Theta Star	261.8
nu star	139.9
A-D Test Statistic	4.693
5% A-D Critical Value	0.788
K-S Test Statistic	0.788
5% K-S Critical Value	0.102

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	19.8
Maximum	2340
Mean	220.5
Median	78.2
SD	339.7
k star	0.843
Theta star	261.8
Nu star	139.9
AppChi2	113.5
95% Gamma Approximate UCL	271.7
95% Adjusted Gamma UCL	272.7

Note: DL/2 is not a recommended method.

Log-transformed Statistics

Minimum Detected	2.986
Maximum Detected	7.758
Mean of Detected	4.718
SD of Detected	1.084
Minimum Non-Detect	N/A
Maximum Non-Detect	N/A

Lognormal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.158
5% Lilliefors Critical Value	0.0973

Data not Lognormal at 5% Significance Level

Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	4.718
SD	1.084
95% H-Stat (DL/2) UCL	265.4
Log ROS Method	
Mean in Log Scale	N/A
SD in Log Scale	N/A
Mean in Original Scale	N/A
SD in Original Scale	N/A
95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A

Data Distribution Test with Detected Values Only

Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	220.5
SD	337.7
SE of Mean	37.29
95% KM (t) UCL	282.6
95% KM (z) UCL	281.9
95% KM (jackknife) UCL	282.6
95% KM (bootstrap t) UCL	309.2
95% KM (BCA) UCL	289.2
95% KM (Percentile Bootstrap) UCL	281.1
95% KM (Chebyshev) UCL	383.1
97.5% KM (Chebyshev) UCL	453.4
99% KM (Chebyshev) UCL	591.6

Potential UCLs to Use

95% KM (Chebyshev) UCL (mg/kg): 383.1 mg/kg

Lead
SWMU 1 Surface Soil

General Statistics

Number of Valid Data	82	Number of Detected Data	82
Number of Distinct Detected Data	80	Number of Non-Detect Data	0
Number of Missing Values	8	Percent Non-Detects	0.00%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.7	Minimum Detected	-0.357
Maximum Detected	2600	Maximum Detected	7.863
Mean of Detected	286.7	Mean of Detected	3.896
SD of Detected	501.6	SD of Detected	2.193
Minimum Non-Detect	N/A	Minimum Non-Detect	N/A
Maximum Non-Detect	N/A	Maximum Non-Detect	N/A

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Lilliefors Test Statistic	0.291	Lilliefors Test Statistic	0.151
5% Lilliefors Critical Value	0.0978	5% Lilliefors Critical Value	0.0978
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	286.7	Mean	3.896
SD	501.6	SD	2.193
95% DL/2 (t) UCL	378.9	95% H-Stat (DL/2) UCL	1308
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	N/A
		SD in Log Scale	N/A
Gamma Distribution Test with Detected Values Only		Mean in Original Scale	N/A
k star (bias corrected)	0.371	SD in Original Scale	N/A
Theta Star	772.4	95% Percentile Bootstrap UCL	N/A
nu star	60.88	95% BCA Bootstrap UCL	N/A
A-D Test Statistic	2.319	Data Distribution Test with Detected Values Only	
5% A-D Critical Value	0.848	Data do not follow a Discernable Distribution (0.05)	
K-S Test Statistic	0.848		
5% K-S Critical Value	0.106	Nonparametric Statistics	
Data not Gamma Distributed at 5% Significance Level		Kaplan-Meier (KM) Method	
		Mean	286.7
Assuming Gamma Distribution		SD	498.5
Gamma ROS Statistics using Extrapolated Data		SE of Mean	55.39
Minimum	0.7	95% KM (t) UCL	378.9
Maximum	2600	95% KM (z) UCL	377.8
Mean	286.7	95% KM (jackknife) UCL	378.9
Median	62.45	95% KM (bootstrap t) UCL	408.3
SD	501.6	95% KM (BCA) UCL	386.3
k star	0.371	95% KM (Percentile Bootstrap) UCL	382.2
Theta star	772.4	95% KM (Chebyshev) UCL	528.2
Nu star	60.88	97.5% KM (Chebyshev) UCL	632.6
AppChi2	43.94	99% KM (Chebyshev) UCL	837.8
95% Gamma Approximate UCL	397.3		
95% Adjusted Gamma UCL	399.6	**Potential UCLs to Use**	
Note: DL/2 is not a recommended method.		**97.5% KM (Chebyshev) UCL (mg/kg):**	**632.6 mg/kg**

Mercury
SWMU 1 Surface Soil

General Statistics

Number of Valid Data	85
Number of Distinct Detected Data	55
Number of Missing Values	5
Number of Detected Data	82
Number of Non-Detect Data	3
Percent Non-Detects	3.53%

Raw Statistics

Minimum Detected	0.023
Maximum Detected	5.7
Mean of Detected	0.262
SD of Detected	0.642
Minimum Non-Detect	0.02
Maximum Non-Detect	0.03

Log-transformed Statistics

Minimum Detected	-3.772
Maximum Detected	1.74
Mean of Detected	-2.058
SD of Detected	1.036
Minimum Non-Detect	-3.912
Maximum Non-Detect	-3.507

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	6
Number treated as Detected	79
Single DL Non-Detect Percentage	7.06%

UCL Statistics
Normal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.355
5% Lilliefors Critical Value	0.0978

Data not Normal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method	
Mean	0.253
SD	0.632
95% DL/2 (t) UCL	0.367
Maximum Likelihood Estimate(MLE) Method	
Mean	0.221
SD	0.658
95% MLE (t) UCL	0.34
95% MLE (Tiku) UCL	0.329

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.801
Theta Star	0.327
nu star	131.3
A-D Test Statistic	4.357
5% A-D Critical Value	0.79
K-S Test Statistic	0.79
5% K-S Critical Value	0.102

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution
Gamma ROS Statistics using Extrapolated Data

Minimum	1.00E-09
Maximum	5.7
Mean	0.253
Median	0.095
SD	0.633
k star	0.468
Theta star	0.54
Nu star	79.55
AppChi2	60
95% Gamma Approximate UCL	0.335
95% Adjusted Gamma UCL	0.337

Note: DL/2 is not a recommended method.

Lognormal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.108
5% Lilliefors Critical Value	0.0978

Data not Lognormal at 5% Significance Level

Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	-2.143
SD	1.112
95% H-Stat (DL/2) UCL	0.285
Log ROS Method	
Mean in Log Scale	-2.144
SD in Log Scale	1.113
Mean in Original Scale	0.253
SD in Original Scale	0.632
95% Percentile Bootstrap UCL	0.375
95% BCA Bootstrap UCL	0.485

Data Distribution Test with Detected Values Only
Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	0.254
SD	0.629
SE of Mean	0.0686
95% KM (t) UCL	0.368
95% KM (z) UCL	0.366
95% KM (jackknife) UCL	0.367
95% KM (bootstrap t) UCL	0.57
95% KM (BCA) UCL	0.39
95% KM (Percentile Bootstrap) UCL	0.382
95% KM (Chebyshev) UCL	0.553
97.5% KM (Chebyshev) UCL	0.682
99% KM (Chebyshev) UCL	0.936

Potential UCLs to Use

95% KM (Chebyshev) UCL (mg/kg): 0.553 mg/kg

Tin
SWMU 1 Surface Soil

General Statistics

Number of Valid Data	69	Number of Detected Data	49
Number of Distinct Detected Data	47	Number of Non-Detect Data	20
Number of Missing Values	21	Percent Non-Detects	28.99%

Raw Statistics

Minimum Detected	0.13
Maximum Detected	1500
Mean of Detected	79.76
SD of Detected	220.9
Minimum Non-Detect	0.57
Maximum Non-Detect	6.6

Log-transformed Statistics

Minimum Detected	-2.04
Maximum Detected	7.313
Mean of Detected	2.427
SD of Detected	2.192
Minimum Non-Detect	-0.562
Maximum Non-Detect	1.887

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	42
Number treated as Detected	27
Single DL Non-Detect Percentage	60.87%

UCL Statistics

Normal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.376
5% Lilliefors Critical Value	0.947

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.968
5% Lilliefors Critical Value	0.947

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method	
Mean	57.02
SD	189.1
95% DL/2 (t) UCL	94.97
Maximum Likelihood Estimate(MLE) Method	N/A
MLE yields a negative mean	

Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	1.662
SD	2.262
95% H-Stat (DL/2) UCL	132.2
Log ROS Method	
Mean in Log Scale	1.415
SD in Log Scale	2.469
Mean in Original Scale	56.78
SD in Original Scale	189.1
95% Percentile Bootstrap UCL	97.57
95% BCA Bootstrap UCL	122.7

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.338
Theta Star	236.2
nu star	33.09
A-D Test Statistic	1.802
5% A-D Critical Value	0.851
K-S Test Statistic	0.851
5% K-S Critical Value	0.137

Data not Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only
Data appear Lognormal at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	1.00E-09
Maximum	1500
Mean	57.95
Median	4.5
SD	188.9
k star	0.115
Theta star	505.4
Nu star	15.82
AppChi2	7.836
95% Gamma Approximate UCL	117
95% Adjusted Gamma UCL	118.8

Note: DL/2 is not a recommended method.

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	56.83
SD	187.7
SE of Mean	22.84
95% KM (t) UCL	94.91
95% KM (z) UCL	94.39
95% KM (jackknife) UCL	94.8
95% KM (bootstrap t) UCL	152.1
95% KM (BCA) UCL	98.05
95% KM (Percentile Bootstrap) UCL	100.2
95% KM (Chebyshev) UCL	156.4
97.5% KM (Chebyshev) UCL	199.4
99% KM (Chebyshev) UCL	284

Potential UCLs to Use
97.5% KM (Chebyshev) UCL (mg/kg): 199.4 mg/kg

Zinc
SWMU 1 Surface Soil

General Statistics

Number of Valid Data	85
Number of Distinct Detected Data	77
Number of Missing Values	5
Number of Detected Data	85
Number of Non-Detect Data	0
Percent Non-Detects	0.00%

Raw Statistics

Minimum Detected	13.9
Maximum Detected	5410
Mean of Detected	585.4
SD of Detected	1048
Minimum Non-Detect	N/A
Maximum Non-Detect	N/A

UCL Statistics
Normal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.295
5% Lilliefors Critical Value	0.0961

Data not Normal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method	
Mean	585.4
SD	1048
95% DL/2 (t) UCL	774.6
Maximum Likelihood Estimate(MLE) Method	N/A
MLE method failed to converge properly	

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.461
Theta Star	1271
nu star	78.33
A-D Test Statistic	4.825
5% A-D Critical Value	0.826
K-S Test Statistic	0.826
5% K-S Critical Value	0.103

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	13.9
Maximum	5410
Mean	585.4
Median	116
SD	1048
k star	0.461
Theta star	1271
Nu star	78.33
AppChi2	58.94
95% Gamma Approximate UCL	778
95% Adjusted Gamma UCL	781.8

Note: DL/2 is not a recommended method.

Log-transformed Statistics

Minimum Detected	2.632
Maximum Detected	8.596
Mean of Detected	5.006
SD of Detected	1.67
Minimum Non-Detect	N/A
Maximum Non-Detect	N/A

Lognormal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.148
5% Lilliefors Critical Value	0.0961

Data not Lognormal at 5% Significance Level

Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	5.006
SD	1.67
95% H-Stat (DL/2) UCL	1030
Log ROS Method	
Mean in Log Scale	N/A
SD in Log Scale	N/A
Mean in Original Scale	N/A
SD in Original Scale	N/A
95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A

Data Distribution Test with Detected Values Only
Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	585.4
SD	1042
SE of Mean	113.7
95% KM (t) UCL	774.6
95% KM (z) UCL	772.5
95% KM (jackknife) UCL	774.6
95% KM (bootstrap t) UCL	818.7
95% KM (BCA) UCL	783.1
95% KM (Percentile Bootstrap) UCL	774.6
95% KM (Chebyshev) UCL	1081
97.5% KM (Chebyshev) UCL	1296
99% KM (Chebyshev) UCL	1717

Potential UCLs to Use
97.5% KM (Chebyshev) UCL (mg/kg): 1296 mg/kg

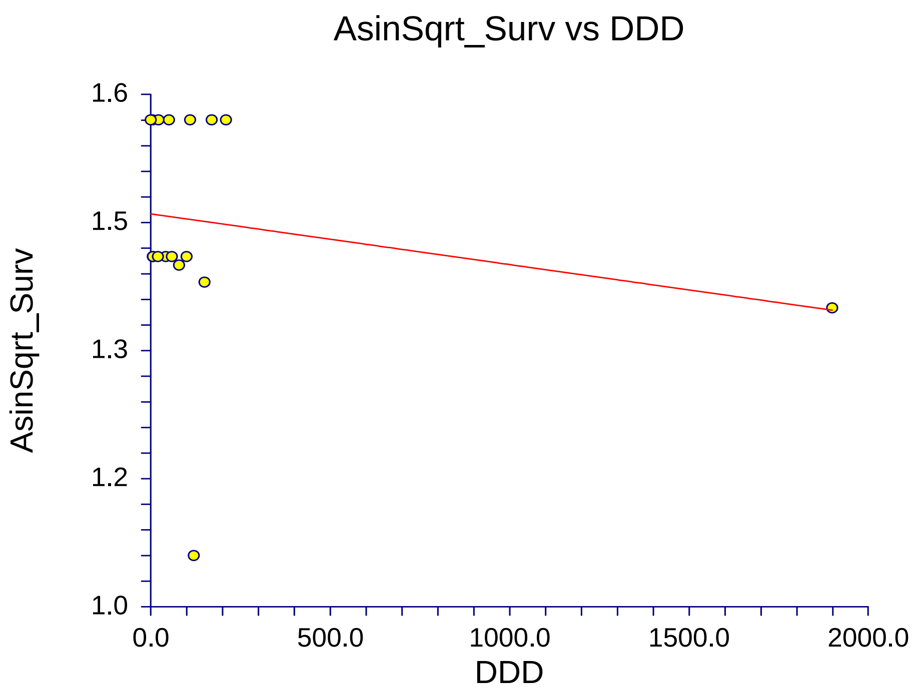
APPENDIX H
REGRESSION REPORTS

PAIR-WISE LINEAR REGRESSIONS

Linear Regression Report

Page/Date/Time 1 3/4/2009 1:25:15 PM
Database
Y = AsinSqrt_Surv X = DDD

Linear Regression Plot Section



Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	AsinSqrt_Surv	Rows Processed	17
Independent Variable	DDD	Rows Used in Estimation	17
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	1.4601	Rows Prediction Only	0
Slope	-0.0001	Sum of Frequencies	17
R-Squared	0.0404	Sum of Weights	17.0000
Correlation	-0.2010	Coefficient of Variation	0.0923
Mean Square Error	1.790537E-02	Square Root of MSE	0.133811

Linear Regression Report

Page/Date/Time 2 3/4/2009 1:25:15 PM
Y = AsinSqrt_Surv X = DDD

Summary Statement
The equation of the straight line relating AsinSqrt_Surv and DDD is estimated as: AsinSqrt_Surv = (1.4601) + (-0.0001) DDD using the 17 observations in this dataset. The y-intercept, the estimated value of AsinSqrt_Surv when DDD is zero, is 1.4601 with a standard error of 0.0351. The slope, the estimated change in AsinSqrt_Surv per unit change in DDD, is -0.0001 with a standard error of 0.0001. The value of R-Squared, the proportion of the variation in AsinSqrt_Surv that can be accounted for by variation in DDD, is 0.0404. The correlation between AsinSqrt_Surv and DDD is -0.2010.

A significance test that the slope is zero resulted in a t-value of -0.7949. The significance level of this t-test is 0.4391. Since 0.4391 > 0.0500, the hypothesis that the slope is zero is not rejected.

The estimated slope is -0.0001. The lower limit of the 95% confidence interval for the slope is -0.0002 and the upper limit is 0.0001. The estimated intercept is 1.4601. The lower limit of the 95% confidence interval for the intercept is 1.3852 and the upper limit is 1.5349.

Descriptive Statistics Section

Parameter	**Dependent**	**Independent**
Variable	AsinSqrt_Surv	DDD
Count	17	17
Mean	1.4494	179.4818
Standard Deviation	0.1323	447.8732
Minimum	1.0600	0.1900
Maximum	1.5700	1900.0000

Linear Regression Report

Page/Date/Time 3 3/4/2009 1:25:15 PM
Database
Y = AsinSqrt_Surv X = DDD

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	1.4601	-0.0001
Lower 95% Confidence Limit	1.3852	-0.0002
Upper 95% Confidence Limit	1.5349	0.0001
Standard Error	0.0351	0.0001
Standardized Coefficient	0.0000	-0.2010
T Value	41.5811	-0.7949
Prob Level (T Test)	0.0000	0.4391
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	1.0000	0.1156
Regression of Y on X	1.4601	-0.0001
Inverse Regression from X on Y	1.7130	-0.0015
Orthogonal Regression of Y and X	1.4601	-0.0001

Notes:
The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(1.46006801870573) + (-5.93723491481583E-05) * (DDD)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	35.7135	35.7135			
Slope	1	1.131354E-02	1.131354E-02	0.6319	0.4391	0.1156
Error	15	0.2685806	1.790537E-02			
Adj. Total	16	0.2798941	1.749338E-02			
Total	17	35.9934				

s = Square Root(1.790537E-02) = 0.133811

Notes:
The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Database
Y = AsinSqrt_Surv X = DDD

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.7538	0.000505	No
Anderson Darling	1.4548	0.000938	No
D'Agostino Skewness	-2.7838	0.005373	No
D'Agostino Kurtosis	2.5987	0.009357	No
D'Agostino Omnibus	14.5029	0.000709	No
Constant Residual Variance?			
Modified Levene Test	0.8426	0.373181	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?
Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:
A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.
A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say N > 500) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

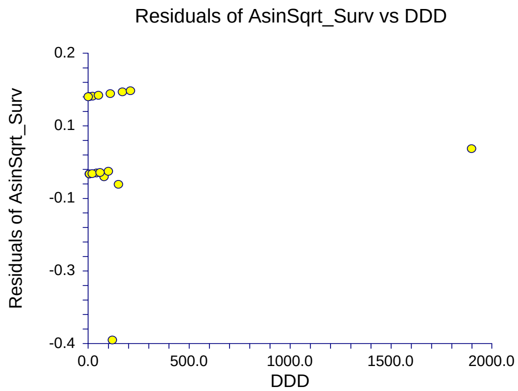
Normality and Constant Residual Variance:
Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

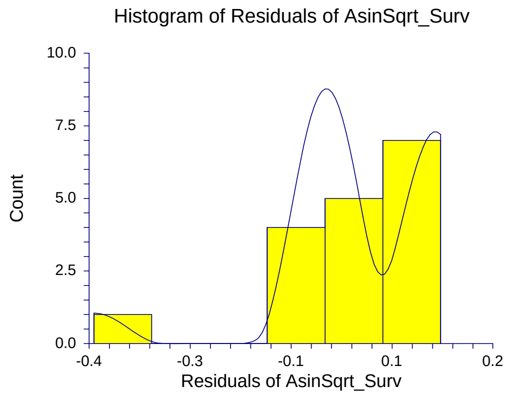
Straight-Line:
Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

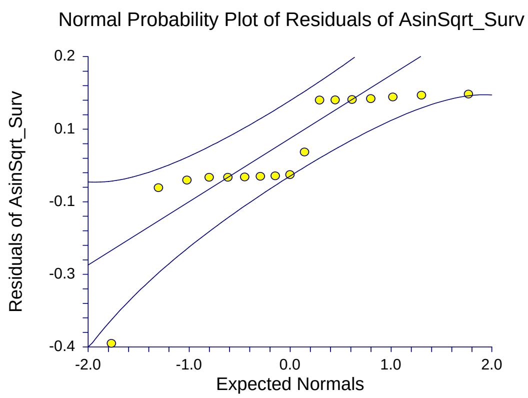
Linear Regression Report

Page/Date/Time 5 3/4/2009 1:25:15 PM
Database
Y = AsinSqrt_Surv X = DDD

Residual Plots Section



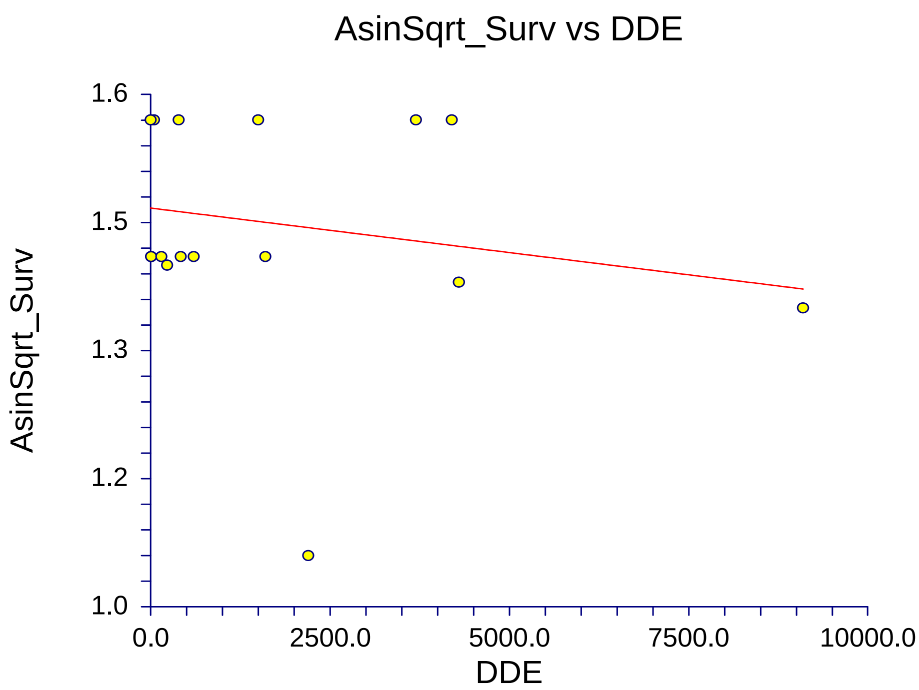




Linear Regression Report

Page/Date/Time 1 3/4/2009 1:26:18 PM
Database
Y = AsinSqrt_Surv X = DDE

Linear Regression Plot Section



Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	AsinSqrt_Surv	Rows Processed	17
Independent Variable	DDE	Rows Used in Estimation	17
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	1.4668	Rows Prediction Only	0
Slope	0.0000	Sum of Frequencies	17
R-Squared	0.0370	Sum of Weights	17.0000
Correlation	-0.1923	Coefficient of Variation	0.0925
Mean Square Error	1.796951E-02	Square Root of MSE	0.1340504

Linear Regression Report

Page/Date/Time 2 3/4/2009 1:26:18 PM
Y = AsinSqrt_Surv X = DDE

Summary Statement

The equation of the straight line relating AsinSqrt_Surv and DDE is estimated as: AsinSqrt_Surv = (1.4668) + (0.0000) DDE using the 17 observations in this dataset. The y-intercept, the estimated value of AsinSqrt_Surv when DDE is zero, is 1.4668 with a standard error of 0.0398. The slope, the estimated change in AsinSqrt_Surv per unit change in DDE, is 0.0000 with a standard error of 0.0000. The value of R-Squared, the proportion of the variation in AsinSqrt_Surv that can be accounted for by variation in DDE, is 0.0370. The correlation between AsinSqrt_Surv and DDE is -0.1923.

A significance test that the slope is zero resulted in a t-value of -0.7590. The significance level of this t-test is 0.4596. Since 0.4596 > 0.0500, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0000. The lower limit of the 95% confidence interval for the slope is 0.0000 and the upper limit is 0.0000. The estimated intercept is 1.4668. The lower limit of the 95% confidence interval for the intercept is 1.3820 and the upper limit is 1.5517.

Descriptive Statistics Section

Parameter	**Dependent**	**Independent**
Variable	AsinSqrt_Surv	DDE
Count	17	17
Mean	1.4494	1673.8935
Standard Deviation	0.1323	2441.9982
Minimum	1.0600	0.1900
Maximum	1.5700	9100.0000

Linear Regression Report

Page/Date/Time 3 3/4/2009 1:26:18 PM
Database
Y = AsinSqrt_Surv X = DDE

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	1.4668	0.0000
Lower 95% Confidence Limit	1.3820	0.0000
Upper 95% Confidence Limit	1.5517	0.0000
Standard Error	0.0398	0.0000
Standardized Coefficient	0.0000	-0.1923
T Value	36.8475	-0.7590
Prob Level (T Test)	0.0000	0.4596
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	1.0000	0.1097
Regression of Y on X	1.4668	0.0000
Inverse Regression from X on Y	1.9208	-0.0003
Orthogonal Regression of Y and X	1.4668	0.0000

Notes:
The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model
(1.46684685324672) + (-1.04158886061106E-05) * (DDE)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	35.7135	35.7135			
Slope	1	0.0103515	0.0103515	0.5761	0.4596	0.1097
Error	15	0.2695426	1.796951E-02			
Adj. Total	16	0.2798941	1.749338E-02			
Total	17	35.9934				

s = Square Root(1.796951E-02) = 0.1340504

Notes:
The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 3/4/2009 1:26:18 PM
Database
Y = AsinSqrt_Surv X = DDE

Tests of Assumptions Section

Assumption/Test	**Test Value**	**Prob Level**	**Is the Assumption Reasonable at the 0.2000 Level of Significance?**
Residuals follow Normal Distribution?			
Shapiro Wilk	0.7910	0.001531	No
Anderson Darling	1.2730	0.002623	No
D'Agostino Skewness	-2.5264	0.011523	No
D'Agostino Kurtosis	2.4010	0.016351	No
D'Agostino Omnibus	12.1476	0.002302	No
Constant Residual Variance?			
Modified Levene Test	0.6549	0.431022	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?
Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:
A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.
A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say N > 500) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

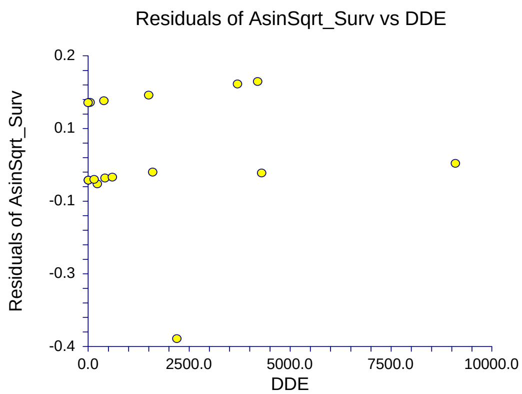
Normality and Constant Residual Variance:
Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

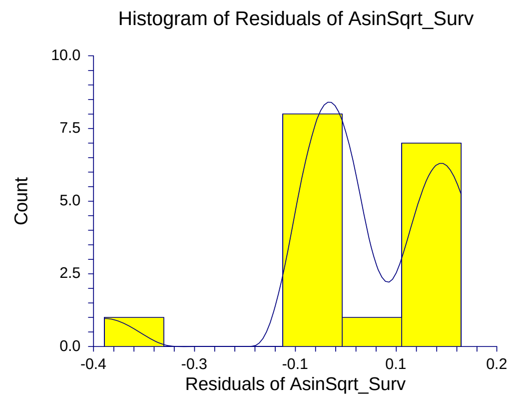
Straight-Line:
Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

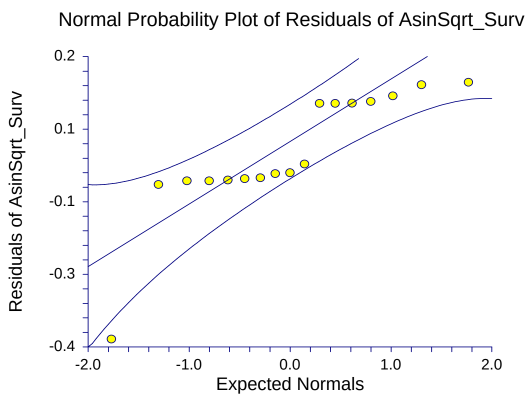
Linear Regression Report

Page/Date/Time 5 3/4/2009 1:26:18 PM
Database
Y = AsinSqrt_Surv X = DDE

Residual Plots Section



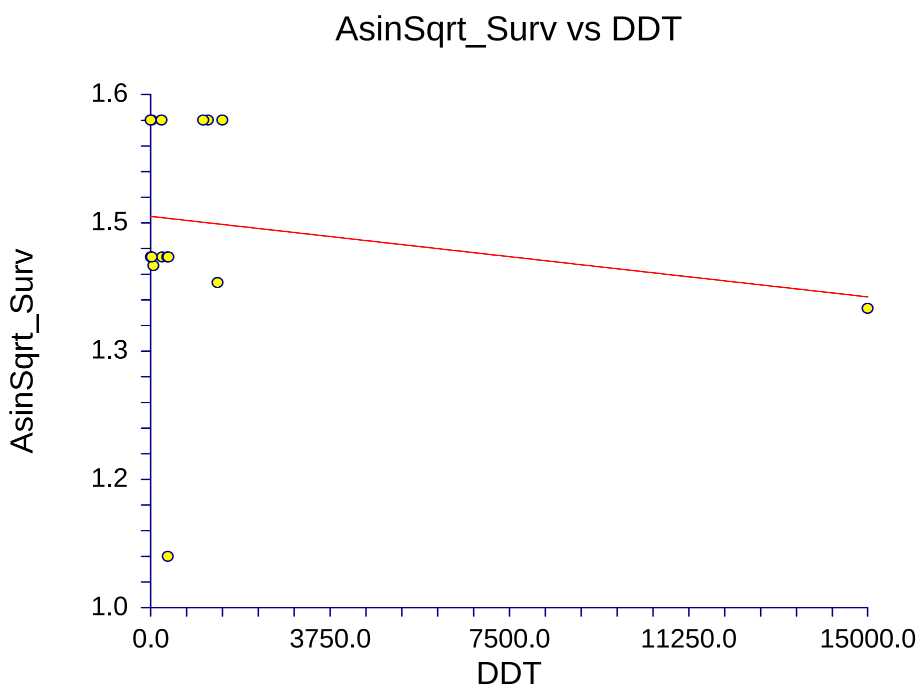




Linear Regression Report

Page/Date/Time 1 3/4/2009 1:26:41 PM
Database
Y = AsinSqrt_Surv X = DDT

Linear Regression Plot Section



Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	AsinSqrt_Surv	Rows Processed	17
Independent Variable	DDT	Rows Used in Estimation	17
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	1.4575	Rows Prediction Only	0
Slope	0.0000	Sum of Frequencies	17
R-Squared	0.0287	Sum of Weights	17.0000
Correlation	-0.1695	Coefficient of Variation	0.0929
Mean Square Error	1.812358E-02	Square Root of MSE	0.1346238

Linear Regression Report

Page/Date/Time 2 3/4/2009 1:26:41 PM
Y = AsinSqrt_Surv X = DDT

Summary Statement

The equation of the straight line relating AsinSqrt_Surv and DDT is estimated as: AsinSqrt_Surv = (1.4575) + (0.0000) DDT using the 17 observations in this dataset. The y-intercept, the estimated value of AsinSqrt_Surv when DDT is zero, is 1.4575 with a standard error of 0.0348. The slope, the estimated change in AsinSqrt_Surv per unit change in DDT, is 0.0000 with a standard error of 0.0000. The value of R-Squared, the proportion of the variation in AsinSqrt_Surv that can be accounted for by variation in DDT, is 0.0287. The correlation between AsinSqrt_Surv and DDT is -0.1695.

A significance test that the slope is zero resulted in a t-value of -0.6661. The significance level of this t-test is 0.5155. Since 0.5155 > 0.0500, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0000. The lower limit of the 95% confidence interval for the slope is 0.0000 and the upper limit is 0.0000. The estimated intercept is 1.4575. The lower limit of the 95% confidence interval for the intercept is 1.3833 and the upper limit is 1.5317.

Descriptive Statistics Section

Parameter	**Dependent**	**Independent**
Variable	AsinSqrt_Surv	DDT
Count	17	17
Mean	1.4494	1286.6571
Standard Deviation	0.1323	3572.6462
Minimum	1.0600	0.1700
Maximum	1.5700	15000.0000

Linear Regression Report

Page/Date/Time 3 3/4/2009 1:26:41 PM
Database
Y = AsinSqrt_Surv X = DDT

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	1.4575	0.0000
Lower 95% Confidence Limit	1.3833	0.0000
Upper 95% Confidence Limit	1.5317	0.0000
Standard Error	0.0348	0.0000
Standardized Coefficient	0.0000	-0.1695
T Value	41.8477	-0.6661
Prob Level (T Test)	0.0000	0.5155
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	1.0000	0.0957
Regression of Y on X	1.4575	0.0000
Inverse Regression from X on Y	1.7305	-0.0002
Orthogonal Regression of Y and X	1.4575	0.0000

Notes:
The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model
(1.45748508052393) + (-6.27464464030069E-06) * (DDT)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	35.7135	35.7135			
Slope	1	8.040411E-03	8.040411E-03	0.4436	0.5155	0.0957
Error	15	0.2718537	1.812358E-02			
Adj. Total	16	0.2798941	1.749338E-02			
Total	17	35.9934				

s = Square Root(1.812358E-02) = 0.1346238

Notes:
The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.7462	0.000406	No
Anderson Darling	1.5297	0.000614	No
D'Agostino Skewness	-2.7703	0.005600	No
D'Agostino Kurtosis	2.5981	0.009373	No
D'Agostino Omnibus	14.4249	0.000737	No
Constant Residual Variance?			
Modified Levene Test	0.6679	0.426575	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?
Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:
A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.
A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say N > 500) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

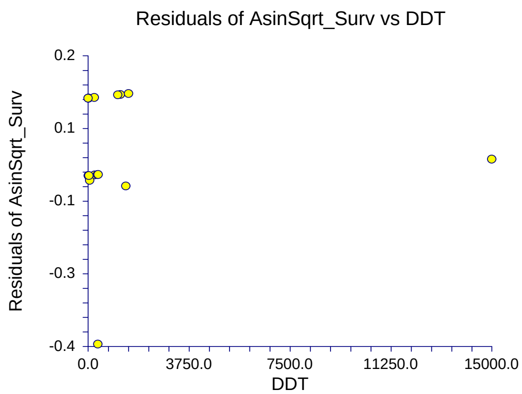
Normality and Constant Residual Variance:
Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

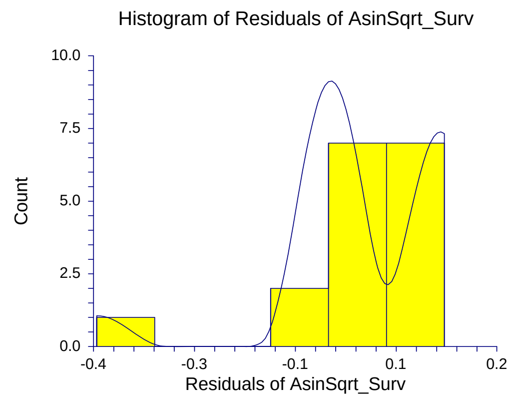
Straight-Line:
Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

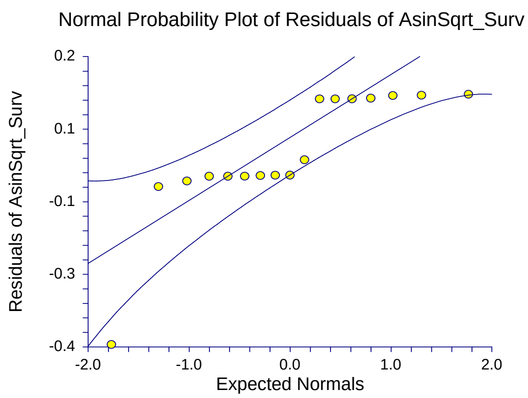
Linear Regression Report

Page/Date/Time 5 3/4/2009 1:26:41 PM
Database
Y = AsinSqrt_Surv X = DDT

Residual Plots Section



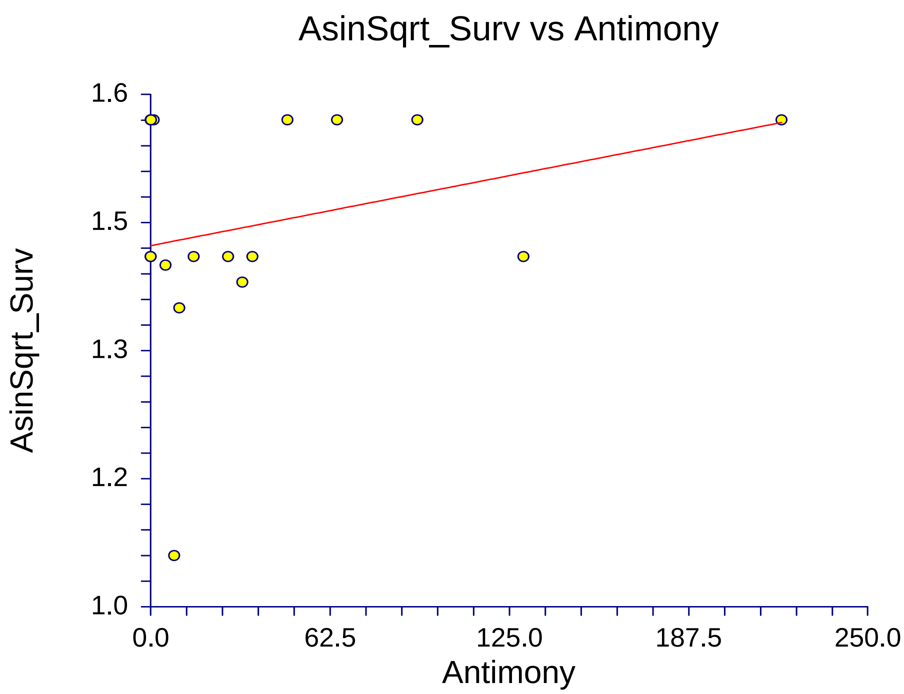




Linear Regression Report

Page/Date/Time 1 3/4/2009 1:27:14 PM
Database
Y = AsinSqrt_Surv X = Antimony

Linear Regression Plot Section



Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	AsinSqrt_Surv	Rows Processed	17
Independent Variable	Antimony	Rows Used in Estimation	17
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	1.4228	Rows Prediction Only	0
Slope	0.0007	Sum of Frequencies	17
R-Squared	0.0858	Sum of Weights	17.0000
Correlation	0.2929	Coefficient of Variation	0.0901
Mean Square Error	1.705828E-02	Square Root of MSE	0.1306073

Linear Regression Report

Y = AsinSqrt_Surv X = Antimony

Summary Statement

The equation of the straight line relating AsinSqrt_Surv and Antimony is estimated as: AsinSqrt_Surv = (1.4228) + (0.0007) Antimony using the 17 observations in this dataset. The y-intercept, the estimated value of AsinSqrt_Surv when Antimony is zero, is 1.4228 with a standard error of 0.0388. The slope, the estimated change in AsinSqrt_Surv per unit change in Antimony, is 0.0007 with a standard error of 0.0006. The value of R-Squared, the proportion of the variation in AsinSqrt_Surv that can be accounted for by variation in Antimony, is 0.0858. The correlation between AsinSqrt_Surv and Antimony is 0.2929.

A significance test that the slope is zero resulted in a t-value of 1.1866. The significance level of this t-test is 0.2538. Since 0.2538 > 0.0500, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0007. The lower limit of the 95% confidence interval for the slope is -0.0005 and the upper limit is 0.0018. The estimated intercept is 1.4228. The lower limit of the 95% confidence interval for the intercept is 1.3401 and the upper limit is 1.5055.

Descriptive Statistics Section

Parameter	**Dependent**	**Independent**
Variable	AsinSqrt_Surv	Antimony
Count	17	17
Mean	1.4494	40.5814
Standard Deviation	0.1323	59.1009
Minimum	1.0600	0.0190
Maximum	1.5700	220.0000

Linear Regression Report

Page/Date/Time 3 3/4/2009 1:27:14 PM
Database
Y = AsinSqrt_Surv X = Antimony

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	1.4228	0.0007
Lower 95% Confidence Limit	1.3401	-0.0005
Upper 95% Confidence Limit	1.5055	0.0018
Standard Error	0.0388	0.0006
Standardized Coefficient	0.0000	0.2929
T Value	36.6623	1.1866
Prob Level (T Test)	0.0000	0.2538
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	1.0000	0.1992
Regression of Y on X	1.4228	0.0007
Inverse Regression from X on Y	1.1394	0.0076
Orthogonal Regression of Y and X	1.4228	0.0007

Notes:
The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model
(1.42280703701836) + (6.55589963353068E-04) * (Antimony)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	35.7135	35.7135			
Slope	1	2.401999E-02	2.401999E-02	1.4081	0.2538	0.1992
Error	15	0.2558741	1.705828E-02			
Adj. Total	16	0.2798941	1.749338E-02			
Total	17	35.9934				

s = Square Root(1.705828E-02) = 0.1306073

Notes:
The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 3/4/2009 1:27:14 PM
Database
Y = AsinSqrt_Surv X = Antimony

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.8493	0.010456	No
Anderson Darling	0.7984	0.038680	No
D'Agostino Skewness	-2.3633	0.018111	No
D'Agostino Kurtosis	2.3102	0.020876	No
D'Agostino Omnibus	10.9225	0.004248	No
Constant Residual Variance?			
Modified Levene Test	0.6240	0.441871	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?
Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:
A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.
A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say N > 500) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

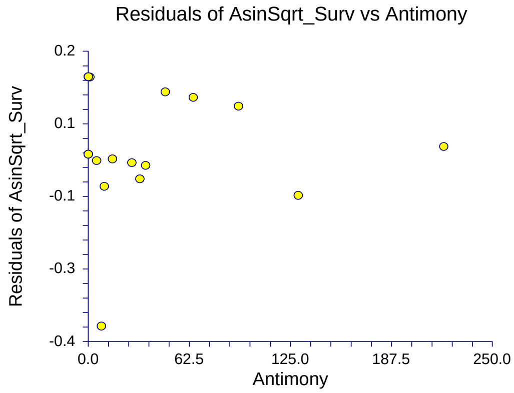
Normality and Constant Residual Variance:
Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

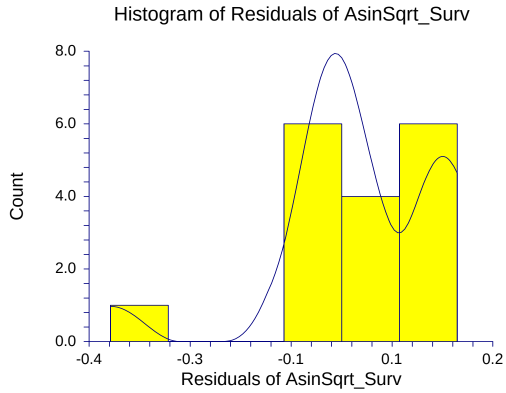
Straight-Line:
Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

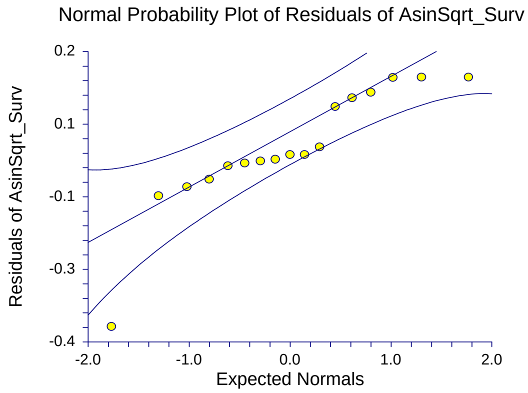
Linear Regression Report

Page/Date/Time 5 3/4/2009 1:27:14 PM
Database
Y = AsinSqrt_Surv X = Antimony

Residual Plots Section



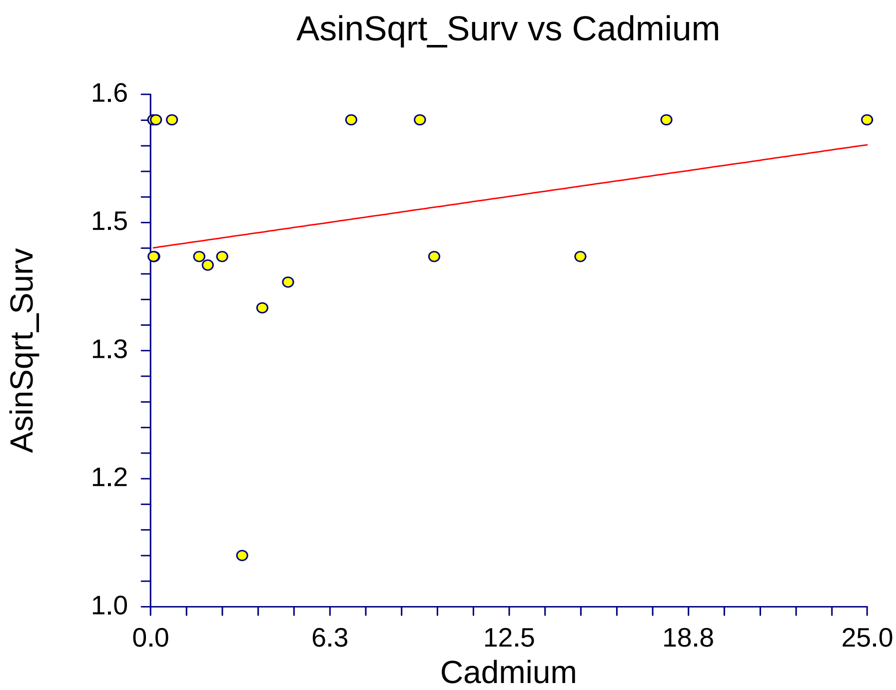




Linear Regression Report

Page/Date/Time 1 3/4/2009 1:28:24 PM
Database
Y = AsinSqrt_Surv X = Cadmium

Linear Regression Plot Section



Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	AsinSqrt_Surv	Rows Processed	17
Independent Variable	Cadmium	Rows Used in Estimation	17
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	1.4199	Rows Prediction Only	0
Slope	0.0048	Sum of Frequencies	17
R-Squared	0.0704	Sum of Weights	17.0000
Correlation	0.2652	Coefficient of Variation	0.0909
Mean Square Error	0.0173468	Square Root of MSE	0.1317073

Linear Regression Report

Page/Date/Time 2 3/4/2009 1:28:24 PM
Y = AsinSqrt_Surv X = Cadmium

Summary Statement

The equation of the straight line relating AsinSqrt_Surv and Cadmium is estimated as: AsinSqrt_Surv = (1.4199) + (0.0048) Cadmium using the 17 observations in this dataset. The y-intercept, the estimated value of AsinSqrt_Surv when Cadmium is zero, is 1.4199 with a standard error of 0.0423. The slope, the estimated change in AsinSqrt_Surv per unit change in Cadmium, is 0.0048 with a standard error of 0.0045. The value of R-Squared, the proportion of the variation in AsinSqrt_Surv that can be accounted for by variation in Cadmium, is 0.0704. The correlation between AsinSqrt_Surv and Cadmium is 0.2652.

A significance test that the slope is zero resulted in a t-value of 1.0655. The significance level of this t-test is 0.3035. Since 0.3035 > 0.0500, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0048. The lower limit of the 95% confidence interval for the slope is -0.0048 and the upper limit is 0.0145. The estimated intercept is 1.4199. The lower limit of the 95% confidence interval for the intercept is 1.3297 and the upper limit is 1.5100.

Descriptive Statistics Section

Parameter	**Dependent**	**Independent**
Variable	AsinSqrt_Surv	Cadmium
Count	17	17
Mean	1.4494	6.0985
Standard Deviation	0.1323	7.2430
Minimum	1.0600	0.0950
Maximum	1.5700	25.0000

Linear Regression Report

Page/Date/Time 3 3/4/2009 1:28:24 PM
Database
Y = AsinSqrt_Surv X = Cadmium

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	1.4199	0.0048
Lower 95% Confidence Limit	1.3297	-0.0048
Upper 95% Confidence Limit	1.5100	0.0145
Standard Error	0.0423	0.0045
Standardized Coefficient	0.0000	0.2652
T Value	33.5692	1.0655
Prob Level (T Test)	0.0000	0.3035
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	1.0000	0.1697
Regression of Y on X	1.4199	0.0048
Inverse Regression from X on Y	1.0296	0.0688
Orthogonal Regression of Y and X	1.4199	0.0048

Notes:
The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(1.41987289081531) + (4.84360603944817E-03) * (Cadmium)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	35.7135	35.7135			
Slope	1	1.969209E-02	1.969209E-02	1.1352	0.3035	0.1697
Error	15	0.260202	0.0173468			
Adj. Total	16	0.2798941	1.749338E-02			
Total	17	35.9934				

s = Square Root(0.0173468) = 0.1317073

Notes:
The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 3/4/2009 1:28:24 PM
Database
Y = AsinSqrt_Surv X = Cadmium

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.8543	0.012501	No
Anderson Darling	0.7067	0.065104	No
D'Agostino Skewness	-2.4596	0.013907	No
D'Agostino Kurtosis	2.4032	0.016253	No
D'Agostino Omnibus	11.8251	0.002705	No
Constant Residual Variance?			
Modified Levene Test	0.2375	0.633082	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?
Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:
A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.
A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say N > 500) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

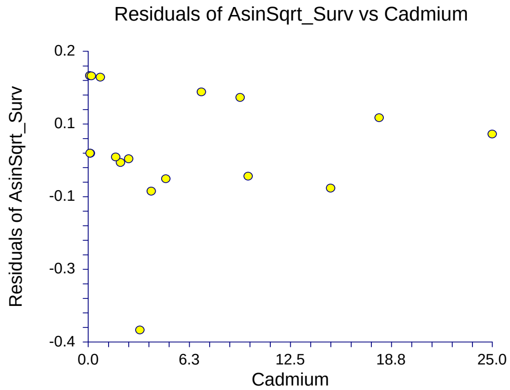
Normality and Constant Residual Variance:
Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

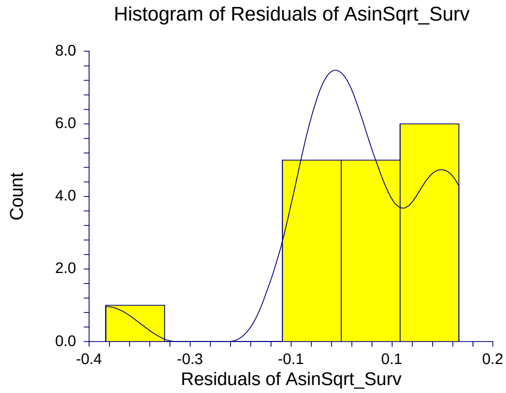
Straight-Line:
Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

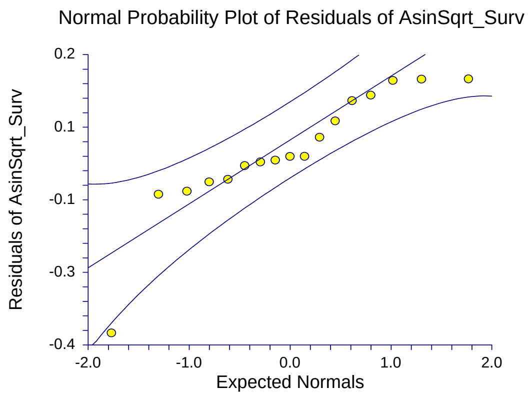
Linear Regression Report

Page/Date/Time 5 3/4/2009 1:28:24 PM
Database
Y = AsinSqrt_Surv X = Cadmium

Residual Plots Section



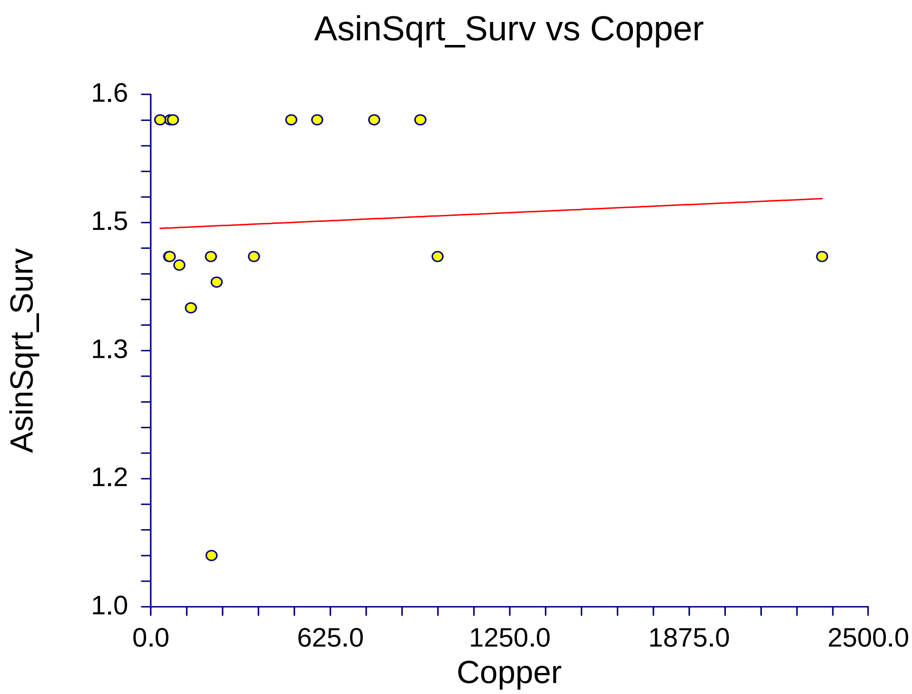




Linear Regression Report

Page/Date/Time 1 3/4/2009 1:28:53 PM
Database
Y = AsinSqrt_Surv X = Copper

Linear Regression Plot Section



Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	AsinSqrt_Surv	Rows Processed	17
Independent Variable	Copper	Rows Used in Estimation	17
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	1.4426	Rows Prediction Only	0
Slope	0.0000	Sum of Frequencies	17
R-Squared	0.0044	Sum of Weights	17.0000
Correlation	0.0662	Coefficient of Variation	0.0940
Mean Square Error	1.857775E-02	Square Root of MSE	0.1363002

Linear Regression Report

Page/Date/Time 2 3/4/2009 1:28:53 PM
Y = AsinSqrt_Surv X = Copper

Summary Statement
The equation of the straight line relating AsinSqrt_Surv and Copper is estimated as: AsinSqrt_Surv = (1.4426) + (0.0000) Copper using the 17 observations in this dataset. The y-intercept, the estimated value of AsinSqrt_Surv when Copper is zero, is 1.4426 with a standard error of 0.0424. The slope, the estimated change in AsinSqrt_Surv per unit change in Copper, is 0.0000 with a standard error of 0.0001. The value of R-Squared, the proportion of the variation in AsinSqrt_Surv that can be accounted for by variation in Copper, is 0.0044. The correlation between AsinSqrt_Surv and Copper is 0.0662.

A significance test that the slope is zero resulted in a t-value of 0.2571. The significance level of this t-test is 0.8006. Since 0.8006 > 0.0500, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0000. The lower limit of the 95% confidence interval for the slope is -0.0001 and the upper limit is 0.0001. The estimated intercept is 1.4426. The lower limit of the 95% confidence interval for the intercept is 1.3522 and the upper limit is 1.5330.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	AsinSqrt_Surv	Copper
Count	17	17
Mean	1.4494	452.3882
Standard Deviation	0.1323	580.1327
Minimum	1.0600	33.0000
Maximum	1.5700	2340.0000

Linear Regression Report

Page/Date/Time 3 3/4/2009 1:28:53 PM
Database
Y = AsinSqrt_Surv X = Copper

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	1.4426	0.0000
Lower 95% Confidence Limit	1.3522	-0.0001
Upper 95% Confidence Limit	1.5330	0.0001
Standard Error	0.0424	0.0001
Standardized Coefficient	0.0000	0.0662
T Value	34.0126	0.2571
Prob Level (T Test)	0.0000	0.8006
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	1.0000	0.0567
Regression of Y on X	1.4426	0.0000
Inverse Regression from X on Y	-0.1078	0.0034
Orthogonal Regression of Y and X	1.4426	0.0000

Notes:
The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model
(1.44258058161251) + (1.51002668955968E-05) * (Copper)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	35.7135	35.7135			
Slope	1	1.227846E-03	1.227846E-03	0.0661	0.8006	0.0567
Error	15	0.2786663	1.857775E-02			
Adj. Total	16	0.2798941	1.749338E-02			
Total	17	35.9934				

s = Square Root(1.857775E-02) = 0.1363002

Notes:
The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 3/4/2009 1:28:53 PM
Database
Y = AsinSqrt_Surv X = Copper

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.7843	0.001245	No
Anderson Darling	1.2951	0.002314	No
D'Agostino Skewness	-2.4767	0.013260	No
D'Agostino Kurtosis	2.2835	0.022399	No
D'Agostino Omnibus	11.3486	0.003433	No
Constant Residual Variance?			
Modified Levene Test	0.1215	0.732284	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?
Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:
A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.
A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say N > 500) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

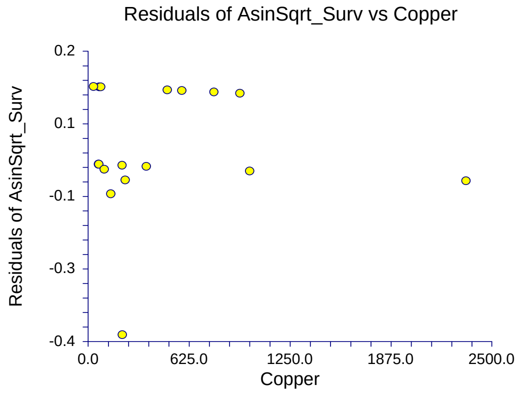
Normality and Constant Residual Variance:
Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

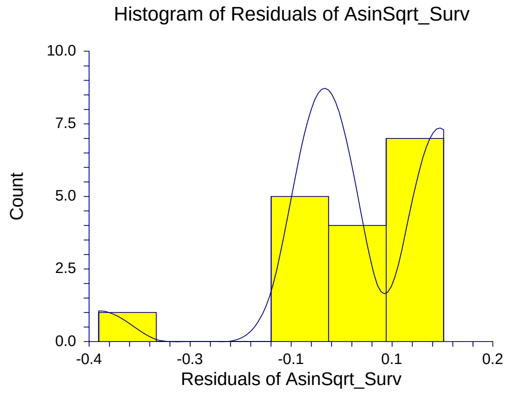
Straight-Line:
Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

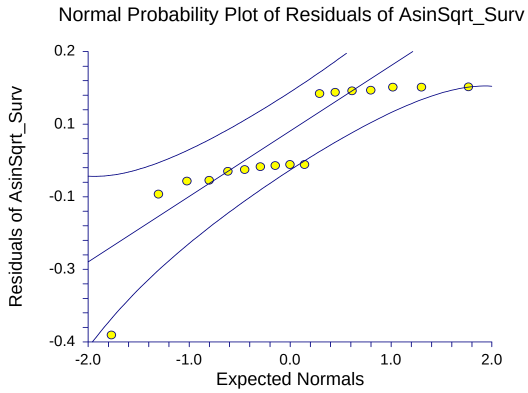
Linear Regression Report

Page/Date/Time 5 3/4/2009 1:28:53 PM
Database
Y = AsinSqrt_Surv X = Copper

Residual Plots Section



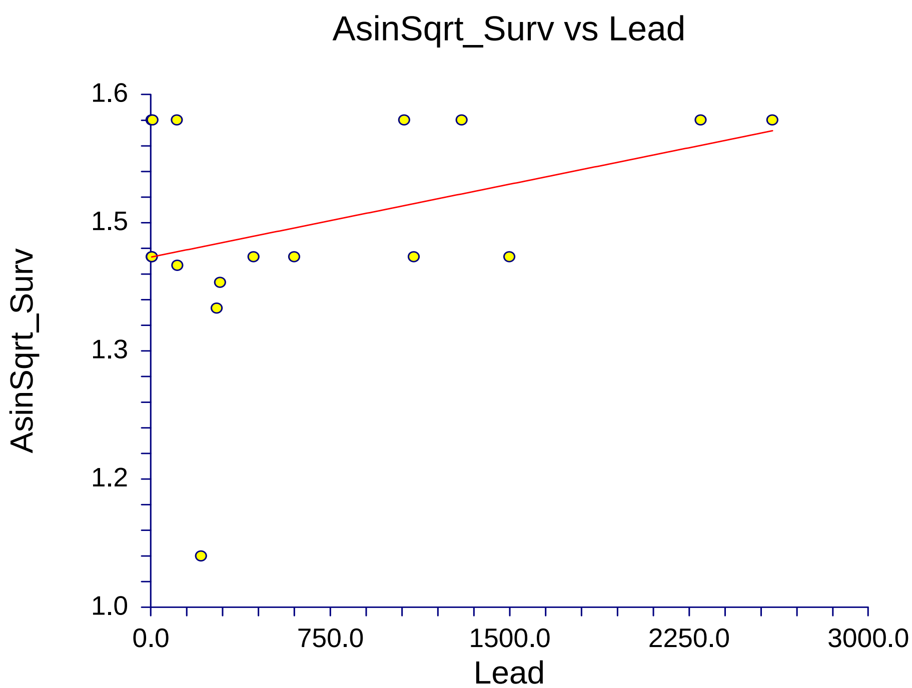




Linear Regression Report

Page/Date/Time 1 3/4/2009 1:29:27 PM
Database
Y = AsinSqrt_Surv X = Lead

Linear Regression Plot Section



Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	AsinSqrt_Surv	Rows Processed	17
Independent Variable	Lead	Rows Used in Estimation	17
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	1.4096	Rows Prediction Only	0
Slope	0.0001	Sum of Frequencies	17
R-Squared	0.1243	Sum of Weights	17.0000
Correlation	0.3525	Coefficient of Variation	0.0882
Mean Square Error	1.634047E-02	Square Root of MSE	0.1278298

Linear Regression Report

Page/Date/Time 2 3/4/2009 1:29:27 PM
Y = AsinSqrt_Surv X = Lead

Summary Statement

The equation of the straight line relating AsinSqrt_Surv and Lead is estimated as: AsinSqrt_Surv = (1.4096) + (0.0001) Lead using the 17 observations in this dataset. The y-intercept, the estimated value of AsinSqrt_Surv when Lead is zero, is 1.4096 with a standard error of 0.0413. The slope, the estimated change in AsinSqrt_Surv per unit change in Lead, is 0.0001 with a standard error of 0.0000. The value of R-Squared, the proportion of the variation in AsinSqrt_Surv that can be accounted for by variation in Lead, is 0.1243. The correlation between AsinSqrt_Surv and Lead is 0.3525.

A significance test that the slope is zero resulted in a t-value of 1.4591. The significance level of this t-test is 0.1652. Since 0.1652 > 0.0500, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0001. The lower limit of the 95% confidence interval for the slope is 0.0000 and the upper limit is 0.0001. The estimated intercept is 1.4096. The lower limit of the 95% confidence interval for the intercept is 1.3215 and the upper limit is 1.4976.

Descriptive Statistics Section

Parameter	**Dependent**	**Independent**
Variable	AsinSqrt_Surv	Lead
Count	17	17
Mean	1.4494	700.3941
Standard Deviation	0.1323	819.9776
Minimum	1.0600	3.8000
Maximum	1.5700	2600.0000

Linear Regression Report

Page/Date/Time 3 3/4/2009 1:29:27 PM
Database
Y = AsinSqrt_Surv X = Lead

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	1.4096	0.0001
Lower 95% Confidence Limit	1.3215	0.0000
Upper 95% Confidence Limit	1.4976	0.0001
Standard Error	0.0413	0.0000
Standardized Coefficient	0.0000	0.3525
T Value	34.1240	1.4591
Prob Level (T Test)	0.0000	0.1652
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	1.0000	0.2769
Regression of Y on X	1.4096	0.0001
Inverse Regression from X on Y	1.1290	0.0005
Orthogonal Regression of Y and X	1.4096	0.0001

Notes:
The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model
(1.40958365885616) + (5.68652774862288E-05) * (Lead)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	35.7135	35.7135			
Slope	1	0.0347871	0.0347871	2.1289	0.1652	0.2769
Error	15	0.245107	1.634047E-02			
Adj. Total	16	0.2798941	1.749338E-02			
Total	17	35.9934				

s = Square Root(1.634047E-02) = 0.1278298

Notes:
The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 3/4/2009 1:29:27 PM
Database
Y = AsinSqrt_Surv X = Lead

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.8644	0.017907	No
Anderson Darling	0.6968	0.068874	No
D'Agostino Skewness	-2.2926	0.021871	No
D'Agostino Kurtosis	2.3915	0.016779	No
D'Agostino Omnibus	10.9753	0.004137	No
Constant Residual Variance?			
Modified Levene Test	1.5820	0.227696	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?
Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:
A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.
A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say N > 500) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

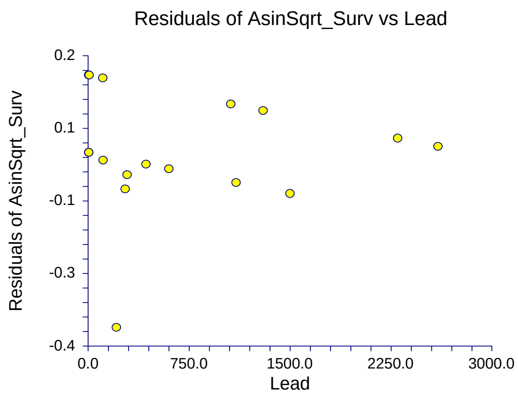
Normality and Constant Residual Variance:
Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

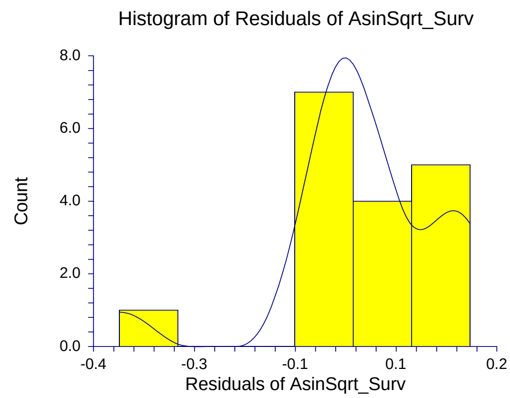
Straight-Line:
Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

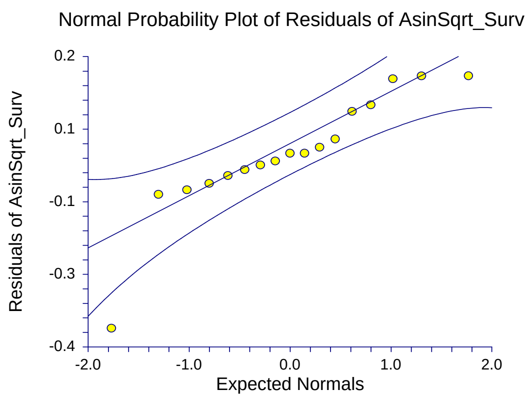
Linear Regression Report

Page/Date/Time 5 3/4/2009 1:29:27 PM
Database
Y = AsinSqrt_Surv X = Lead

Residual Plots Section



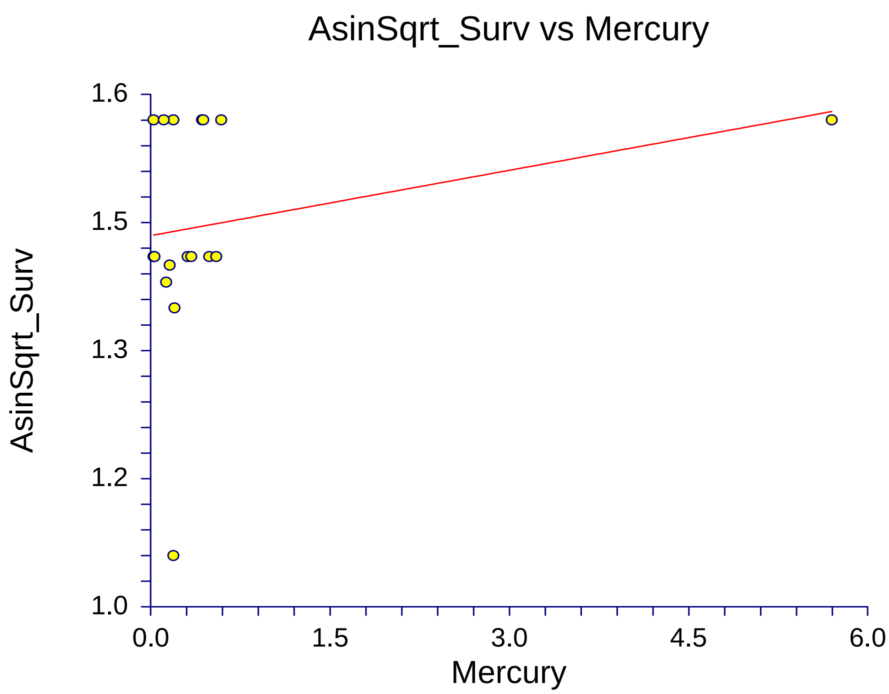




Linear Regression Report

Page/Date/Time 1 3/4/2009 1:30:41 PM
Database
Y = AsinSqrt_Surv X = Mercury

Linear Regression Plot Section



Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	AsinSqrt_Surv	Rows Processed	17
Independent Variable	Mercury	Rows Used in Estimation	17
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	1.4345	Rows Prediction Only	0
Slope	0.0255	Sum of Frequencies	17
R-Squared	0.0658	Sum of Weights	17.0000
Correlation	0.2566	Coefficient of Variation	0.0911
Mean Square Error	0.0174311	Square Root of MSE	0.1320269

Linear Regression Report

Page/Date/Time 2 3/4/2009 1:30:41 PM
Y = AsinSqrt_Surv X = Mercury

Summary Statement
The equation of the straight line relating AsinSqrt_Surv and Mercury is estimated as: AsinSqrt_Surv = (1.4345) + (0.0255) Mercury using the 17 observations in this dataset. The y-intercept, the estimated value of AsinSqrt_Surv when Mercury is zero, is 1.4345 with a standard error of 0.0351. The slope, the estimated change in AsinSqrt_Surv per unit change in Mercury, is 0.0255 with a standard error of 0.0248. The value of R-Squared, the proportion of the variation in AsinSqrt_Surv that can be accounted for by variation in Mercury, is 0.0658. The correlation between AsinSqrt_Surv and Mercury is 0.2566.

A significance test that the slope is zero resulted in a t-value of 1.0282. The significance level of this t-test is 0.3202. Since 0.3202 > 0.0500, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0255. The lower limit of the 95% confidence interval for the slope is -0.0274 and the upper limit is 0.0783. The estimated intercept is 1.4345. The lower limit of the 95% confidence interval for the intercept is 1.3597 and the upper limit is 1.5094.

Descriptive Statistics Section

Parameter	**Dependent**	**Independent**
Variable	AsinSqrt_Surv	Mercury
Count	17	17
Mean	1.4494	0.5831
Standard Deviation	0.1323	1.3313
Minimum	1.0600	0.0250
Maximum	1.5700	5.7000

Linear Regression Report

Page/Date/Time 3 3/4/2009 1:30:41 PM
Database
Y = AsinSqrt_Surv X = Mercury

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	1.4345	0.0255
Lower 95% Confidence Limit	1.3597	-0.0274
Upper 95% Confidence Limit	1.5094	0.0783
Standard Error	0.0351	0.0248
Standardized Coefficient	0.0000	0.2566
T Value	40.8315	1.0282
Prob Level (T Test)	0.0000	0.3202
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	1.0000	0.1612
Regression of Y on X	1.4345	0.0255
Inverse Regression from X on Y	1.2236	0.3872
Orthogonal Regression of Y and X	1.4344	0.0257

Notes:
The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model
(1.43454757914125) + (2.54908861695425E-02) * (Mercury)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	35.7135	35.7135			
Slope	1	1.842765E-02	1.842765E-02	1.0572	0.3202	0.1612
Error	15	0.2614665	0.0174311			
Lack of Fit	13	0.1186165	9.124344E-03	0.1277	0.9941	
Pure Error	2	0.14285	0.071425			
Adj. Total	16	0.2798941	1.749338E-02			
Total	17	35.9934				

s = Square Root(0.0174311) = 0.1320269

Notes:
The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 3/4/2009 1:30:41 PM
Database
Y = AsinSqrt_Surv X = Mercury

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.7839	0.001230	No
Anderson Darling	1.3176	0.002037	No
D'Agostino Skewness	-2.5092	0.012099	No
D'Agostino Kurtosis	2.4525	0.014188	No
D'Agostino Omnibus	12.3109	0.002122	No
Constant Residual Variance?			
Modified Levene Test	0.7899	0.388149	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(13, 2) Test	0.1277	0.994129	Yes

No Serial Correlation?
Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:
A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.
A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say N > 500) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

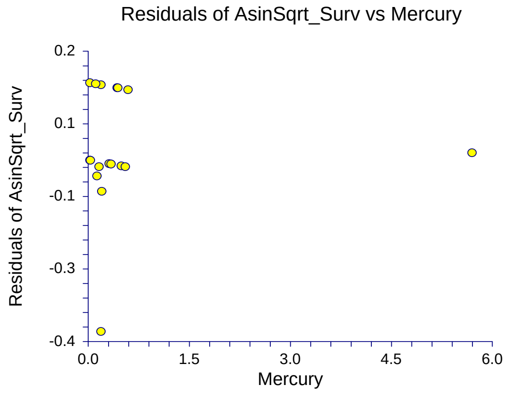
Normality and Constant Residual Variance:
Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

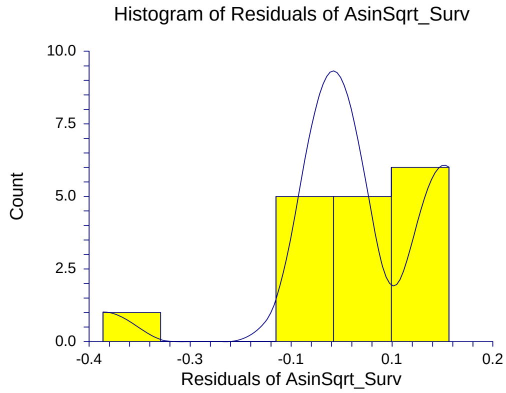
Straight-Line:
Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

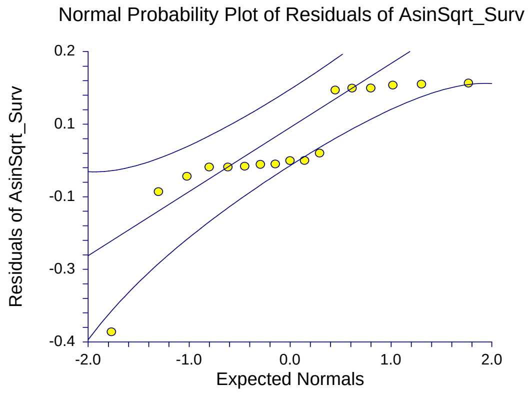
Linear Regression Report

Page/Date/Time 5 3/4/2009 1:30:41 PM
Database
Y = AsinSqrt_Surv X = Mercury

Residual Plots Section



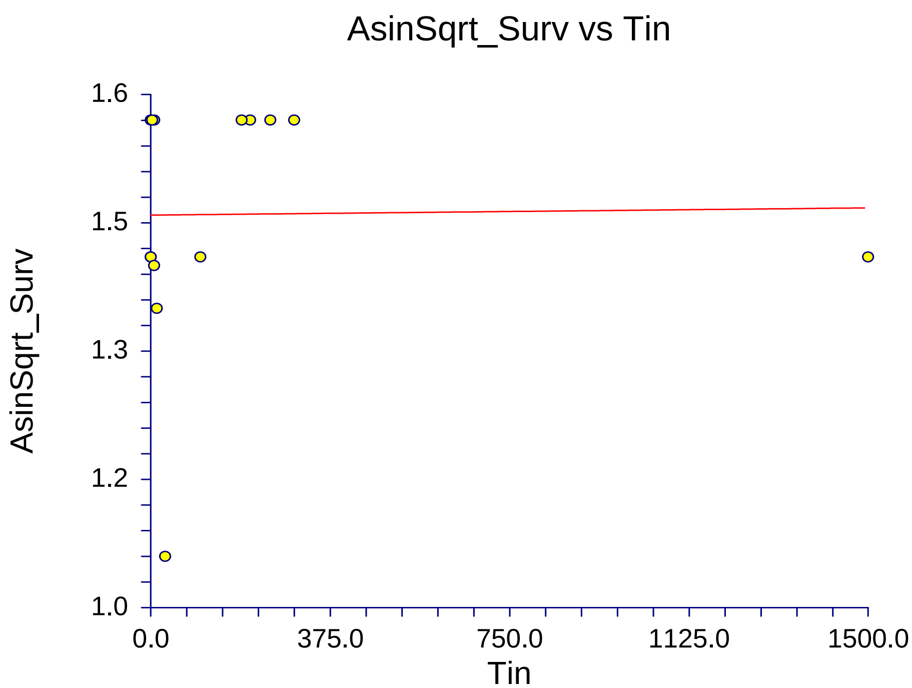




Linear Regression Report

Page/Date/Time 1 3/4/2009 1:29:49 PM
Database
Y = AsinSqrt_Surv X = Tin

Linear Regression Plot Section



Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	AsinSqrt_Surv	Rows Processed	17
Independent Variable	Tin	Rows Used in Estimation	14
Frequency Variable	None	Rows with X Missing	3
Weight Variable	None	Rows with Freq Missing	0
Intercept	1.4589	Rows Prediction Only	0
Slope	0.0000	Sum of Frequencies	14
R-Squared	0.0002	Sum of Weights	14.0000
Correlation	0.0153	Coefficient of Variation	0.1028
Mean Square Error	2.252803E-02	Square Root of MSE	0.1500934

Linear Regression Report

Page/Date/Time 2 3/4/2009 1:29:49 PM
Y = AsinSqrt_Surv X = Tin

Summary Statement

The equation of the straight line relating AsinSqrt_Surv and Tin is estimated as: AsinSqrt_Surv = (1.4589) + (0.0000) Tin using the 14 observations in this dataset. The y-intercept, the estimated value of AsinSqrt_Surv when Tin is zero, is 1.4589 with a standard error of 0.0447. The slope, the estimated change in AsinSqrt_Surv per unit change in Tin, is 0.0000 with a standard error of 0.0001. The value of R-Squared, the proportion of the variation in AsinSqrt_Surv that can be accounted for by variation in Tin, is 0.0002. The correlation between AsinSqrt_Surv and Tin is 0.0153.

A significance test that the slope is zero resulted in a t-value of 0.0532. The significance level of this t-test is 0.9585. Since 0.9585 > 0.0500, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0000. The lower limit of the 95% confidence interval for the slope is -0.0002 and the upper limit is 0.0002. The estimated intercept is 1.4589. The lower limit of the 95% confidence interval for the intercept is 1.3615 and the upper limit is 1.5564.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	AsinSqrt_Surv	Tin
Count	14	14
Mean	1.4600	186.6500
Standard Deviation	0.1442	392.8333
Minimum	1.0600	0.2300
Maximum	1.5700	1500.0000

Linear Regression Report

Page/Date/Time 3 3/4/2009 1:29:49 PM
Database
Y = AsinSqrt_Surv X = Tin

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	1.4589	0.0000
Lower 95% Confidence Limit	1.3615	-0.0002
Upper 95% Confidence Limit	1.5564	0.0002
Standard Error	0.0447	0.0001
Standardized Coefficient	0.0000	0.0153
T Value	32.6201	0.0532
Prob Level (T Test)	0.0000	0.9585
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	1.0000	0.0503
Regression of Y on X	1.4589	0.0000
Inverse Regression from X on Y	-3.0061	0.0239
Orthogonal Regression of Y and X	1.4589	0.0000

Notes:
The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model
(1.45894857735789) + (5.63312425454598E-06) * (Tin)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	29.8424	29.8424			
Slope	1	6.365881E-05	6.365881E-05	0.0028	0.9585	0.0503
Error	12	0.2703363	2.252803E-02			
Lack of Fit	11	0.2575364	0.0234124	1.8291	0.5249	
Pure Error	1	0.0128	0.0128			
Adj. Total	13	0.2704	0.0208			
Total	14	30.1128				

s = Square Root(2.252803E-02) = 0.1500934

Notes:
The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 3/4/2009 1:29:49 PM
Database
Y = AsinSqrt_Surv X = Tin

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.7424	0.001054	No
Anderson Darling	1.3674	0.001537	No
D'Agostino Skewness	-2.6369	0.008366	No
D'Agostino Kurtosis	2.2596	0.023848	No
D'Agostino Omnibus	12.0590	0.002407	No
Constant Residual Variance?			
Modified Levene Test	0.2804	0.606079	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(11, 1) Test	1.8291	0.524855	Yes

No Serial Correlation?
Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:
A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.
A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say N > 500) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

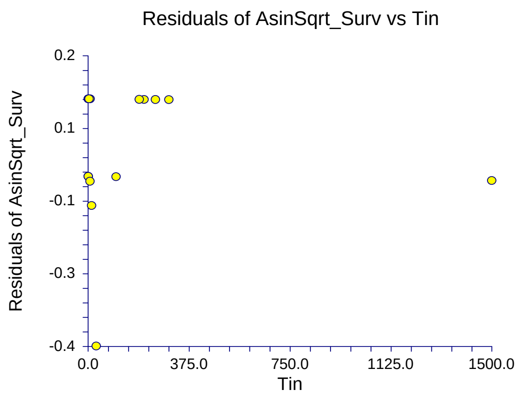
Normality and Constant Residual Variance:
Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

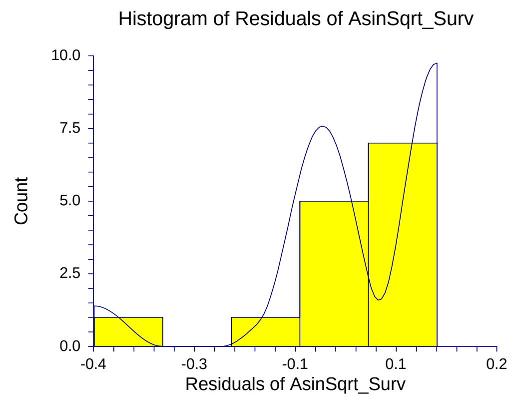
Straight-Line:
Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

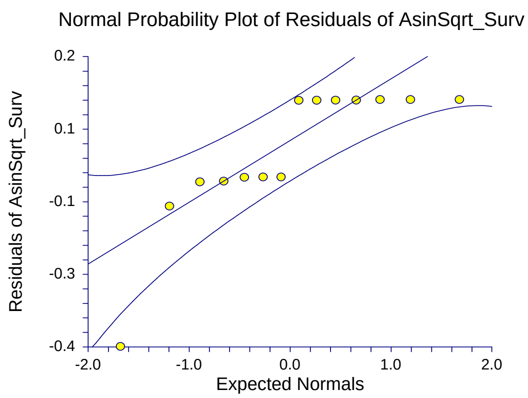
Linear Regression Report

Page/Date/Time 5 3/4/2009 1:29:49 PM
Database
Y = AsinSqrt_Surv X = Tin

Residual Plots Section



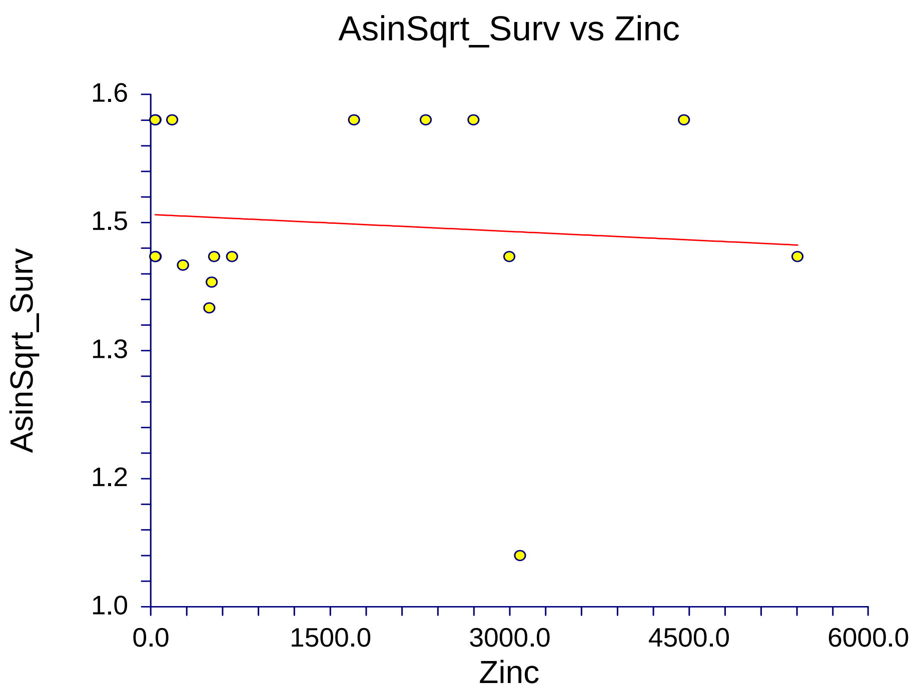




Linear Regression Report

Page/Date/Time 1 3/4/2009 1:30:18 PM
Database
Y = AsinSqrt_Surv X = Zinc

Linear Regression Plot Section



Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	AsinSqrt_Surv	Rows Processed	17
Independent Variable	Zinc	Rows Used in Estimation	17
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	1.4593	Rows Prediction Only	0
Slope	0.0000	Sum of Frequencies	17
R-Squared	0.0072	Sum of Weights	17.0000
Correlation	-0.0850	Coefficient of Variation	0.0939
Mean Square Error	0.0185248	Square Root of MSE	0.1361059

Linear Regression Report

Page/Date/Time 2 3/4/2009 1:30:18 PM
Y = AsinSqrt_Surv X = Zinc

Summary Statement
The equation of the straight line relating AsinSqrt_Surv and Zinc is estimated as: AsinSqrt_Surv = (1.4593) + (0.0000) Zinc using the 17 observations in this dataset. The y-intercept, the estimated value of AsinSqrt_Surv when Zinc is zero, is 1.4593 with a standard error of 0.0446. The slope, the estimated change in AsinSqrt_Surv per unit change in Zinc, is 0.0000 with a standard error of 0.0000. The value of R-Squared, the proportion of the variation in AsinSqrt_Surv that can be accounted for by variation in Zinc, is 0.0072. The correlation between AsinSqrt_Surv and Zinc is -0.0850.

A significance test that the slope is zero resulted in a t-value of -0.3304. The significance level of this t-test is 0.7457. Since 0.7457 > 0.0500, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0000. The lower limit of the 95% confidence interval for the slope is 0.0000 and the upper limit is 0.0000. The estimated intercept is 1.4593. The lower limit of the 95% confidence interval for the intercept is 1.3643 and the upper limit is 1.5543.

Descriptive Statistics Section

Parameter	**Dependent**	**Independent**
Variable	AsinSqrt_Surv	Zinc
Count	17	17
Mean	1.4494	1498.7647
Standard Deviation	0.1323	1701.9457
Minimum	1.0600	38.0000
Maximum	1.5700	5410.0000

Linear Regression Report

Page/Date/Time 3 3/4/2009 1:30:18 PM
Database
Y = AsinSqrt_Surv X = Zinc

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	1.4593	0.0000
Lower 95% Confidence Limit	1.3643	0.0000
Upper 95% Confidence Limit	1.5543	0.0000
Standard Error	0.0446	0.0000
Standardized Coefficient	0.0000	-0.0850
T Value	32.7332	-0.3304
Prob Level (T Test)	0.0000	0.7457
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	1.0000	0.0611
Regression of Y on X	1.4593	0.0000
Inverse Regression from X on Y	2.8197	-0.0009
Orthogonal Regression of Y and X	1.4593	0.0000

Notes:
The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model
(1.45931154705036) + (-6.60529455065301E-06) * (Zinc)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	35.7135	35.7135			
Slope	1	2.022068E-03	2.022068E-03	0.1092	0.7457	0.0611
Error	15	0.2778721	0.0185248			
Adj. Total	16	0.2798941	1.749338E-02			
Total	17	35.9934				

s = Square Root(0.0185248) = 0.1361059

Notes:
The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 3/4/2009 1:30:18 PM
Database
Y = AsinSqrt_Surv X = Zinc

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.8166	0.003456	No
Anderson Darling	1.0842	0.007641	No
D'Agostino Skewness	-2.3577	0.018389	No
D'Agostino Kurtosis	2.1411	0.032269	No
D'Agostino Omnibus	10.1429	0.006273	No
Constant Residual Variance?			
Modified Levene Test	1.4198	0.251955	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?
Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:
A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.
A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say N > 500) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

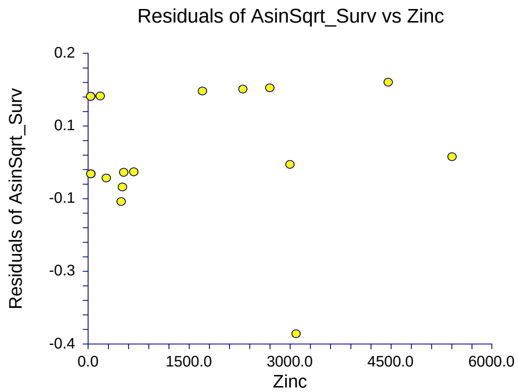
Normality and Constant Residual Variance:
Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

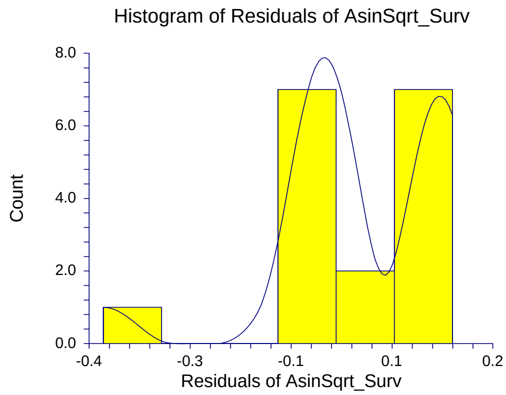
Straight-Line:
Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

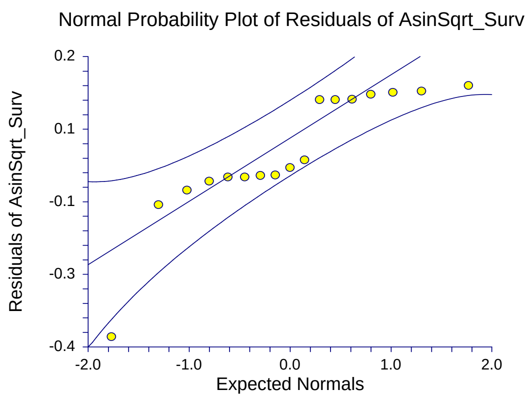
Linear Regression Report

Page/Date/Time 5 3/4/2009 1:30:18 PM
Database
Y = AsinSqrt_Surv X = Zinc

Residual Plots Section



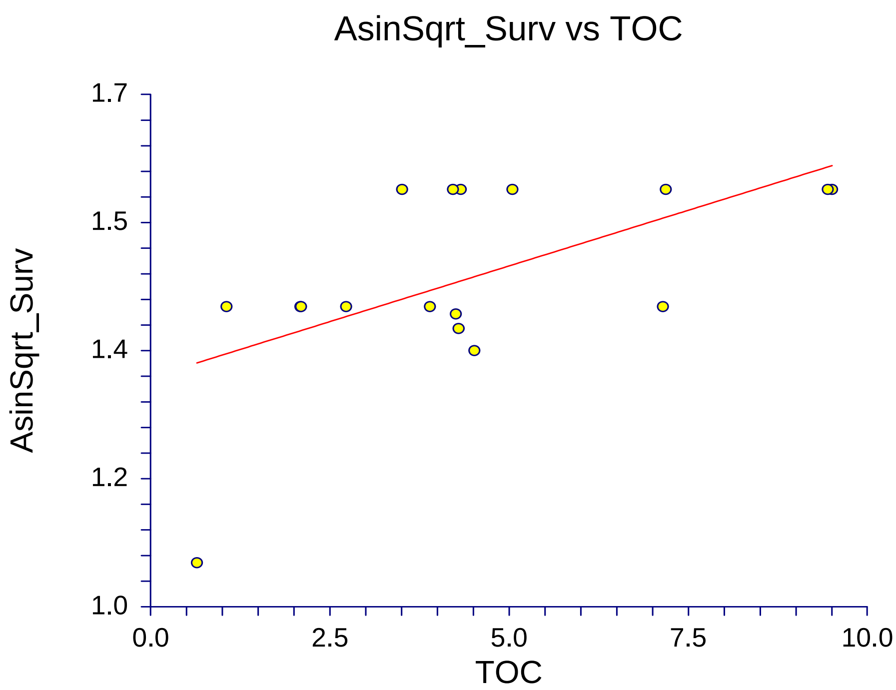




Linear Regression Report

Page/Date/Time 1 3/4/2009 1:32:20 PM
Database
Y = AsinSqrt_Surv X = TOC

Linear Regression Plot Section



Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	AsinSqrt_Surv	Rows Processed	17
Independent Variable	TOC	Rows Used in Estimation	17
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	1.3134	Rows Prediction Only	0
Slope	0.0304	Sum of Frequencies	17
R-Squared	0.3538	Sum of Weights	17.0000
Correlation	0.5948	Coefficient of Variation	0.0758
Mean Square Error	1.205739E-02	Square Root of MSE	0.1098061

Linear Regression Report

Page/Date/Time 2 3/4/2009 1:32:20 PM
Y = AsinSqrt_Surv X = TOC

Summary Statement

The equation of the straight line relating AsinSqrt_Surv and TOC is estimated as: AsinSqrt_Surv = (1.3134) + (0.0304) TOC using the 17 observations in this dataset. The y-intercept, the estimated value of AsinSqrt_Surv when TOC is zero, is 1.3134 with a standard error of 0.0544. The slope, the estimated change in AsinSqrt_Surv per unit change in TOC, is 0.0304 with a standard error of 0.0106. The value of R-Squared, the proportion of the variation in AsinSqrt_Surv that can be accounted for by variation in TOC, is 0.3538. The correlation between AsinSqrt_Surv and TOC is 0.5948.

A significance test that the slope is zero resulted in a t-value of 2.8659. The significance level of this t-test is 0.0118. Since 0.0118 < 0.0500, the hypothesis that the slope is zero is rejected.

The estimated slope is 0.0304. The lower limit of the 95% confidence interval for the slope is 0.0078 and the upper limit is 0.0530. The estimated intercept is 1.3134. The lower limit of the 95% confidence interval for the intercept is 1.1974 and the upper limit is 1.4294.

Descriptive Statistics Section

Parameter	**Dependent**	**Independent**
Variable	AsinSqrt_Surv	TOC
Count	17	17
Mean	1.4494	4.4716
Standard Deviation	0.1323	2.5869
Minimum	1.0600	0.6470
Maximum	1.5700	9.5100

Linear Regression Report

Page/Date/Time 3 3/4/2009 1:32:20 PM
Database
Y = AsinSqrt_Surv X = TOC

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	1.3134	0.0304
Lower 95% Confidence Limit	1.1974	0.0078
Upper 95% Confidence Limit	1.4294	0.0530
Standard Error	0.0544	0.0106
Standardized Coefficient	0.0000	0.5948
T Value	24.1378	2.8659
Prob Level (T Test)	0.0000	0.0118
Reject H0 (Alpha = 0.0500)	Yes	Yes
Power (Alpha = 0.0500)	1.0000	0.7639
Regression of Y on X	1.3134	0.0304
Inverse Regression from X on Y	1.0651	0.0860
Orthogonal Regression of Y and X	1.3132	0.0305

Notes:
The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model
(1.31342169144018) + (.030412029487049) * (TOC)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	35.7135	35.7135			
Slope	1	0.0990333	0.0990333	8.2135	0.0118	0.7639
Error	15	0.1808608	1.205739E-02			
Adj. Total	16	0.2798941	1.749338E-02			
Total	17	35.9934				

s = Square Root(1.205739E-02) = 0.1098061

Notes:
The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 3/4/2009 1:32:20 PM
Database
Y = AsinSqrt_Surv X = TOC

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.9429	0.354278	Yes
Anderson Darling	0.2969	0.591614	Yes
D'Agostino Skewness	-1.5899	0.111856	No
D'Agostino Kurtosis	1.3045	0.192062	No
D'Agostino Omnibus	4.2295	0.120662	No
Constant Residual Variance?			
Modified Levene Test	0.0492	0.827454	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?
Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:
A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.
A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say N > 500) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

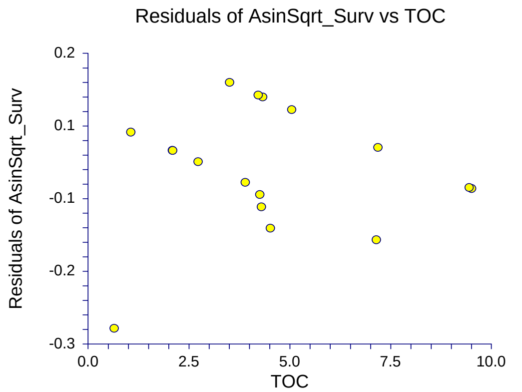
Normality and Constant Residual Variance:
Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

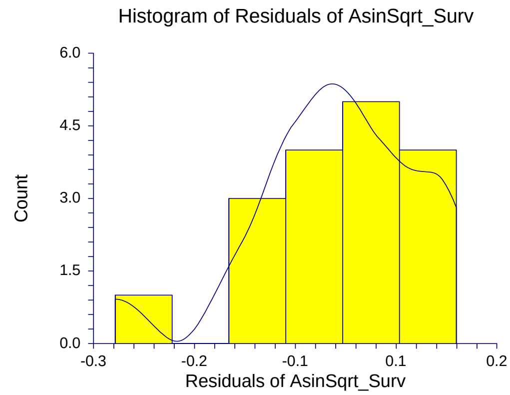
Straight-Line:
Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

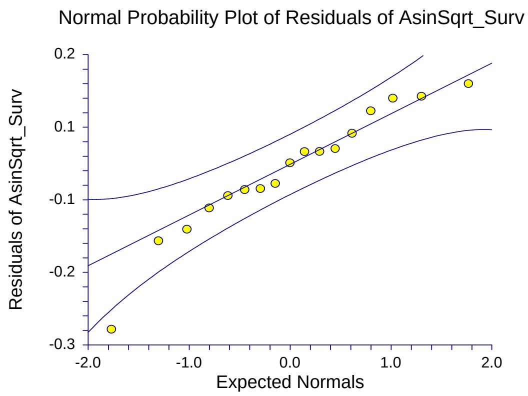
Linear Regression Report

Page/Date/Time 5 3/4/2009 1:32:20 PM
Database
Y = AsinSqrt_Surv X = TOC

Residual Plots Section



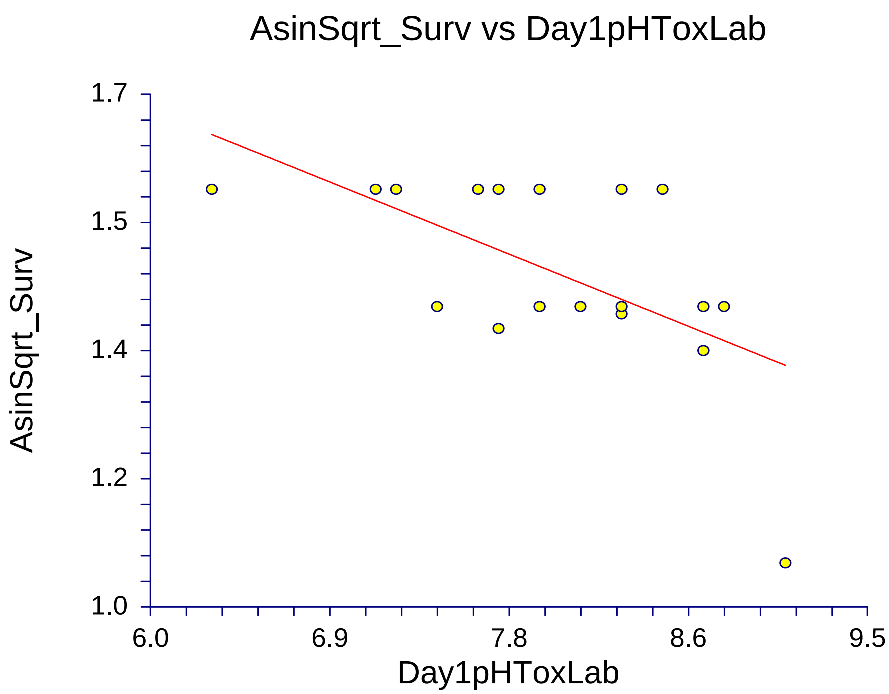




Linear Regression Report

Page/Date/Time 1 4/13/2009 3:29:14 PM
Database
Y = AsinSqrt_Surv X = Day1pHToxLab

Linear Regression Plot Section



Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	AsinSqrt_Surv	Rows Processed	18
Independent Variable	Day1pHToxLab	Rows Used in Estimation	18
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	2.3539	Rows Prediction Only	0
Slope	-0.1125	Sum of Frequencies	18
R-Squared	0.3628	Sum of Weights	18.0000
Correlation	-0.6023	Coefficient of Variation	0.0743
Mean Square Error	1.169412E-02	Square Root of MSE	0.1081393

Linear Regression Report

Page/Date/Time 2 4/13/2009 3:29:14 PM
Y = AsinSqrt_Surv X = Day1pHToxLab

Summary Statement

The equation of the straight line relating AsinSqrt_Surv and Day1pHToxLab is estimated as: AsinSqrt_Surv = (2.3539) + (-0.1125) Day1pHToxLab using the 18 observations in this dataset. The y-intercept, the estimated value of AsinSqrt_Surv when Day1pHToxLab is zero, is 2.3539 with a standard error of 0.2986. The slope, the estimated change in AsinSqrt_Surv per unit change in Day1pHToxLab, is -0.1125 with a standard error of 0.0373. The value of R-Squared, the proportion of the variation in AsinSqrt_Surv that can be accounted for by variation in Day1pHToxLab, is 0.3628. The correlation between AsinSqrt_Surv and Day1pHToxLab is -0.6023.

A significance test that the slope is zero resulted in a t-value of -3.0181. The significance level of this t-test is 0.0082. Since 0.0082 < 0.0500, the hypothesis that the slope is zero is rejected.

The estimated slope is -0.1125. The lower limit of the 95% confidence interval for the slope is -0.1916 and the upper limit is -0.0335. The estimated intercept is 2.3539. The lower limit of the 95% confidence interval for the intercept is 1.7210 and the upper limit is 2.9868.

Descriptive Statistics Section

Parameter	**Dependent**	**Independent**
Variable	AsinSqrt_Surv	Day1pHToxLab
Count	18	18
Mean	1.4561	7.9778
Standard Deviation	0.1314	0.7034
Minimum	1.0600	6.3000
Maximum	1.5700	9.1000

Linear Regression Report

Page/Date/Time 3 4/13/2009 3:29:14 PM
Database
Y = AsinSqrt_Surv X = Day1pHToxLab

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	2.3539	-0.1125
Lower 95% Confidence Limit	1.7210	-0.1916
Upper 95% Confidence Limit	2.9868	-0.0335
Standard Error	0.2986	0.0373
Standardized Coefficient	0.0000	-0.6023
T Value	7.8843	-3.0181
Prob Level (T Test)	0.0000	0.0082
Reject H0 (Alpha = 0.0500)	Yes	Yes
Power (Alpha = 0.0500)	1.0000	0.8087
Regression of Y on X	2.3539	-0.1125
Inverse Regression from X on Y	3.9309	-0.3102
Orthogonal Regression of Y and X	2.3741	-0.1151

Notes:
The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model
(2.35390092470281) + (-.112536327608987) * (Day1pHToxLab)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	38.16467	38.16467			
Slope	1	0.1065219	0.1065219	9.1090	0.0082	0.8087
Error	16	0.1871059	1.169412E-02			
Lack of Fit	11	0.1362559	0.0123869	1.2180	0.4404	
Pure Error	5	0.05085	0.01017			
Adj. Total	17	0.2936278	1.727222E-02			
Total	18	38.4583				

s = Square Root(1.169412E-02) = 0.1081393

Notes:
The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 4/13/2009 3:29:14 PM
Database
Y = AsinSqrt_Surv X = Day1pHToxLab

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.9632	0.664624	Yes
Anderson Darling	0.2179	0.841053	Yes
D'Agostino Skewness	-1.3279	0.184225	No
D'Agostino Kurtosis	1.3362	0.181478	No
D'Agostino Omnibus	3.5487	0.169595	No
Constant Residual Variance?			
Modified Levene Test	0.1442	0.709164	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(11, 5) Test	1.2180	0.440379	Yes

No Serial Correlation?
Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:
A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.
A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say N > 500) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

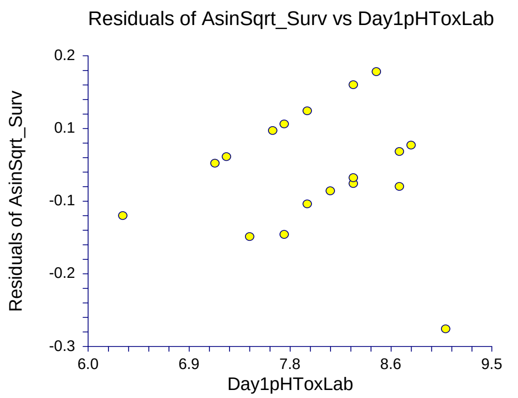
Normality and Constant Residual Variance:
Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

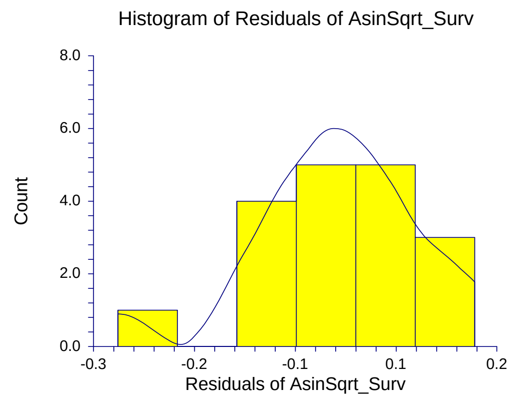
Straight-Line:
Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

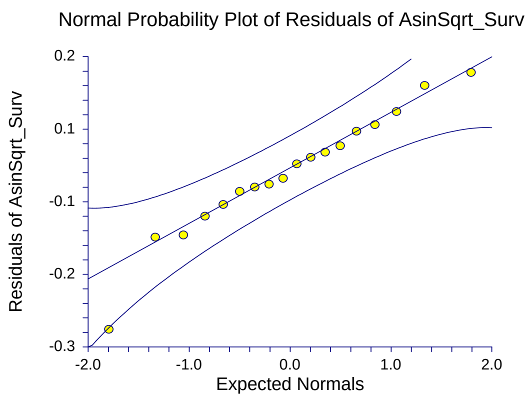
Linear Regression Report

Page/Date/Time 5 4/13/2009 3:29:14 PM
Database
Y = AsinSqrt_Surv X = Day1pHToxLab

Residual Plots Section



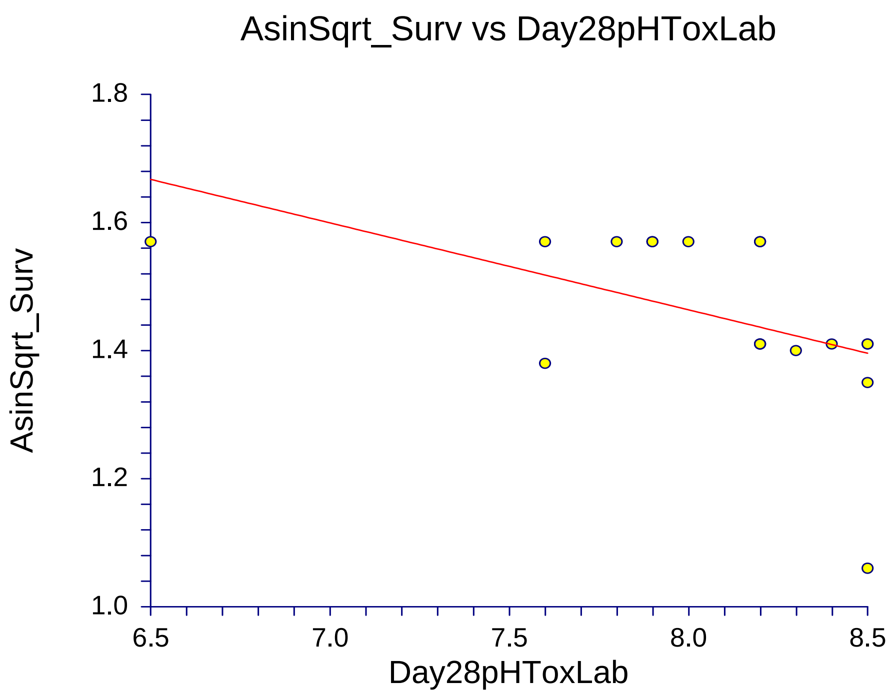




Linear Regression Report

Page/Date/Time 1 4/13/2009 3:27:48 PM
Database
Y = AsinSqrt_Surv X = Day28pHToxLab

Linear Regression Plot Section



Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	AsinSqrt_Surv	Rows Processed	18
Independent Variable	Day28pHToxLab	Rows Used in Estimation	18
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	2.5492	Rows Prediction Only	0
Slope	-0.1357	Sum of Frequencies	18
R-Squared	0.2524	Sum of Weights	18.0000
Correlation	-0.5024	Coefficient of Variation	0.0804
Mean Square Error	1.372008E-02	Square Root of MSE	0.1171328

Linear Regression Report

Page/Date/Time 2 4/13/2009 3:27:48 PM
Y = AsinSqrt_Surv X = Day28pHToxLab

Summary Statement

The equation of the straight line relating AsinSqrt_Surv and Day28pHToxLab is estimated as: AsinSqrt_Surv = (2.5492) + (-0.1357) Day28pHToxLab using the 18 observations in this dataset. The y-intercept, the estimated value of AsinSqrt_Surv when Day28pHToxLab is zero, is 2.5492 with a standard error of 0.4712. The slope, the estimated change in AsinSqrt_Surv per unit change in Day28pHToxLab, is -0.1357 with a standard error of 0.0584. The value of R-Squared, the proportion of the variation in AsinSqrt_Surv that can be accounted for by variation in Day28pHToxLab, is 0.2524. The correlation between AsinSqrt_Surv and Day28pHToxLab is -0.5024.

A significance test that the slope is zero resulted in a t-value of -2.3241. The significance level of this t-test is 0.0336. Since 0.0336 < 0.0500, the hypothesis that the slope is zero is rejected.

The estimated slope is -0.1357. The lower limit of the 95% confidence interval for the slope is -0.2595 and the upper limit is -0.0119. The estimated intercept is 2.5492. The lower limit of the 95% confidence interval for the intercept is 1.5504 and the upper limit is 3.5481.

Descriptive Statistics Section

Parameter	**Dependent**	**Independent**
Variable	AsinSqrt_Surv	Day28pHToxLab
Count	18	18
Mean	1.4561	8.0556
Standard Deviation	0.1314	0.4866
Minimum	1.0600	6.5000
Maximum	1.5700	8.5000

Linear Regression Report

Page/Date/Time 3 4/13/2009 3:27:48 PM
Database
Y = AsinSqrt_Surv X = Day28pHToxLab

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	2.5492	-0.1357
Lower 95% Confidence Limit	1.5504	-0.2595
Upper 95% Confidence Limit	3.5481	-0.0119
Standard Error	0.4712	0.0584
Standardized Coefficient	0.0000	-0.5024
T Value	5.4106	-2.3241
Prob Level (T Test)	0.0001	0.0336
Reject H0 (Alpha = 0.0500)	Yes	Yes
Power (Alpha = 0.0500)	0.9990	0.5884
Regression of Y on X	2.5492	-0.1357
Inverse Regression from X on Y	5.7873	-0.5377
Orthogonal Regression of Y and X	2.6110	-0.1434

Notes:
The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model
(2.54923799006074) + (-.135698509110983) * (Day28pHToxLab)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	38.16467	38.16467			
Slope	1	7.410646E-02	7.410646E-02	5.4013	0.0336	0.5884
Error	16	0.2195213	1.372008E-02			
Lack of Fit	7	8.667631E-02	1.238233E-02	0.8389	0.5823	
Pure Error	9	0.132845	1.476056E-02			
Adj. Total	17	0.2936278	1.727222E-02			
Total	18	38.4583				

s = Square Root(1.372008E-02) = 0.1171328

Notes:
The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 4/13/2009 3:27:48 PM
Database
Y = AsinSqrt_Surv X = Day28pHToxLab

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.8733	0.020195	No
Anderson Darling	0.6489	0.090432	No
D'Agostino Skewness	-2.6148	0.008928	No
D'Agostino Kurtosis	2.3121	0.020773	No
D'Agostino Omnibus	12.1829	0.002262	No
Constant Residual Variance?			
Modified Levene Test	0.0326	0.859050	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(7, 9) Test	0.8389	0.582281	Yes

No Serial Correlation?
Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:
A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.
A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say N > 500) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

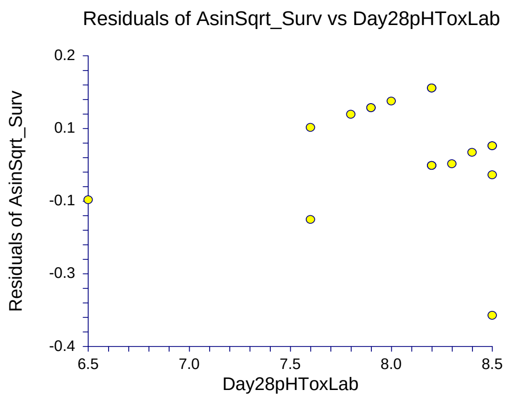
Normality and Constant Residual Variance:
Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

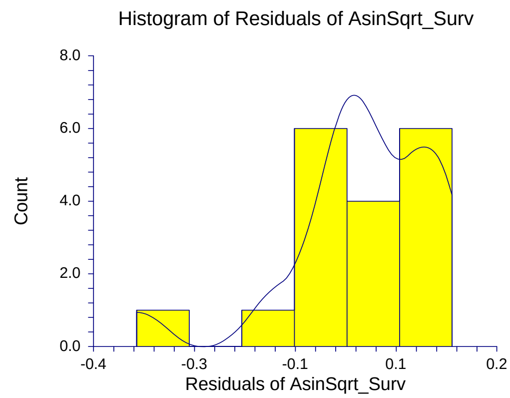
Straight-Line:
Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

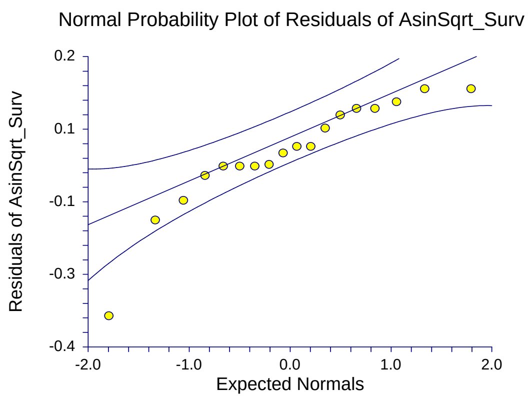
Linear Regression Report

Page/Date/Time 5 4/13/2009 3:27:48 PM
Database
Y = AsinSqrt_Surv X = Day28pHToxLab

Residual Plots Section



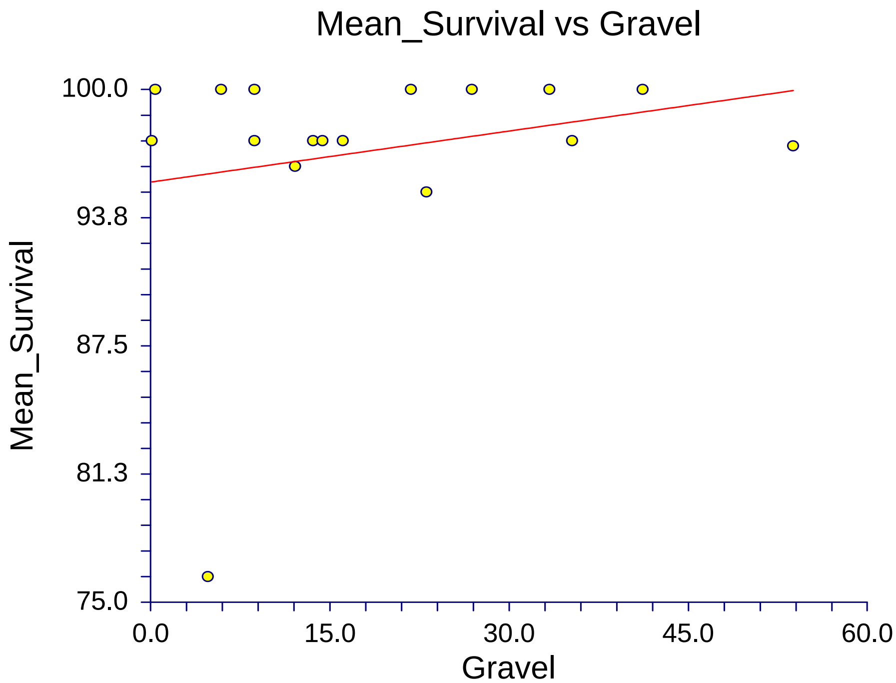




Linear Regression Report

Page/Date/Time 1 4/8/2009 9:08:12 AM
Database
Y = Mean_Survival X = Gravel

Linear Regression Plot Section



Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	Mean_Survival	Rows Processed	17
Independent Variable	Gravel	Rows Used in Estimation	17
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	95.4814	Rows Prediction Only	0
Slope	0.0829	Sum of Frequencies	17
R-Squared	0.0504	Sum of Weights	17.0000
Correlation	0.2244	Coefficient of Variation	0.0580
Mean Square Error	31.63241	Square Root of MSE	5.624269

Linear Regression Report

Y = Mean_Survival X = Gravel

Summary Statement

The equation of the straight line relating Mean_Survival and Gravel is estimated as: Mean_Survival = (95.4814) + (0.0829) Gravel using the 17 observations in this dataset. The y-intercept, the estimated value of Mean_Survival when Gravel is zero, is 95.4814 with a standard error of 2.2204. The slope, the estimated change in Mean_Survival per unit change in Gravel, is 0.0829 with a standard error of 0.0930. The value of R-Squared, the proportion of the variation in Mean_Survival that can be accounted for by variation in Gravel, is 0.0504. The correlation between Mean_Survival and Gravel is 0.2244.

A significance test that the slope is zero resulted in a t-value of 0.8920. The significance level of this t-test is 0.3865. Since 0.3865 > 0.0500, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0829. The lower limit of the 95% confidence interval for the slope is -0.1153 and the upper limit is 0.2811. The estimated intercept is 95.4814. The lower limit of the 95% confidence interval for the intercept is 90.7488 and the upper limit is 100.2140.

Descriptive Statistics Section

Parameter	**Dependent**	**Independent**
Variable	Mean_Survival	Gravel
Count	17	17
Mean	97.0441	18.8412
Standard Deviation	5.5882	15.1214
Minimum	76.2500	0.1000
Maximum	100.0000	53.8000

Linear Regression Report

Page/Date/Time 3 4/8/2009 9:08:12 AM
Database
Y = Mean_Survival X = Gravel

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	95.4814	0.0829
Lower 95% Confidence Limit	90.7488	-0.1153
Upper 95% Confidence Limit	100.2140	0.2811
Standard Error	2.2204	0.0930
Standardized Coefficient	0.0000	0.2244
T Value	43.0023	0.8920
Prob Level (T Test)	0.0000	0.3865
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	1.0000	0.1331
Regression of Y on X	95.4814	0.0829
Inverse Regression from X on Y	66.0200	1.6466
Orthogonal Regression of Y and X	95.2506	0.0952

Notes:
The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model
(95.4813891159543) + (8.29421949072027E-02) * (Gravel)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	160098.5	160098.5			
Slope	1	25.16832	25.16832	0.7956	0.3865	0.1331
Error	15	474.4861	31.63241			
Lack of Fit	14	471.3611	33.66865	10.7740	0.2349	
Pure Error	1	3.125	3.125			
Adj. Total	16	499.6544	31.2284			
Total	17	160598.2				

s = Square Root(31.63241) = 5.624269

Notes:
The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 4/8/2009 9:08:12 AM
Database
Y = Mean_Survival X = Gravel

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.6152	0.000015	No
Anderson Darling	2.1875	0.000015	No
D'Agostino Skewness	-4.3868	0.000012	No
D'Agostino Kurtosis	3.9366	0.000083	No
D'Agostino Omnibus	34.7412	0.000000	No
Constant Residual Variance?			
Modified Levene Test	0.6810	0.422159	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(14, 1) Test	10.7740	0.234891	Yes

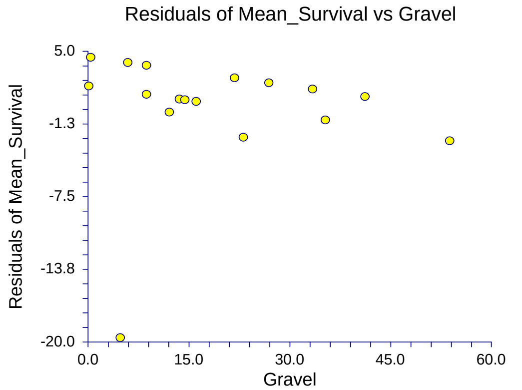
No Serial Correlation?
Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

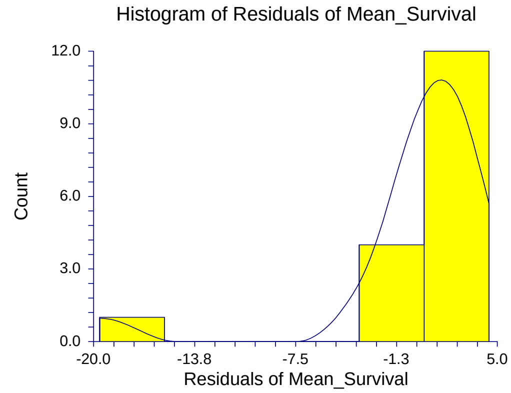
Notes:
A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.
A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say N > 500) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

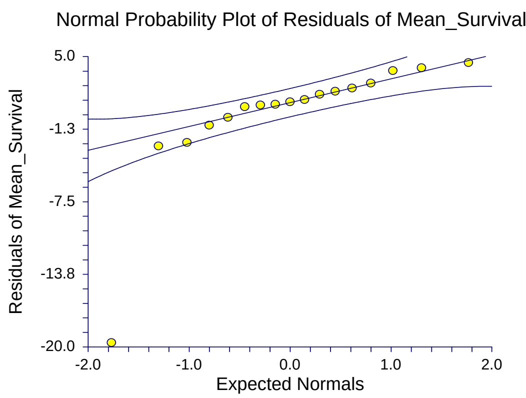
Normality and Constant Residual Variance:
Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:
Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

Residual Plots Section



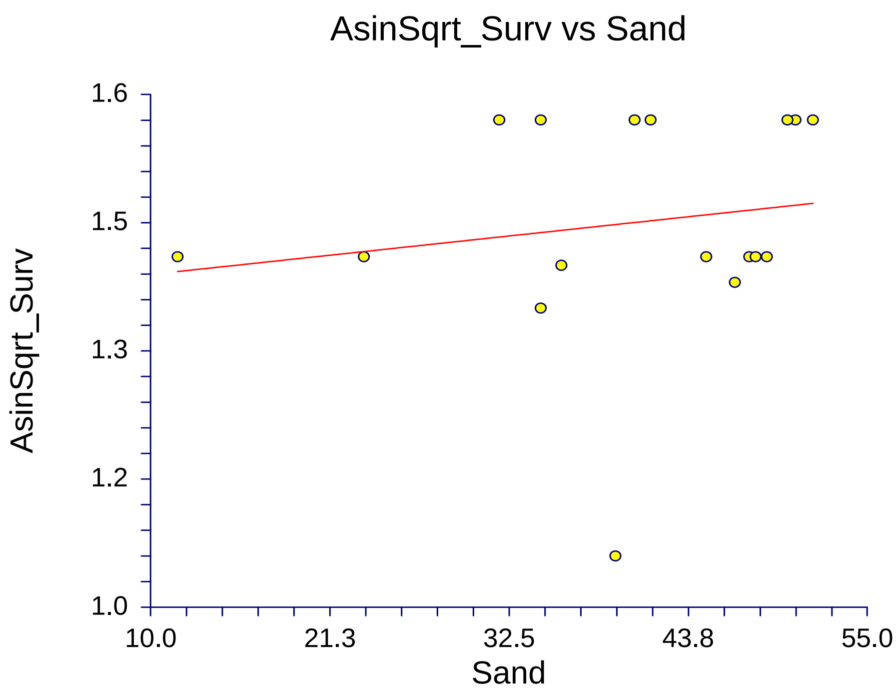




Linear Regression Report

Page/Date/Time 1 3/4/2009 1:33:08 PM
Database
Y = AsinSqrt_Surv X = Sand

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	AsinSqrt_Surv	Rows Processed	17
Independent Variable	Sand	Rows Used in Estimation	17
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	1.3693	Rows Prediction Only	0
Slope	0.0020	Sum of Frequencies	17
R-Squared	0.0262	Sum of Weights	17.0000
Correlation	0.1619	Coefficient of Variation	0.0930
Mean Square Error	1.817071E-02	Square Root of MSE	0.1347988

Linear Regression Report

Page/Date/Time 2 3/4/2009 1:33:08 PM
Y = AsinSqrt_Surv X = Sand

Summary Statement

The equation of the straight line relating AsinSqrt_Surv and Sand is estimated as: AsinSqrt_Surv = (1.3693) + (0.0020) Sand using the 17 observations in this dataset. The y-intercept, the estimated value of AsinSqrt_Surv when Sand is zero, is 1.3693 with a standard error of 0.1302. The slope, the estimated change in AsinSqrt_Surv per unit change in Sand, is 0.0020 with a standard error of 0.0031. The value of R-Squared, the proportion of the variation in AsinSqrt_Surv that can be accounted for by variation in Sand, is 0.0262. The correlation between AsinSqrt_Surv and Sand is 0.1619.

A significance test that the slope is zero resulted in a t-value of 0.6353. The significance level of this t-test is 0.5348. Since 0.5348 > 0.0500, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0020. The lower limit of the 95% confidence interval for the slope is -0.0047 and the upper limit is 0.0087. The estimated intercept is 1.3693. The lower limit of the 95% confidence interval for the intercept is 1.0918 and the upper limit is 1.6469.

Descriptive Statistics Section

Parameter	**Dependent**	**Independent**
Variable	AsinSqrt_Surv	Sand
Count	17	17
Mean	1.4494	40.0471
Standard Deviation	0.1323	10.7065
Minimum	1.0600	11.7000
Maximum	1.5700	51.6000

Linear Regression Report

Page/Date/Time 3 3/4/2009 1:33:08 PM
Database
Y = AsinSqrt_Surv X = Sand

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	1.3693	0.0020
Lower 95% Confidence Limit	1.0918	-0.0047
Upper 95% Confidence Limit	1.6469	0.0087
Standard Error	0.1302	0.0031
Standardized Coefficient	0.0000	0.1619
T Value	10.5154	0.6353
Prob Level (T Test)	0.0000	0.5348
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	1.0000	0.0915
Regression of Y on X	1.3693	0.0020
Inverse Regression from X on Y	-1.6069	0.0763
Orthogonal Regression of Y and X	1.3693	0.0020

Notes:
The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model
(1.36933280306869) + (1.99962154499456E-03) * (Sand)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	35.7135	35.7135			
Slope	1	7.333553E-03	7.333553E-03	0.4036	0.5348	0.0915
Error	15	0.2725606	1.817071E-02			
Lack of Fit	14	0.2483606	1.774004E-02	0.7331	0.7377	
Pure Error	1	0.0242	0.0242			
Adj. Total	16	0.2798941	1.749338E-02			
Total	17	35.9934				

s = Square Root(1.817071E-02) = 0.1347988

Notes:
The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 3/4/2009 1:33:08 PM
Database
Y = AsinSqrt_Surv X = Sand

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.8187	0.003706	No
Anderson Darling	0.9459	0.016745	No
D'Agostino Skewness	-2.6453	0.008161	No
D'Agostino Kurtosis	2.4240	0.015351	No
D'Agostino Omnibus	12.8736	0.001602	No
Constant Residual Variance?			
Modified Levene Test	1.1671	0.297055	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(14, 1) Test	0.7331	0.737674	Yes

No Serial Correlation?
Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:
A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.
A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say N > 500) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

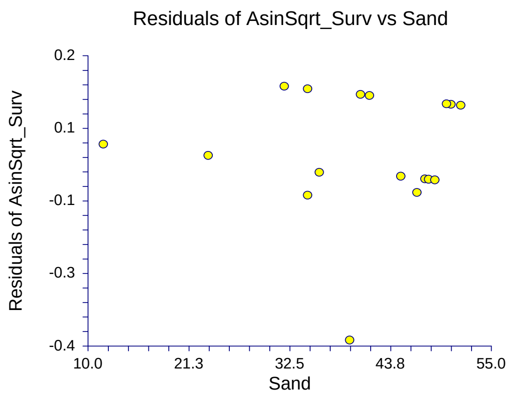
Normality and Constant Residual Variance:
Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

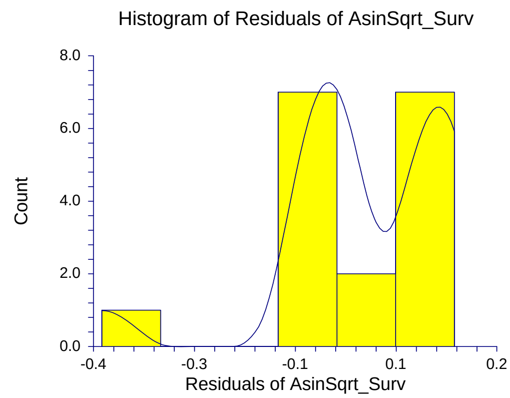
Straight-Line:
Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

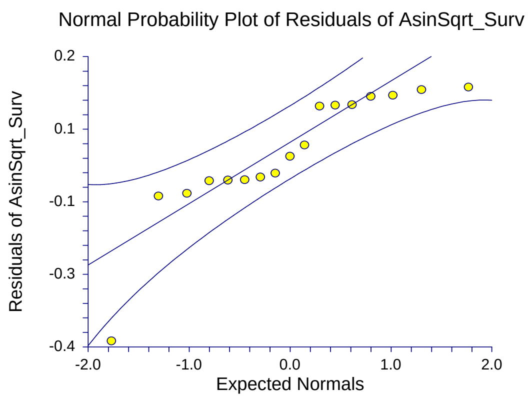
Linear Regression Report

Page/Date/Time 5 3/4/2009 1:33:08 PM
Database
Y = AsinSqrt_Surv X = Sand

Residual Plots Section



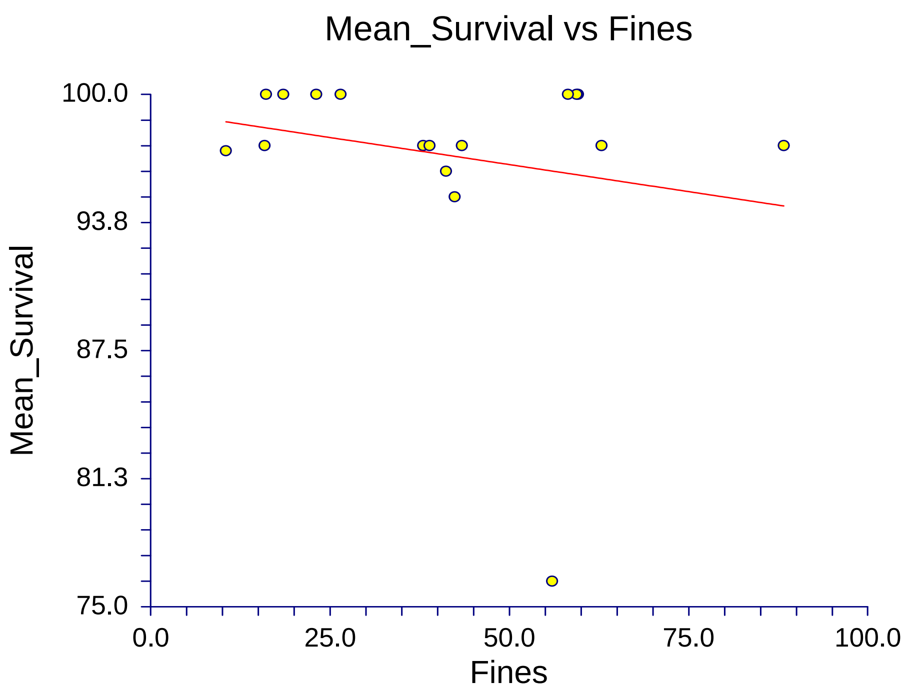




Linear Regression Report

Page/Date/Time 1 4/8/2009 8:15:04 AM
Database
Y = Mean_Survival X = Fines

Linear Regression Plot Section



Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	Mean_Survival	Rows Processed	17
Independent Variable	Fines	Rows Used in Estimation	17
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	99.2145	Rows Prediction Only	0
Slope	-0.0528	Sum of Frequencies	17
R-Squared	0.0399	Sum of Weights	17.0000
Correlation	-0.1998	Coefficient of Variation	0.0583
Mean Square Error	31.97992	Square Root of MSE	5.655079

Linear Regression Report

Page/Date/Time 2 4/8/2009 8:15:04 AM
Y = Mean_Survival X = Fines

Summary Statement
The equation of the straight line relating Mean_Survival and Fines is estimated as: Mean_Survival = (99.2145) + (-0.0528) Fines using the 17 observations in this dataset. The y-intercept, the estimated value of Mean_Survival when Fines is zero, is 99.2145 with a standard error of 3.0708. The slope, the estimated change in Mean_Survival per unit change in Fines, is -0.0528 with a standard error of 0.0668. The value of R-Squared, the proportion of the variation in Mean_Survival that can be accounted for by variation in Fines, is 0.0399. The correlation between Mean_Survival and Fines is -0.1998.

A significance test that the slope is zero resulted in a t-value of -0.7899. The significance level of this t-test is 0.4419. Since 0.4419 > 0.0500, the hypothesis that the slope is zero is not rejected.

The estimated slope is -0.0528. The lower limit of the 95% confidence interval for the slope is -0.1952 and the upper limit is 0.0897. The estimated intercept is 99.2145. The lower limit of the 95% confidence interval for the intercept is 92.6692 and the upper limit is 105.7598.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Mean_Survival	Fines
Count	17	17
Mean	97.0441	41.1118
Standard Deviation	5.5882	21.1548
Minimum	76.2500	10.5000
Maximum	100.0000	88.3000

Linear Regression Report

Page/Date/Time 3 4/8/2009 8:15:04 AM
Database
Y = Mean_Survival X = Fines

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	99.2145	-0.0528
Lower 95% Confidence Limit	92.6692	-0.1952
Upper 95% Confidence Limit	105.7598	0.0897
Standard Error	3.0708	0.0668
Standardized Coefficient	0.0000	-0.1998
T Value	32.3089	-0.7899
Prob Level (T Test)	0.0000	0.4419
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	1.0000	0.1148
Regression of Y on X	99.2145	-0.0528
Inverse Regression from X on Y	151.3859	-1.3218
Orthogonal Regression of Y and X	99.3698	-0.0566

Notes:
The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model
(99.2144733417697) + (-5.27915965232289E-02) * (Fines)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	160098.5	160098.5			
Slope	1	19.95569	19.95569	0.6240	0.4419	0.1148
Error	15	479.6987	31.97992			
Adj. Total	16	499.6544	31.2284			
Total	17	160598.2				

s = Square Root(31.97992) = 5.655079

Notes:
The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 4/8/2009 8:15:04 AM
Database
Y = Mean_Survival X = Fines

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.5817	0.000007	No
Anderson Darling	2.3716	0.000005	No
D'Agostino Skewness	-4.5010	0.000007	No
D'Agostino Kurtosis	4.0306	0.000056	No
D'Agostino Omnibus	36.5053	0.000000	No
Constant Residual Variance?			
Modified Levene Test	1.6568	0.217548	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?
Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:
A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.
A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say N > 500) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

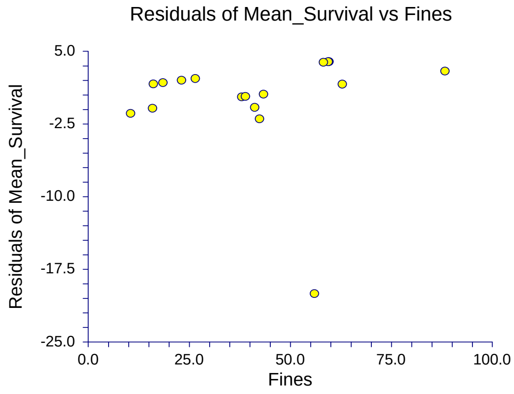
Normality and Constant Residual Variance:
Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

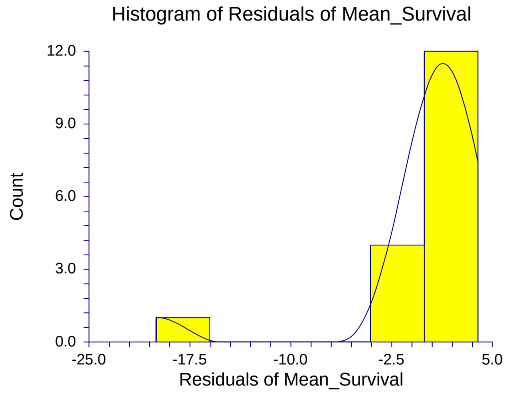
Straight-Line:
Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

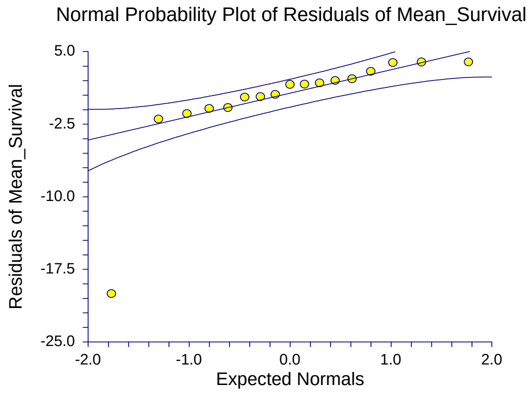
Linear Regression Report

Page/Date/Time 5 4/8/2009 8:15:04 AM
Database
Y = Mean_Survival X = Fines

Residual Plots Section



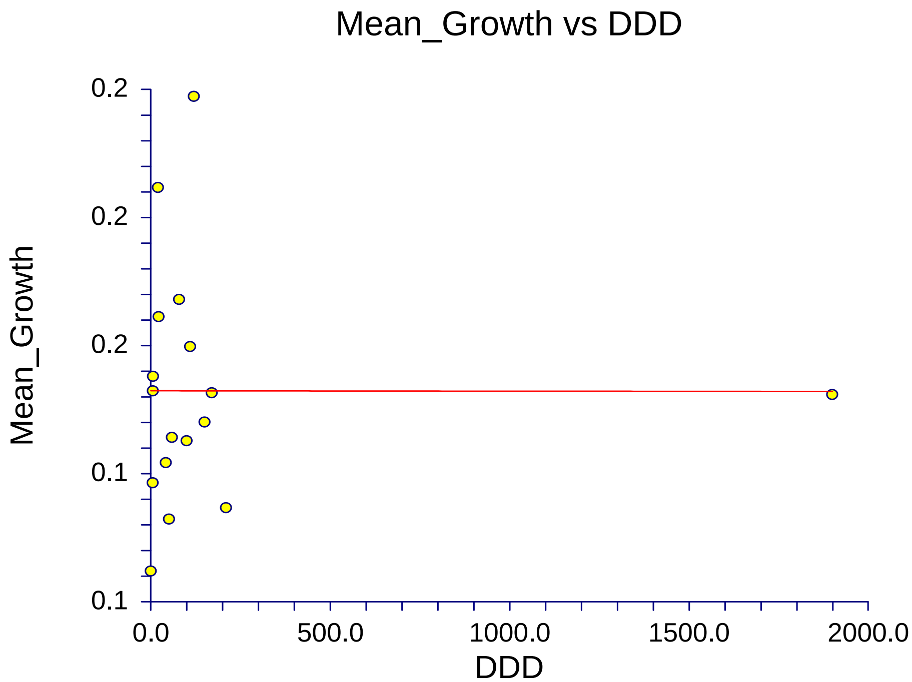




Linear Regression Report

Page/Date/Time 1 3/4/2009 1:33:46 PM
Database
Y = Mean_Growth X = DDD

Linear Regression Plot Section



Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	Mean_Growth	Rows Processed	17
Independent Variable	DDD	Rows Used in Estimation	17
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.1576	Rows Prediction Only	0
Slope	0.0000	Sum of Frequencies	17
R-Squared	0.0000	Sum of Weights	17.0000
Correlation	-0.0015	Coefficient of Variation	0.2127
Mean Square Error	1.124549E-03	Square Root of MSE	0.0335343

Linear Regression Report

Page/Date/Time 2 3/4/2009 1:33:46 PM
Y = Mean_Growth X = DDD

Summary Statement

The equation of the straight line relating Mean_Growth and DDD is estimated as: Mean_Growth = (0.1576) + (0.0000) DDD using the 17 observations in this dataset. The y-intercept, the estimated value of Mean_Growth when DDD is zero, is 0.1576 with a standard error of 0.0088. The slope, the estimated change in Mean_Growth per unit change in DDD, is 0.0000 with a standard error of 0.0000. The value of R-Squared, the proportion of the variation in Mean_Growth that can be accounted for by variation in DDD, is 0.0000. The correlation between Mean_Growth and DDD is -0.0015.

A significance test that the slope is zero resulted in a t-value of -0.0057. The significance level of this t-test is 0.9955. Since 0.9955 > 0.0500, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0000. The lower limit of the 95% confidence interval for the slope is 0.0000 and the upper limit is 0.0000. The estimated intercept is 0.1576. The lower limit of the 95% confidence interval for the intercept is 0.1389 and the upper limit is 0.1764.

Descriptive Statistics Section

Parameter	**Dependent**	**Independent**
Variable	Mean_Growth	DDD
Count	17	17
Mean	0.1576	179.4818
Standard Deviation	0.0325	447.8732
Minimum	0.1084	0.1900
Maximum	0.2381	1900.0000

Linear Regression Report

Page/Date/Time 3 3/4/2009 1:33:46 PM
Database
Y = Mean_Growth X = DDD

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.1576	0.0000
Lower 95% Confidence Limit	0.1389	0.0000
Upper 95% Confidence Limit	0.1764	0.0000
Standard Error	0.0088	0.0000
Standardized Coefficient	0.0000	-0.0015
T Value	17.9143	-0.0057
Prob Level (T Test)	0.0000	0.9955
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	1.0000	0.0500
Regression of Y on X	0.1576	0.0000
Inverse Regression from X on Y	8.9308	-0.0489
Orthogonal Regression of Y and X	0.1576	0.0000

Notes:
The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model
(.157642827906853) + (-1.07523430693640E-07) * (DDD)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	0.422368	0.422368			
Slope	1	3.710534E-08	3.710534E-08	0.0000	0.9955	0.0500
Error	15	1.686823E-02	1.124549E-03			
Adj. Total	16	1.686827E-02	1.054267E-03			
Total	17	0.4392363				

s = Square Root(1.124549E-03) = 0.0335343

Notes:
The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 3/4/2009 1:33:46 PM
Database
Y = Mean_Growth X = DDD

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.9346	0.259599	Yes
Anderson Darling	0.4362	0.297722	Yes
D'Agostino Skewness	1.8503	0.064267	No
D'Agostino Kurtosis	1.2903	0.196935	No
D'Agostino Omnibus	5.0887	0.078526	No
Constant Residual Variance?			
Modified Levene Test	0.0224	0.882903	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?
Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:
A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.
A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say N > 500) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:
Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

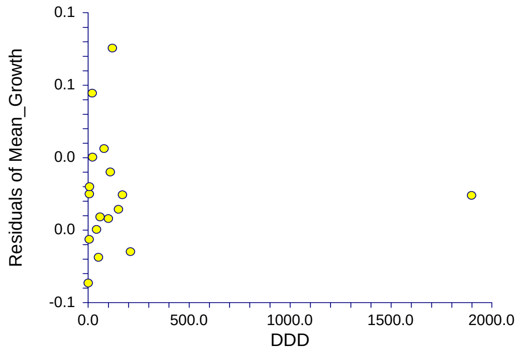
Straight-Line:
Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

Linear Regression Report

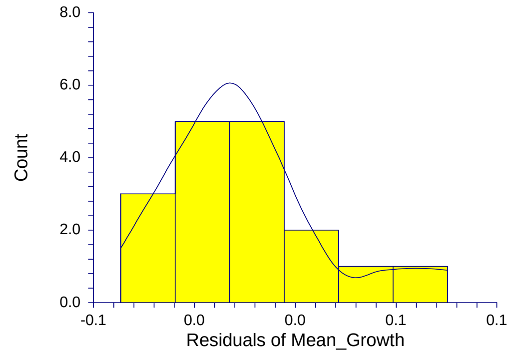
Page/Date/Time 5 3/4/2009 1:33:46 PM
Database
Y = Mean_Growth X = DDD

Residual Plots Section

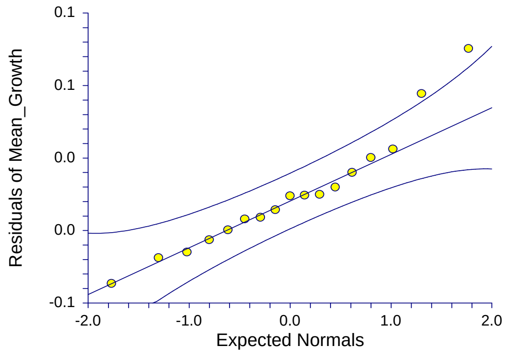
Residuals of Mean_Growth vs DDD



Histogram of Residuals of Mean_Growth



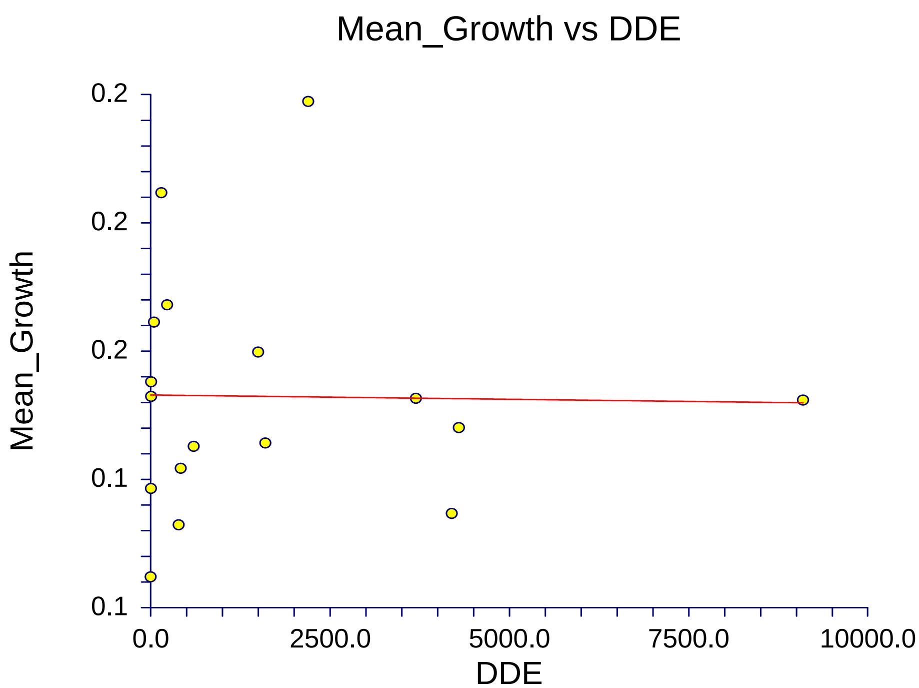
Normal Probability Plot of Residuals of Mean_Growth



Linear Regression Report

Page/Date/Time 1 3/4/2009 1:36:20 PM
Database
Y = Mean_Growth X = DDE

Linear Regression Plot Section



Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	Mean_Growth	Rows Processed	17
Independent Variable	DDE	Rows Used in Estimation	17
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.1580	Rows Prediction Only	0
Slope	0.0000	Sum of Frequencies	17
R-Squared	0.0003	Sum of Weights	17.0000
Correlation	-0.0176	Coefficient of Variation	0.2127
Mean Square Error	1.124203E-03	Square Root of MSE	3.352914E-02

Linear Regression Report

Page/Date/Time 2 3/4/2009 1:36:20 PM
Y = Mean_Growth X = DDE

Summary Statement

The equation of the straight line relating Mean_Growth and DDE is estimated as: Mean_Growth = (0.1580) + (0.0000) DDE using the 17 observations in this dataset. The y-intercept, the estimated value of Mean_Growth when DDE is zero, is 0.1580 with a standard error of 0.0100. The slope, the estimated change in Mean_Growth per unit change in DDE, is 0.0000 with a standard error of 0.0000. The value of R-Squared, the proportion of the variation in Mean_Growth that can be accounted for by variation in DDE, is 0.0003. The correlation between Mean_Growth and DDE is -0.0176.

A significance test that the slope is zero resulted in a t-value of -0.0681. The significance level of this t-test is 0.9466. Since 0.9466 > 0.0500, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0000. The lower limit of the 95% confidence interval for the slope is 0.0000 and the upper limit is 0.0000. The estimated intercept is 0.1580. The lower limit of the 95% confidence interval for the intercept is 0.1368 and the upper limit is 0.1792.

Descriptive Statistics Section

Parameter	**Dependent**	**Independent**
Variable	Mean_Growth	DDE
Count	17	17
Mean	0.1576	1673.8935
Standard Deviation	0.0325	2441.9982
Minimum	0.1084	0.1900
Maximum	0.2381	9100.0000

Linear Regression Report

Page/Date/Time 3 3/4/2009 1:36:20 PM
Database
Y = Mean_Growth X = DDE

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.1580	0.0000
Lower 95% Confidence Limit	0.1368	0.0000
Upper 95% Confidence Limit	0.1792	0.0000
Standard Error	0.0100	0.0000
Standardized Coefficient	0.0000	-0.0176
T Value	15.8697	-0.0681
Prob Level (T Test)	0.0000	0.9466
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	1.0000	0.0505
Regression of Y on X	0.1580	0.0000
Inverse Regression from X on Y	1.4227	-0.0008
Orthogonal Regression of Y and X	0.1580	0.0000

Notes:
The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model
(.158015075837834) + (-2.33913578844355E-07) * (DDE)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	0.422368	0.422368			
Slope	1	5.220613E-06	5.220613E-06	0.0046	0.9466	0.0505
Error	15	1.686305E-02	1.124203E-03			
Adj. Total	16	1.686827E-02	1.054267E-03			
Total	17	0.4392363				

s = Square Root(1.124203E-03) = 3.352914E-02

Notes:
The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 3/4/2009 1:36:20 PM
Database
Y = Mean_Growth X = DDE

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.9360	0.273850	Yes
Anderson Darling	0.4273	0.312579	Yes
D'Agostino Skewness	1.8353	0.066465	No
D'Agostino Kurtosis	1.3021	0.192886	No
D'Agostino Omnibus	5.0637	0.079513	No
Constant Residual Variance?			
Modified Levene Test	0.2947	0.595206	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?
Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:
A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.
A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say N > 500) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

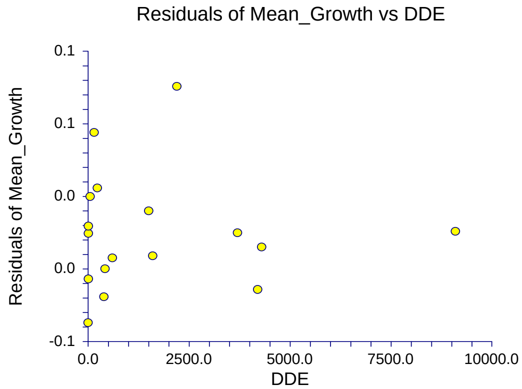
Normality and Constant Residual Variance:
Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

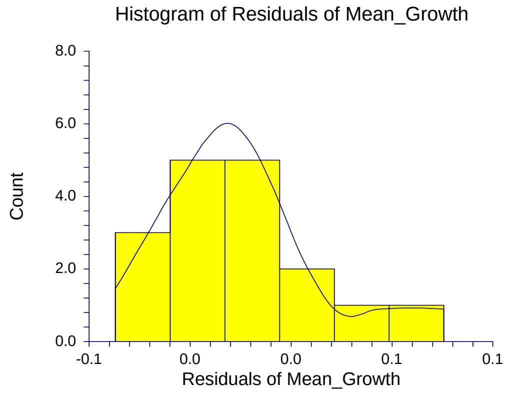
Straight-Line:
Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

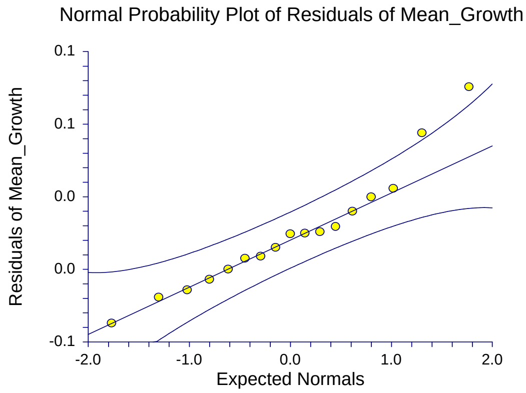
Linear Regression Report

Page/Date/Time 5 3/4/2009 1:36:20 PM
Database
Y = Mean_Growth X = DDE

Residual Plots Section



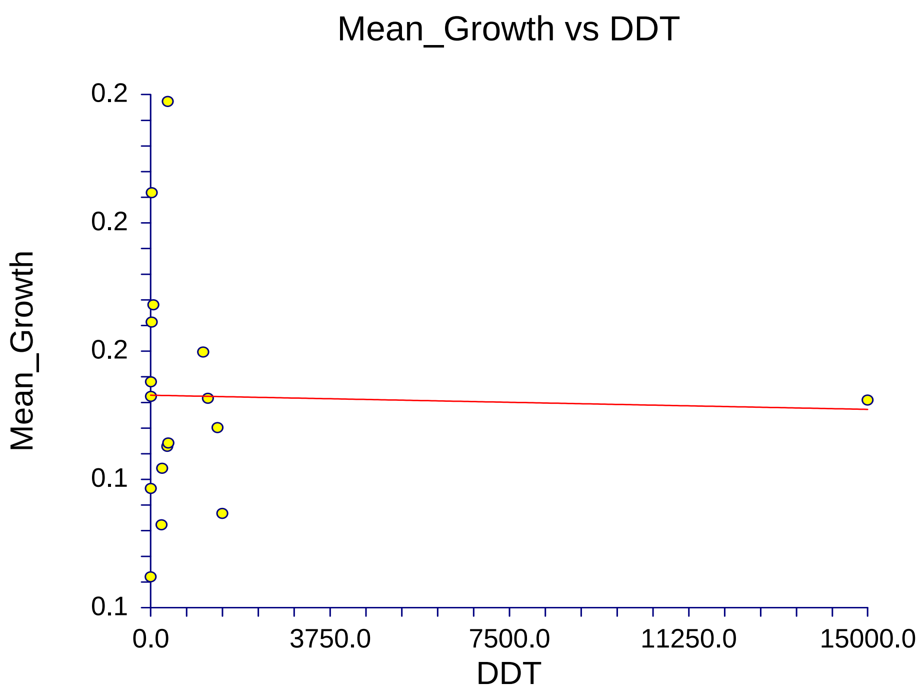




Linear Regression Report

Page/Date/Time 1 3/4/2009 1:36:36 PM
Database
Y = Mean_Growth X = DDT

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Mean_Growth	Rows Processed	17
Independent Variable	DDT	Rows Used in Estimation	17
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.1580	Rows Prediction Only	0
Slope	0.0000	Sum of Frequencies	17
R-Squared	0.0008	Sum of Weights	17.0000
Correlation	-0.0284	Coefficient of Variation	0.2127
Mean Square Error	1.123647E-03	Square Root of MSE	3.352085E-02

Linear Regression Report

Y = Mean_Growth X = DDT

Summary Statement

The equation of the straight line relating Mean_Growth and DDT is estimated as: Mean_Growth = (0.1580) + (0.0000) DDT using the 17 observations in this dataset. The y-intercept, the estimated value of Mean_Growth when DDT is zero, is 0.1580 with a standard error of 0.0087. The slope, the estimated change in Mean_Growth per unit change in DDT, is 0.0000 with a standard error of 0.0000. The value of R-Squared, the proportion of the variation in Mean_Growth that can be accounted for by variation in DDT, is 0.0008. The correlation between Mean_Growth and DDT is -0.0284.

A significance test that the slope is zero resulted in a t-value of -0.1098. The significance level of this t-test is 0.9140. Since 0.9140 > 0.0500, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0000. The lower limit of the 95% confidence interval for the slope is 0.0000 and the upper limit is 0.0000. The estimated intercept is 0.1580. The lower limit of the 95% confidence interval for the intercept is 0.1395 and the upper limit is 0.1764.

Descriptive Statistics Section

Parameter	**Dependent**	**Independent**
Variable	Mean_Growth	DDT
Count	17	17
Mean	0.1576	1286.6571
Standard Deviation	0.0325	3572.6462
Minimum	0.1084	0.1700
Maximum	0.2381	15000.0000

Linear Regression Report

Page/Date/Time 3 3/4/2009 1:36:36 PM
Database
Y = Mean_Growth X = DDT

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.1580	0.0000
Lower 95% Confidence Limit	0.1395	0.0000
Upper 95% Confidence Limit	0.1764	0.0000
Standard Error	0.0087	0.0000
Standardized Coefficient	0.0000	-0.0284
T Value	18.2141	-0.1098
Prob Level (T Test)	0.0000	0.9140
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	1.0000	0.0512
Regression of Y on X	0.1580	0.0000
Inverse Regression from X on Y	0.5701	-0.0003
Orthogonal Regression of Y and X	0.1580	0.0000

Notes:
The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model
(.15795506170577) + (-2.57669510093118E-07) * (DDT)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	0.422368	0.422368			
Slope	1	1.355895E-05	1.355895E-05	0.0121	0.9140	0.0512
Error	15	1.685471E-02	1.123647E-03			
Adj. Total	16	1.686827E-02	1.054267E-03			
Total	17	0.4392363				

s = Square Root(1.123647E-03) = 3.352085E-02

Notes:
The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 3/4/2009 1:36:36 PM
Database
Y = Mean_Growth X = DDT

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.9378	0.292994	Yes
Anderson Darling	0.4119	0.339993	Yes
D'Agostino Skewness	1.8106	0.070196	No
D'Agostino Kurtosis	1.2700	0.204080	Yes
D'Agostino Omnibus	4.8914	0.086667	No
Constant Residual Variance?			
Modified Levene Test	0.2690	0.611597	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?
Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:
A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.
A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say N > 500) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:
Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

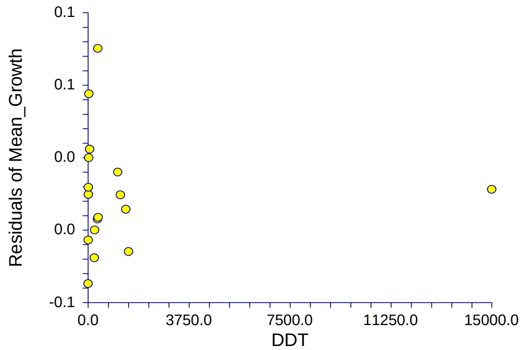
Straight-Line:
Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

Linear Regression Report

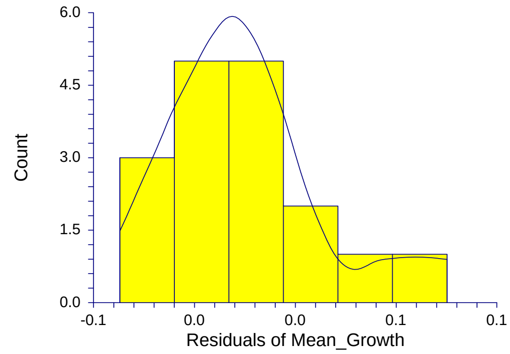
Page/Date/Time 5 3/4/2009 1:36:36 PM
Database
Y = Mean_Growth X = DDT

Residual Plots Section

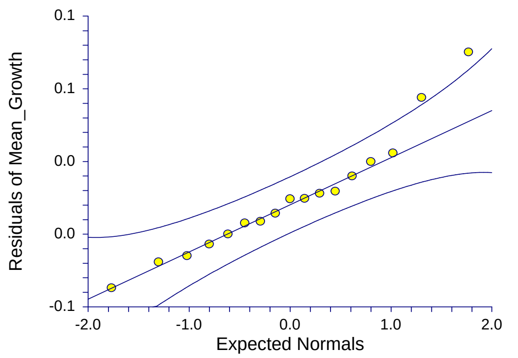
Residuals of Mean_Growth vs DDT



Histogram of Residuals of Mean_Growth



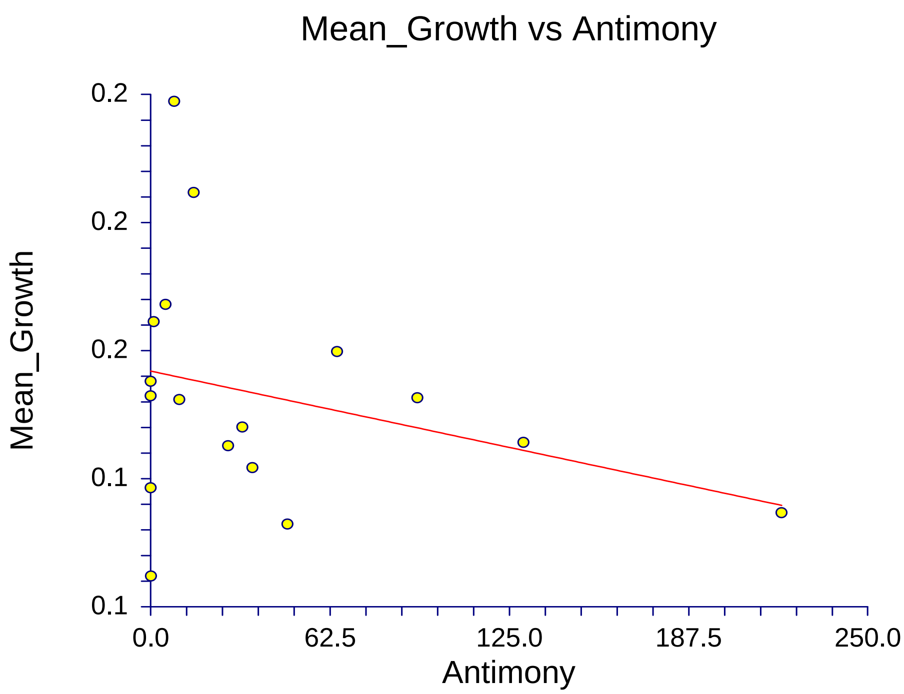
Normal Probability Plot of Residuals of Mean_Growth



Linear Regression Report

Page/Date/Time 1 3/4/2009 1:36:53 PM
Database
Y = Mean_Growth X = Antimony

Linear Regression Plot Section



Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	Mean_Growth	Rows Processed	17
Independent Variable	Antimony	Rows Used in Estimation	17
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.1644	Rows Prediction Only	0
Slope	-0.0002	Sum of Frequencies	17
R-Squared	0.0921	Sum of Weights	17.0000
Correlation	-0.3035	Coefficient of Variation	0.2027
Mean Square Error	1.020943E-03	Square Root of MSE	0.0319522

Linear Regression Report

Page/Date/Time 2 3/4/2009 1:36:53 PM
Y = Mean_Growth X = Antimony

Summary Statement
The equation of the straight line relating Mean_Growth and Antimony is estimated as: Mean_Growth = (0.1644) + (-0.0002) Antimony using the 17 observations in this dataset. The y-intercept, the estimated value of Mean_Growth when Antimony is zero, is 0.1644 with a standard error of 0.0095. The slope, the estimated change in Mean_Growth per unit change in Antimony, is -0.0002 with a standard error of 0.0001. The value of R-Squared, the proportion of the variation in Mean_Growth that can be accounted for by variation in Antimony, is 0.0921. The correlation between Mean_Growth and Antimony is -0.3035.

A significance test that the slope is zero resulted in a t-value of -1.2338. The significance level of this t-test is 0.2363. Since 0.2363 > 0.0500, the hypothesis that the slope is zero is not rejected.

The estimated slope is -0.0002. The lower limit of the 95% confidence interval for the slope is -0.0005 and the upper limit is 0.0001. The estimated intercept is 0.1644. The lower limit of the 95% confidence interval for the intercept is 0.1442 and the upper limit is 0.1846.

Descriptive Statistics Section

Parameter	**Dependent**	**Independent**
Variable	Mean_Growth	Antimony
Count	17	17
Mean	0.1576	40.5814
Standard Deviation	0.0325	59.1009
Minimum	0.1084	0.0190
Maximum	0.2381	220.0000

Linear Regression Report

Page/Date/Time 3 3/4/2009 1:36:53 PM
Database
Y = Mean_Growth X = Antimony

Regression Estimation Section

Parameter	**Intercept B(0)**	**Slope B(1)**
Regression Coefficients	0.1644	-0.0002
Lower 95% Confidence Limit	0.1442	-0.0005
Upper 95% Confidence Limit	0.1846	0.0001
Standard Error	0.0095	0.0001
Standardized Coefficient	0.0000	-0.3035
T Value	17.3148	-1.2338
Prob Level (T Test)	0.0000	0.2363
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	1.0000	0.2116
Regression of Y on X	0.1644	-0.0002
Inverse Regression from X on Y	0.2311	-0.0018
Orthogonal Regression of Y and X	0.1644	-0.0002

Notes:
The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model
(.164390823533259) + (-1.66758711354528E-04) * (Antimony)

Analysis of Variance Section

Source	**DF**	**Sum of Squares**	**Mean Square**	**F-Ratio**	**Prob Level**	**Power (5%)**
Intercept	1	0.422368	0.422368			
Slope	1	1.554122E-03	1.554122E-03	1.5222	0.2363	0.2116
Error	15	1.531415E-02	1.020943E-03			
Adj. Total	16	1.686827E-02	1.054267E-03			
Total	17	0.4392363				

s = Square Root(1.020943E-03) = 0.0319522

Notes:
The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 3/4/2009 1:36:53 PM
Database
Y = Mean_Growth X = Antimony

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.9485	0.433277	Yes
Anderson Darling	0.4174	0.330041	Yes
D'Agostino Skewness	1.3875	0.165281	No
D'Agostino Kurtosis	1.3510	0.176696	No
D'Agostino Omnibus	3.7504	0.153322	No
Constant Residual Variance?			
Modified Levene Test	2.4613	0.137536	No
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?
Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:
A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.
A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say N > 500) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

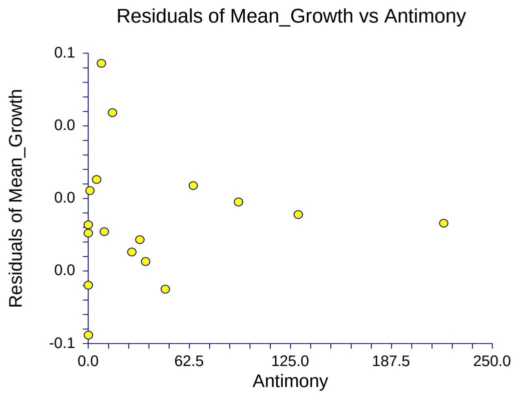
Normality and Constant Residual Variance:
Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

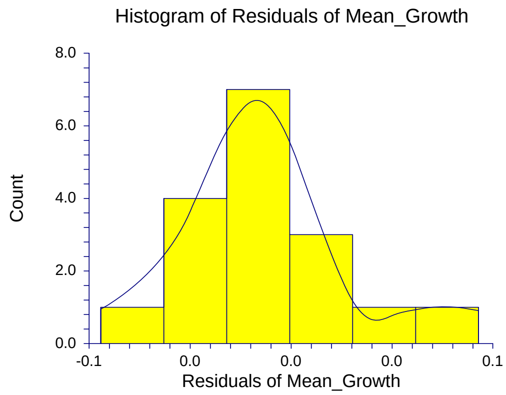
Straight-Line:
Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

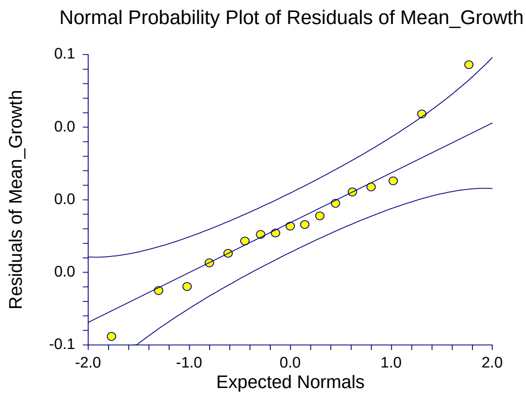
Linear Regression Report

Page/Date/Time 5 3/4/2009 1:36:53 PM
Database
Y = Mean_Growth X = Antimony

Residual Plots Section



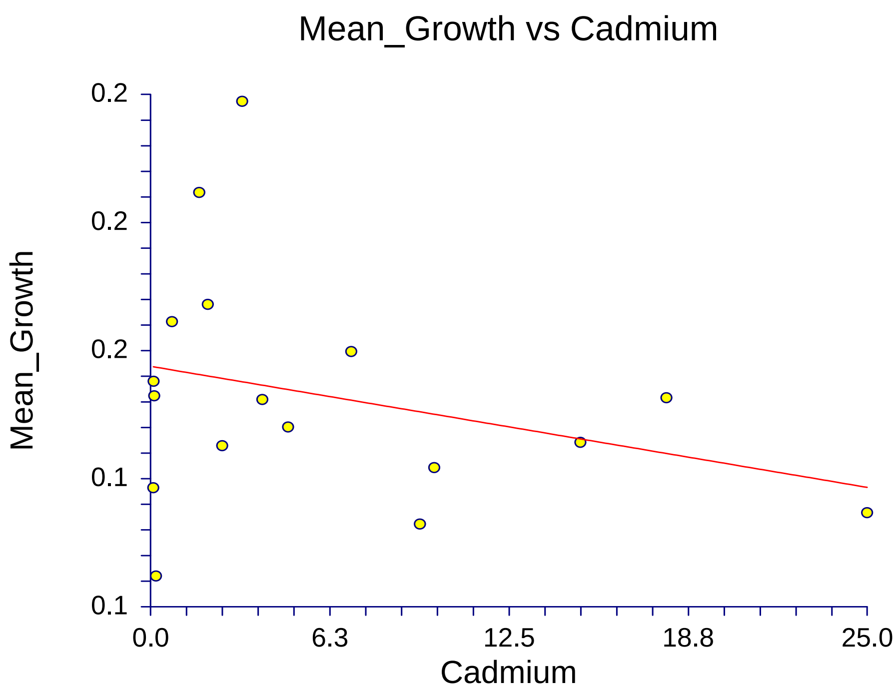




Linear Regression Report

Page/Date/Time 1 3/4/2009 1:37:21 PM
Database
Y = Mean_Growth X = Cadmium

Linear Regression Plot Section



Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	Mean_Growth	Rows Processed	17
Independent Variable	Cadmium	Rows Used in Estimation	17
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.1657	Rows Prediction Only	0
Slope	-0.0013	Sum of Frequencies	17
R-Squared	0.0871	Sum of Weights	17.0000
Correlation	-0.2951	Coefficient of Variation	0.2033
Mean Square Error	1.026617E-03	Square Root of MSE	3.204087E-02

Linear Regression Report

Page/Date/Time 2 3/4/2009 1:37:21 PM
Y = Mean_Growth X = Cadmium

Summary Statement

The equation of the straight line relating Mean_Growth and Cadmium is estimated as: Mean_Growth = (0.1657) + (-0.0013) Cadmium using the 17 observations in this dataset. The y-intercept, the estimated value of Mean_Growth when Cadmium is zero, is 0.1657 with a standard error of 0.0103. The slope, the estimated change in Mean_Growth per unit change in Cadmium, is -0.0013 with a standard error of 0.0011. The value of R-Squared, the proportion of the variation in Mean_Growth that can be accounted for by variation in Cadmium, is 0.0871. The correlation between Mean_Growth and Cadmium is -0.2951.

A significance test that the slope is zero resulted in a t-value of -1.1962. The significance level of this t-test is 0.2502. Since 0.2502 > 0.0500, the hypothesis that the slope is zero is not rejected.

The estimated slope is -0.0013. The lower limit of the 95% confidence interval for the slope is -0.0037 and the upper limit is 0.0010. The estimated intercept is 0.1657. The lower limit of the 95% confidence interval for the intercept is 0.1438 and the upper limit is 0.1876.

Descriptive Statistics Section

Parameter	**Dependent**	**Independent**
Variable	Mean_Growth	Cadmium
Count	17	17
Mean	0.1576	6.0985
Standard Deviation	0.0325	7.2430
Minimum	0.1084	0.0950
Maximum	0.2381	25.0000

Linear Regression Report

Page/Date/Time 3 3/4/2009 1:37:21 PM
Database
Y = Mean_Growth X = Cadmium

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.1657	-0.0013
Lower 95% Confidence Limit	0.1438	-0.0037
Upper 95% Confidence Limit	0.1876	0.0010
Standard Error	0.0103	0.0011
Standardized Coefficient	0.0000	-0.2951
T Value	16.1026	-1.1962
Prob Level (T Test)	0.0000	0.2502
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	1.0000	0.2017
Regression of Y on X	0.1657	-0.0013
Inverse Regression from X on Y	0.2503	-0.0152
Orthogonal Regression of Y and X	0.1657	-0.0013

Notes:
The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(.165691435540503) + (-1.32292649325823E-03) * (Cadmium)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	0.422368	0.422368			
Slope	1	1.469013E-03	1.469013E-03	1.4309	0.2502	0.2017
Error	15	1.539926E-02	1.026617E-03			
Adj. Total	16	1.686827E-02	1.054267E-03			
Total	17	0.4392363				

s = Square Root(1.026617E-03) = 3.204087E-02

Notes:
The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 3/4/2009 1:37:21 PM
Database
Y = Mean_Growth X = Cadmium

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.9416	0.337858	Yes
Anderson Darling	0.4856	0.226365	Yes
D'Agostino Skewness	1.4393	0.150075	No
D'Agostino Kurtosis	1.4539	0.145962	No
D'Agostino Omnibus	4.1854	0.123351	No
Constant Residual Variance?			
Modified Levene Test	3.9810	0.064511	No
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?
Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:
A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.
A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say N > 500) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

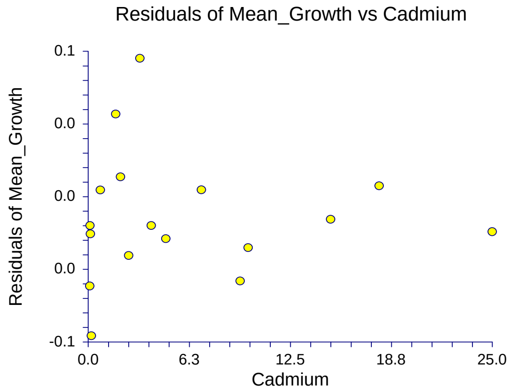
Normality and Constant Residual Variance:
Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

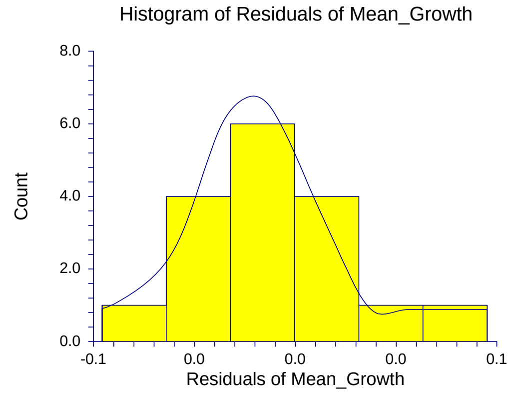
Straight-Line:
Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

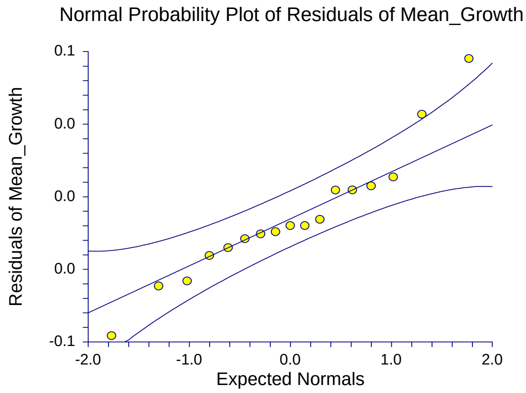
Linear Regression Report

Page/Date/Time 5 3/4/2009 1:37:21 PM
Database
Y = Mean_Growth X = Cadmium

Residual Plots Section



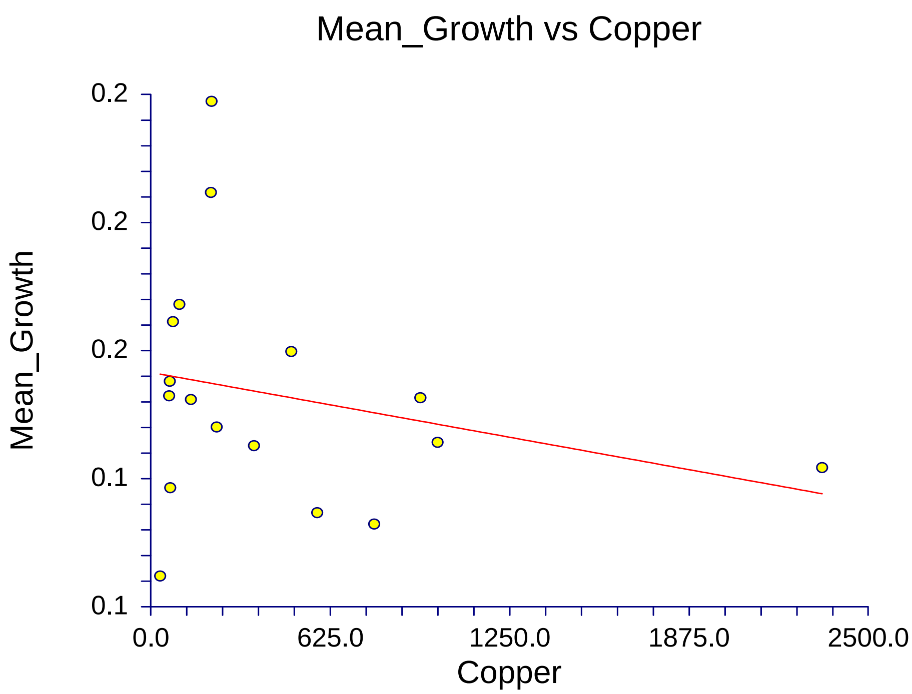




Linear Regression Report

Page/Date/Time 1 3/4/2009 1:37:39 PM
Database
Y = Mean_Growth X = Copper

Linear Regression Plot Section



Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	Mean_Growth	Rows Processed	17
Independent Variable	Copper	Rows Used in Estimation	17
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.1640	Rows Prediction Only	0
Slope	0.0000	Sum of Frequencies	17
R-Squared	0.0641	Sum of Weights	17.0000
Correlation	-0.2532	Coefficient of Variation	0.2058
Mean Square Error	1.052467E-03	Square Root of MSE	3.244175E-02

Linear Regression Report

Page/Date/Time 2 3/4/2009 1:37:39 PM
Y = Mean_Growth X = Copper

Summary Statement

The equation of the straight line relating Mean_Growth and Copper is estimated as: Mean_Growth = (0.1640) + (0.0000) Copper using the 17 observations in this dataset. The y-intercept, the estimated value of Mean_Growth when Copper is zero, is 0.1640 with a standard error of 0.0101. The slope, the estimated change in Mean_Growth per unit change in Copper, is 0.0000 with a standard error of 0.0000. The value of R-Squared, the proportion of the variation in Mean_Growth that can be accounted for by variation in Copper, is 0.0641. The correlation between Mean_Growth and Copper is -0.2532.

A significance test that the slope is zero resulted in a t-value of -1.0136. The significance level of this t-test is 0.3269. Since 0.3269 > 0.0500, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0000. The lower limit of the 95% confidence interval for the slope is 0.0000 and the upper limit is 0.0000. The estimated intercept is 0.1640. The lower limit of the 95% confidence interval for the intercept is 0.1425 and the upper limit is 0.1856.

Descriptive Statistics Section

Parameter	**Dependent**	**Independent**
Variable	Mean_Growth	Copper
Count	17	17
Mean	0.1576	452.3882
Standard Deviation	0.0325	580.1327
Minimum	0.1084	33.0000
Maximum	0.2381	2340.0000

Linear Regression Report

Page/Date/Time 3 3/4/2009 1:37:39 PM
Database
Y = Mean_Growth X = Copper

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.1640	0.0000
Lower 95% Confidence Limit	0.1425	0.0000
Upper 95% Confidence Limit	0.1856	0.0000
Standard Error	0.0101	0.0000
Standardized Coefficient	0.0000	-0.2532
T Value	16.2490	-1.0136
Prob Level (T Test)	0.0000	0.3269
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	1.0000	0.1580
Regression of Y on X	0.1640	0.0000
Inverse Regression from X on Y	0.2576	-0.0002
Orthogonal Regression of Y and X	0.1640	0.0000

Notes:
The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(.164033986101911) + (-1.41702550818517E-05) * (Copper)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	0.422368	0.422368			
Slope	1	1.08126E-03	1.08126E-03	1.0274	0.3269	0.1580
Error	15	1.578701E-02	1.052467E-03			
Adj. Total	16	1.686827E-02	1.054267E-03			
Total	17	0.4392363				

s = Square Root(1.052467E-03) = 3.244175E-02

Notes:
The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 3/4/2009 1:37:39 PM
Database
Y = Mean_Growth X = Copper

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.9399	0.316841	Yes
Anderson Darling	0.4600	0.261097	Yes
D'Agostino Skewness	1.5046	0.132415	No
D'Agostino Kurtosis	1.3632	0.172829	No
D'Agostino Omnibus	4.1222	0.127315	No
Constant Residual Variance?			
Modified Levene Test	2.3572	0.145527	No
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?
Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:
A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.
A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say N > 500) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

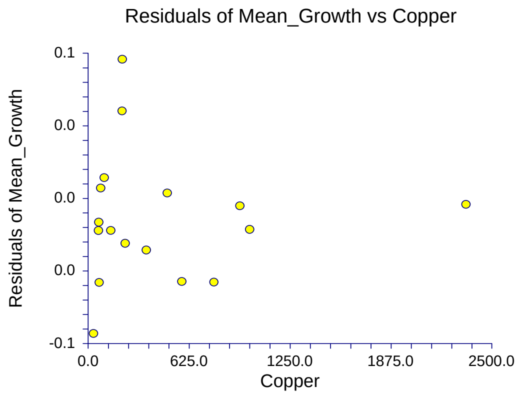
Normality and Constant Residual Variance:
Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

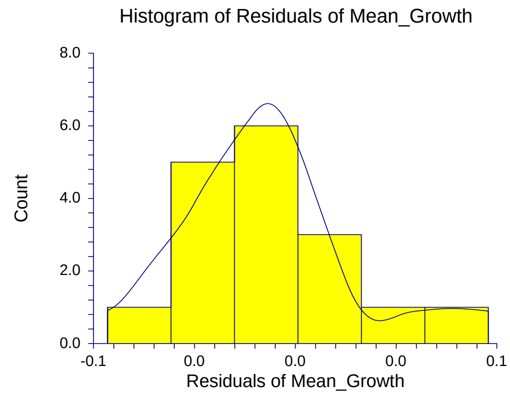
Straight-Line:
Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

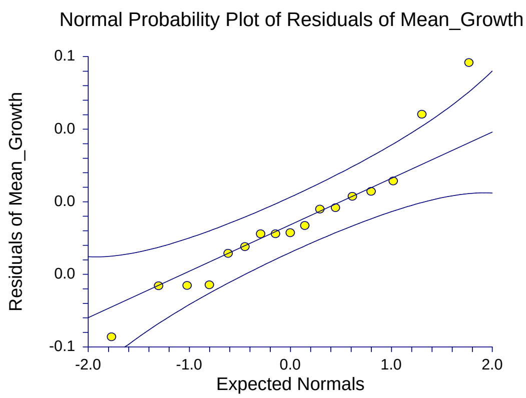
Linear Regression Report

Page/Date/Time 5 3/4/2009 1:37:39 PM
Database
Y = Mean_Growth X = Copper

Residual Plots Section



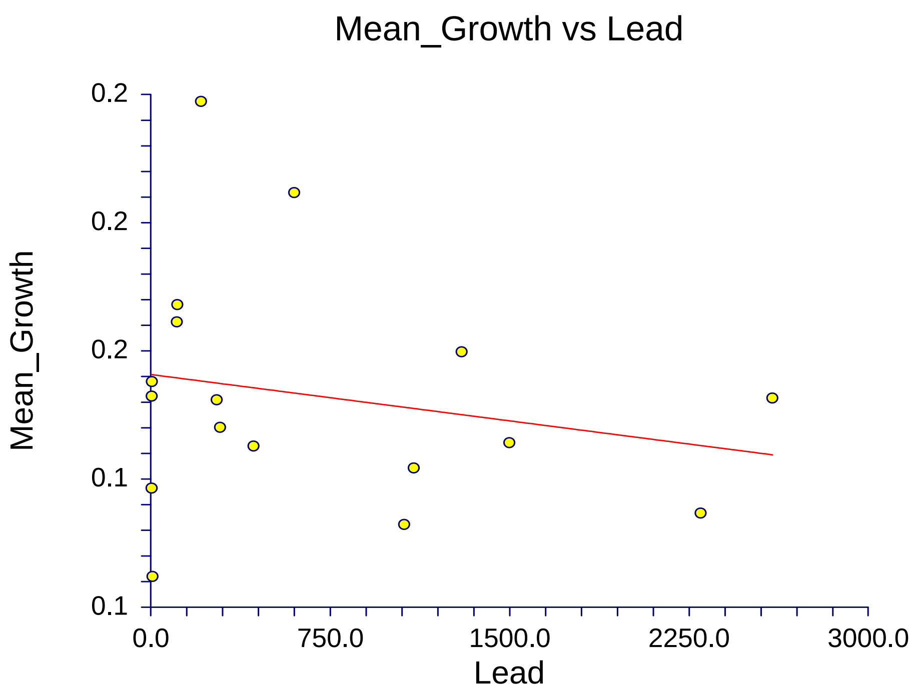




Linear Regression Report

Page/Date/Time 1 3/4/2009 1:38:01 PM
Database
Y = Mean_Growth X = Lead

Linear Regression Plot Section



Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	Mean_Growth	Rows Processed	17
Independent Variable	Lead	Rows Used in Estimation	17
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.1635	Rows Prediction Only	0
Slope	0.0000	Sum of Frequencies	17
R-Squared	0.0454	Sum of Weights	17.0000
Correlation	-0.2130	Coefficient of Variation	0.2079
Mean Square Error	1.073548E-03	Square Root of MSE	3.276504E-02

Linear Regression Report

Page/Date/Time 2 3/4/2009 1:38:01 PM
Y = Mean_Growth X = Lead

Summary Statement
The equation of the straight line relating Mean_Growth and Lead is estimated as: Mean_Growth = (0.1635) + (0.0000) Lead using the 17 observations in this dataset. The y-intercept, the estimated value of Mean_Growth when Lead is zero, is 0.1635 with a standard error of 0.0106. The slope, the estimated change in Mean_Growth per unit change in Lead, is 0.0000 with a standard error of 0.0000. The value of R-Squared, the proportion of the variation in Mean_Growth that can be accounted for by variation in Lead, is 0.0454. The correlation between Mean_Growth and Lead is -0.2130.

A significance test that the slope is zero resulted in a t-value of -0.8442. The significance level of this t-test is 0.4118. Since 0.4118 > 0.0500, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0000. The lower limit of the 95% confidence interval for the slope is 0.0000 and the upper limit is 0.0000. The estimated intercept is 0.1635. The lower limit of the 95% confidence interval for the intercept is 0.1410 and the upper limit is 0.1861.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Mean_Growth	Lead
Count	17	17
Mean	0.1576	700.3941
Standard Deviation	0.0325	819.9776
Minimum	0.1084	3.8000
Maximum	0.2381	2600.0000

Linear Regression Report

Page/Date/Time 3 3/4/2009 1:38:01 PM
Database
Y = Mean_Growth X = Lead

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.1635	0.0000
Lower 95% Confidence Limit	0.1410	0.0000
Upper 95% Confidence Limit	0.1861	0.0000
Standard Error	0.0106	0.0000
Standardized Coefficient	0.0000	-0.2130
T Value	15.4450	-0.8442
Prob Level (T Test)	0.0000	0.4118
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	1.0000	0.1242
Regression of Y on X	0.1635	0.0000
Inverse Regression from X on Y	0.2879	-0.0002
Orthogonal Regression of Y and X	0.1635	0.0000

Notes:
The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model
(.163529982467063) + (-8.43304206371771E-06) * (Lead)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	0.422368	0.422368			
Slope	1	7.650547E-04	7.650547E-04	0.7126	0.4118	0.1242
Error	15	1.610322E-02	1.073548E-03			
Adj. Total	16	1.686827E-02	1.054267E-03			
Total	17	0.4392363				

s = Square Root(1.073548E-03) = 3.276504E-02

Notes:
The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 3/4/2009 1:38:01 PM
Database
Y = Mean_Growth X = Lead

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.9361	0.274837	Yes
Anderson Darling	0.5069	0.200675	Yes
D'Agostino Skewness	1.5641	0.117806	No
D'Agostino Kurtosis	1.2384	0.215573	Yes
D'Agostino Omnibus	3.9799	0.136705	No
Constant Residual Variance?			
Modified Levene Test	0.0761	0.786358	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?
Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:
A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.
A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say N > 500) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

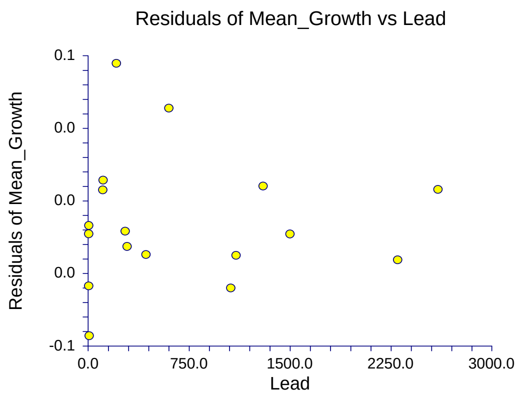
Normality and Constant Residual Variance:
Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

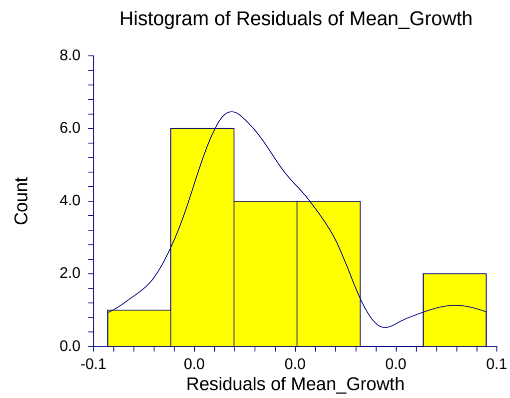
Straight-Line:
Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

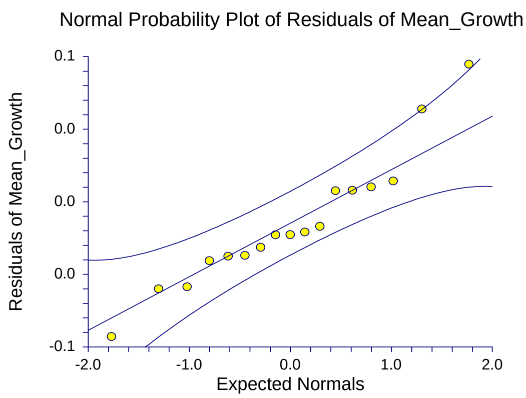
Linear Regression Report

Page/Date/Time 5 3/4/2009 1:38:01 PM
Database
Y = Mean_Growth X = Lead

Residual Plots Section



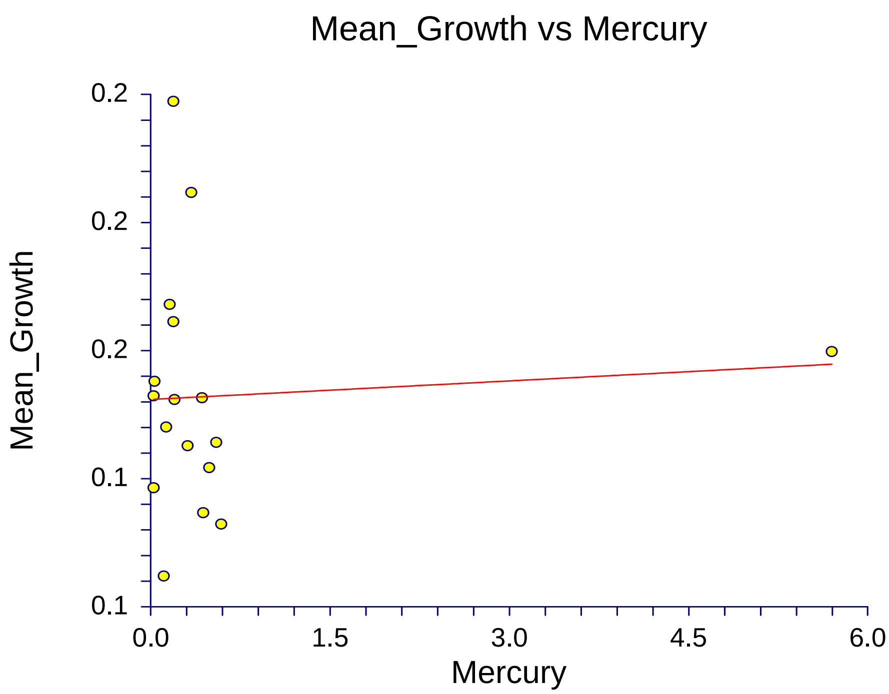




Linear Regression Report

Page/Date/Time 1 3/4/2009 1:38:57 PM
Database
Y = Mean_Growth X = Mercury

Linear Regression Plot Section



Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	Mean_Growth	Rows Processed	17
Independent Variable	Mercury	Rows Used in Estimation	17
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.1566	Rows Prediction Only	0
Slope	0.0017	Sum of Frequencies	17
R-Squared	0.0048	Sum of Weights	17.0000
Correlation	0.0692	Coefficient of Variation	0.2122
Mean Square Error	1.119164E-03	Square Root of MSE	0.0334539

Linear Regression Report

Page/Date/Time 2 3/4/2009 1:38:57 PM
Y = Mean_Growth X = Mercury

Summary Statement

The equation of the straight line relating Mean_Growth and Mercury is estimated as: Mean_Growth = (0.1566) + (0.0017) Mercury using the 17 observations in this dataset. The y-intercept, the estimated value of Mean_Growth when Mercury is zero, is 0.1566 with a standard error of 0.0089. The slope, the estimated change in Mean_Growth per unit change in Mercury, is 0.0017 with a standard error of 0.0063. The value of R-Squared, the proportion of the variation in Mean_Growth that can be accounted for by variation in Mercury, is 0.0048. The correlation between Mean_Growth and Mercury is 0.0692.

A significance test that the slope is zero resulted in a t-value of 0.2687. The significance level of this t-test is 0.7918. Since 0.7918 > 0.0500, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0017. The lower limit of the 95% confidence interval for the slope is -0.0117 and the upper limit is 0.0151. The estimated intercept is 0.1566. The lower limit of the 95% confidence interval for the intercept is 0.1377 and the upper limit is 0.1756.

Descriptive Statistics Section

Parameter	**Dependent**	**Independent**
Variable	Mean_Growth	Mercury
Count	17	17
Mean	0.1576	0.5831
Standard Deviation	0.0325	1.3313
Minimum	0.1084	0.0250
Maximum	0.2381	5.7000

Linear Regression Report

Page/Date/Time 3 3/4/2009 1:38:57 PM
Database
Y = Mean_Growth X = Mercury

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.1566	0.0017
Lower 95% Confidence Limit	0.1377	-0.0117
Upper 95% Confidence Limit	0.1756	0.0151
Standard Error	0.0089	0.0063
Standardized Coefficient	0.0000	0.0692
T Value	17.5953	0.2687
Prob Level (T Test)	0.0000	0.7918
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	1.0000	0.0573
Regression of Y on X	0.1566	0.0017
Inverse Regression from X on Y	-0.0478	0.3523
Orthogonal Regression of Y and X	0.1566	0.0017

Notes:
The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model
(.156639159820248) + (1.68811490525498E-03) * (Mercury)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	0.422368	0.422368			
Slope	1	8.081724E-05	8.081724E-05	0.0722	0.7918	0.0573
Error	15	1.678745E-02	1.119164E-03			
Lack of Fit	13	1.466043E-02	1.127725E-03	1.0604	0.5855	
Pure Error	2	2.127025E-03	1.063513E-03			
Adj. Total	16	1.686827E-02	1.054267E-03			
Total	17	0.4392363				

s = Square Root(1.119164E-03) = 0.0334539

Notes:
The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 3/4/2009 1:38:57 PM
Database
Y = Mean_Growth X = Mercury

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.9235	0.169090	No
Anderson Darling	0.5241	0.181982	No
D'Agostino Skewness	1.9503	0.051143	No
D'Agostino Kurtosis	1.3826	0.166797	No
D'Agostino Omnibus	5.7151	0.057410	No
Constant Residual Variance?			
Modified Levene Test	0.2135	0.650691	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(13, 2) Test	1.0604	0.585474	Yes

No Serial Correlation?
Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:
A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.
A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say N > 500) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

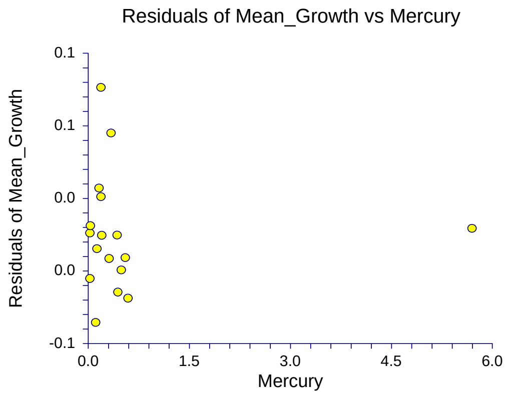
Normality and Constant Residual Variance:
Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

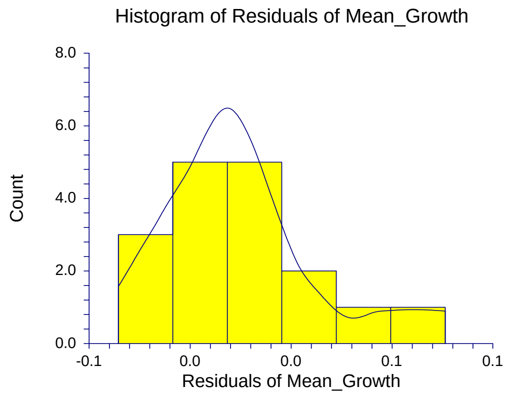
Straight-Line:
Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

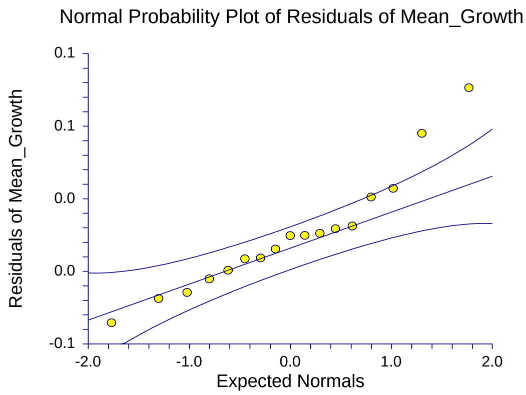
Linear Regression Report

Page/Date/Time 5 3/4/2009 1:38:57 PM
Database
Y = Mean_Growth X = Mercury

Residual Plots Section



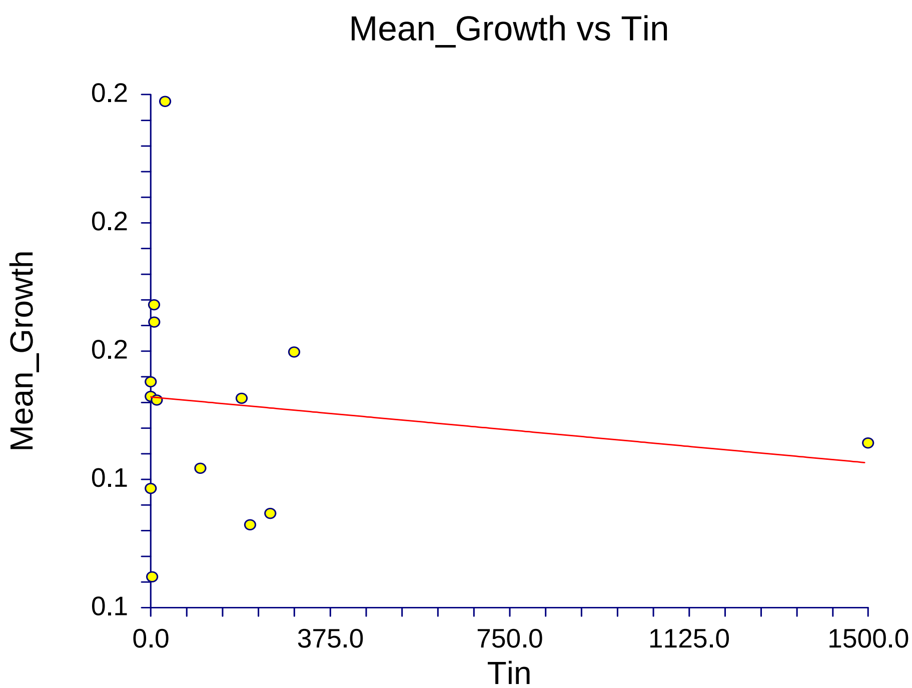




Linear Regression Report

Page/Date/Time 1 3/4/2009 1:38:22 PM
Database
Y = Mean_Growth X = Tin

Linear Regression Plot Section



Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	Mean_Growth	Rows Processed	17
Independent Variable	Tin	Rows Used in Estimation	14
Frequency Variable	None	Rows with X Missing	3
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.1575	Rows Prediction Only	0
Slope	0.0000	Sum of Frequencies	14
R-Squared	0.0214	Sum of Weights	14.0000
Correlation	-0.1464	Coefficient of Variation	0.2133
Mean Square Error	1.096117E-03	Square Root of MSE	3.310766E-02

Linear Regression Report

Page/Date/Time 2 3/4/2009 1:38:22 PM
Y = Mean_Growth X = Tin

Summary Statement

The equation of the straight line relating Mean_Growth and Tin is estimated as: Mean_Growth = (0.1575) + (0.0000) Tin using the 14 observations in this dataset. The y-intercept, the estimated value of Mean_Growth when Tin is zero, is 0.1575 with a standard error of 0.0099. The slope, the estimated change in Mean_Growth per unit change in Tin, is 0.0000 with a standard error of 0.0000. The value of R-Squared, the proportion of the variation in Mean_Growth that can be accounted for by variation in Tin, is 0.0214. The correlation between Mean_Growth and Tin is -0.1464.

A significance test that the slope is zero resulted in a t-value of -0.5126. The significance level of this t-test is 0.6175. Since 0.6175 > 0.0500, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0000. The lower limit of the 95% confidence interval for the slope is -0.0001 and the upper limit is 0.0000. The estimated intercept is 0.1575. The lower limit of the 95% confidence interval for the intercept is 0.1360 and the upper limit is 0.1790.

Descriptive Statistics Section

Parameter	**Dependent**	**Independent**
Variable	Mean_Growth	Tin
Count	14	14
Mean	0.1552	186.6500
Standard Deviation	0.0322	392.8333
Minimum	0.1084	0.2300
Maximum	0.2381	1500.0000

Linear Regression Report

Page/Date/Time 3 3/4/2009 1:38:23 PM
Database
Y = Mean_Growth X = Tin

Regression Estimation Section

Parameter	**Intercept B(0)**	**Slope B(1)**
Regression Coefficients	0.1575	0.0000
Lower 95% Confidence Limit	0.1360	-0.0001
Upper 95% Confidence Limit	0.1790	0.0000
Standard Error	0.0099	0.0000
Standardized Coefficient	0.0000	-0.1464
T Value	15.9618	-0.5126
Prob Level (T Test)	0.0000	0.6175
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	1.0000	0.0760
Regression of Y on X	0.1575	0.0000
Inverse Regression from X on Y	0.2596	-0.0006
Orthogonal Regression of Y and X	0.1575	0.0000

Notes:
The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model
(.157472271337888) + (-1.19826255139206E-05) * (Tin)

Analysis of Variance Section

Source	**DF**	**Sum of Squares**	**Mean Square**	**F-Ratio**	**Prob Level**	**Power (5%)**
Intercept	1	0.3373738	0.3373738			
Slope	1	2.880473E-04	2.880473E-04	0.2628	0.6175	0.0760
Error	12	0.0131534	1.096117E-03			
Lack of Fit	11	0.01273	1.157273E-03	2.7333	0.4425	
Pure Error	1	4.23405E-04	4.23405E-04			
Adj. Total	13	1.344145E-02	1.033958E-03			
Total	14	0.3508152				

s = Square Root(1.096117E-03) = 3.310766E-02

Notes:
The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 3/4/2009 1:38:23 PM
Database
Y = Mean_Growth X = Tin

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.9229	0.241820	Yes
Anderson Darling	0.4271	0.313015	Yes
D'Agostino Skewness	1.6992	0.089276	No
D'Agostino Kurtosis	1.7335	0.083002	No
D'Agostino Omnibus	5.8925	0.052537	No
Constant Residual Variance?			
Modified Levene Test	0.4521	0.514084	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(11, 1) Test	2.7333	0.442461	Yes

No Serial Correlation?
Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:
A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.
A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say N > 500) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

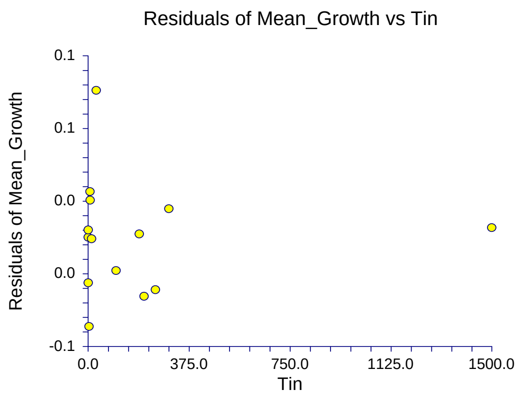
Normality and Constant Residual Variance:
Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

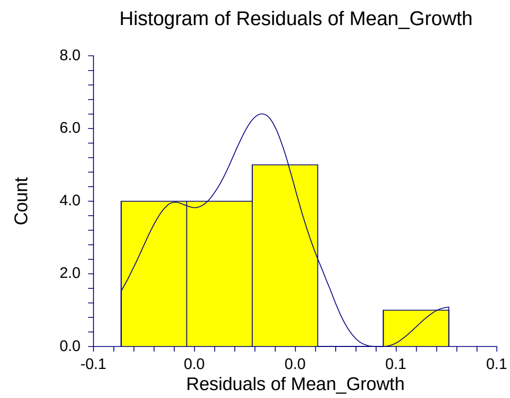
Straight-Line:
Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

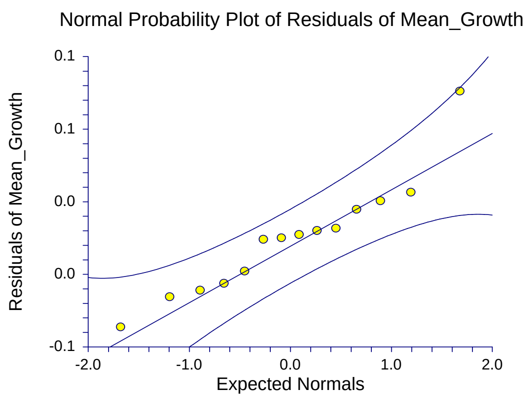
Linear Regression Report

Page/Date/Time 5 3/4/2009 1:38:23 PM
Database
Y = Mean_Growth X = Tin

Residual Plots Section



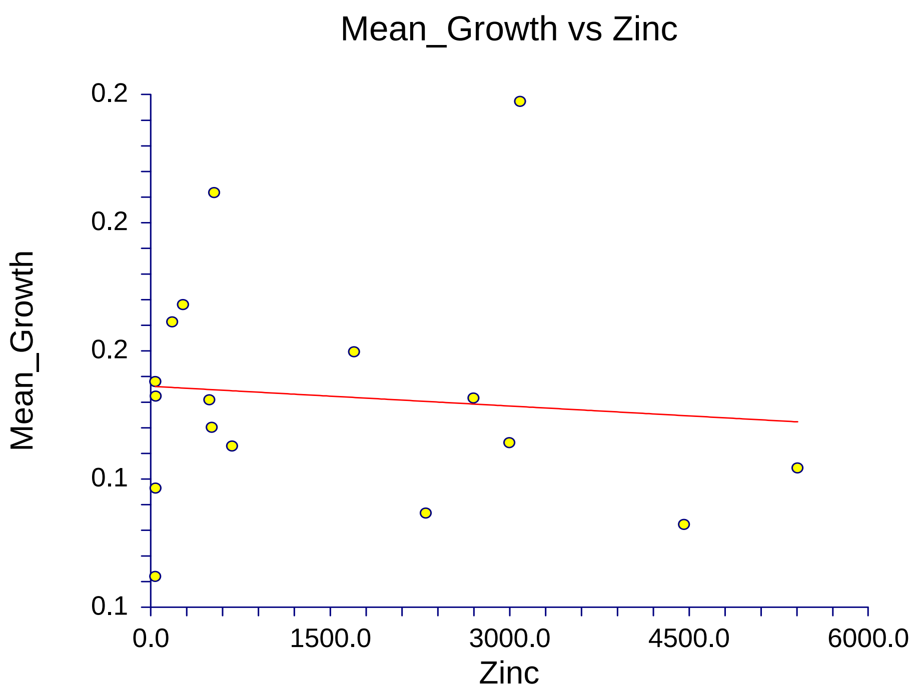




Linear Regression Report

Page/Date/Time 1 3/4/2009 1:38:41 PM
Database
Y = Mean_Growth X = Zinc

Linear Regression Plot Section



Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	Mean_Growth	Rows Processed	17
Independent Variable	Zinc	Rows Used in Estimation	17
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.1603	Rows Prediction Only	0
Slope	0.0000	Sum of Frequencies	17
R-Squared	0.0088	Sum of Weights	17.0000
Correlation	-0.0941	Coefficient of Variation	0.2118
Mean Square Error	1.114601E-03	Square Root of MSE	3.338564E-02

Linear Regression Report

Page/Date/Time 2 3/4/2009 1:38:41 PM
Y = Mean_Growth X = Zinc

Summary Statement

The equation of the straight line relating Mean_Growth and Zinc is estimated as: Mean_Growth = (0.1603) + (0.0000) Zinc using the 17 observations in this dataset. The y-intercept, the estimated value of Mean_Growth when Zinc is zero, is 0.1603 with a standard error of 0.0109. The slope, the estimated change in Mean_Growth per unit change in Zinc, is 0.0000 with a standard error of 0.0000. The value of R-Squared, the proportion of the variation in Mean_Growth that can be accounted for by variation in Zinc, is 0.0088. The correlation between Mean_Growth and Zinc is -0.0941.

A significance test that the slope is zero resulted in a t-value of -0.3659. The significance level of this t-test is 0.7195. Since 0.7195 > 0.0500, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0000. The lower limit of the 95% confidence interval for the slope is 0.0000 and the upper limit is 0.0000. The estimated intercept is 0.1603. The lower limit of the 95% confidence interval for the intercept is 0.1370 and the upper limit is 0.1836.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Mean_Growth	Zinc
Count	17	17
Mean	0.1576	1498.7647
Standard Deviation	0.0325	1701.9457
Minimum	0.1084	38.0000
Maximum	0.2381	5410.0000

Linear Regression Report

Page/Date/Time 3 3/4/2009 1:38:41 PM
Database
Y = Mean_Growth X = Zinc

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.1603	0.0000
Lower 95% Confidence Limit	0.1370	0.0000
Upper 95% Confidence Limit	0.1836	0.0000
Standard Error	0.0109	0.0000
Standardized Coefficient	0.0000	-0.0941
T Value	14.6598	-0.3659
Prob Level (T Test)	0.0000	0.7195
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	1.0000	0.0636
Regression of Y on X	0.1603	0.0000
Inverse Regression from X on Y	0.4616	-0.0002
Orthogonal Regression of Y and X	0.1603	0.0000

Notes:
The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model
(.160313173261037) + (-1.79457378380707E-06) * (Zinc)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	0.422368	0.422368			
Slope	1	1.492568E-04	1.492568E-04	0.1339	0.7195	0.0636
Error	15	1.671901E-02	1.114601E-03			
Adj. Total	16	1.686827E-02	1.054267E-03			
Total	17	0.4392363				

s = Square Root(1.114601E-03) = 3.338564E-02

Notes:
The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 3/4/2009 1:38:41 PM
Database
Y = Mean_Growth X = Zinc

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.9203	0.149583	No
Anderson Darling	0.5589	0.148870	No
D'Agostino Skewness	1.9936	0.046193	No
D'Agostino Kurtosis	1.6001	0.109569	No
D'Agostino Omnibus	6.5350	0.038102	No
Constant Residual Variance?			
Modified Levene Test	0.0058	0.940448	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?
Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:
A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.
A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say N > 500) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

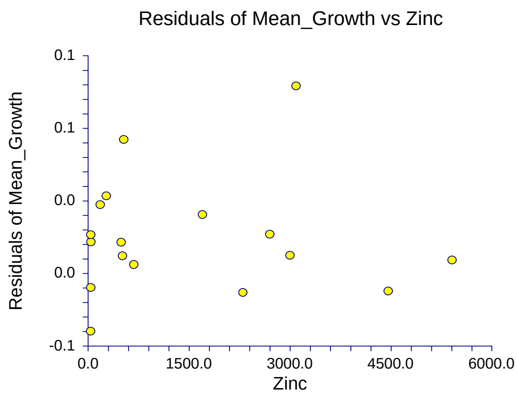
Normality and Constant Residual Variance:
Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

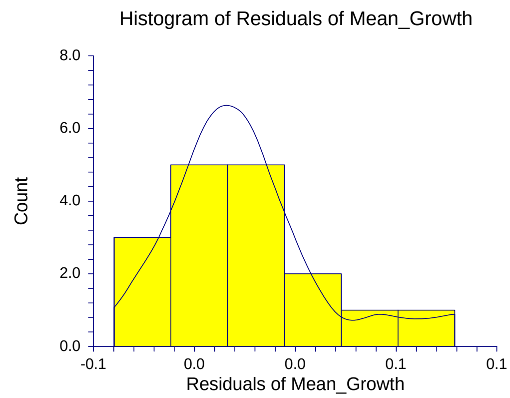
Straight-Line:
Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

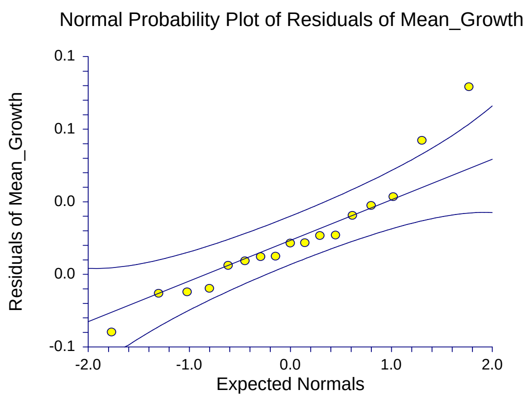
Linear Regression Report

Page/Date/Time 5 3/4/2009 1:38:41 PM
Database
Y = Mean_Growth X = Zinc

Residual Plots Section



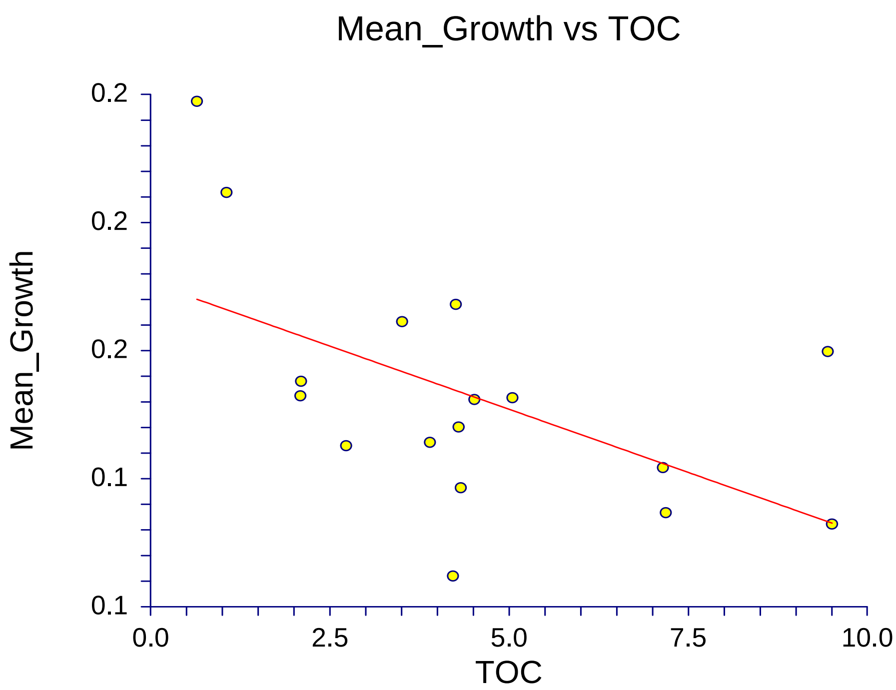




Linear Regression Report

Page/Date/Time 1 3/4/2009 1:39:52 PM
Database
Y = Mean_Growth X = TOC

Linear Regression Plot Section



Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	Mean_Growth	Rows Processed	17
Independent Variable	TOC	Rows Used in Estimation	17
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.1885	Rows Prediction Only	0
Slope	-0.0069	Sum of Frequencies	17
R-Squared	0.3025	Sum of Weights	17.0000
Correlation	-0.5500	Coefficient of Variation	0.1777
Mean Square Error	7.843616E-04	Square Root of MSE	2.800646E-02

Linear Regression Report

Y = Mean_Growth X = TOC

Summary Statement
The equation of the straight line relating Mean_Growth and TOC is estimated as: Mean_Growth = (0.1885) + (-0.0069) TOC using the 17 observations in this dataset. The y-intercept, the estimated value of Mean_Growth when TOC is zero, is 0.1885 with a standard error of 0.0139. The slope, the estimated change in Mean_Growth per unit change in TOC, is -0.0069 with a standard error of 0.0027. The value of R-Squared, the proportion of the variation in Mean_Growth that can be accounted for by variation in TOC, is 0.3025. The correlation between Mean_Growth and TOC is -0.5500.

A significance test that the slope is zero resulted in a t-value of -2.5506. The significance level of this t-test is 0.0222. Since 0.0222 < 0.0500, the hypothesis that the slope is zero is rejected.

The estimated slope is -0.0069. The lower limit of the 95% confidence interval for the slope is -0.0127 and the upper limit is -0.0011. The estimated intercept is 0.1885. The lower limit of the 95% confidence interval for the intercept is 0.1589 and the upper limit is 0.2181.

Descriptive Statistics Section

Parameter	**Dependent**	**Independent**
Variable	Mean_Growth	TOC
Count	17	17
Mean	0.1576	4.4716
Standard Deviation	0.0325	2.5869
Minimum	0.1084	0.6470
Maximum	0.2381	9.5100

Linear Regression Report

Page/Date/Time 3 3/4/2009 1:39:52 PM
Database
Y = Mean_Growth X = TOC

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.1885	-0.0069
Lower 95% Confidence Limit	0.1589	-0.0127
Upper 95% Confidence Limit	0.2181	-0.0011
Standard Error	0.0139	0.0027
Standardized Coefficient	0.0000	-0.5500
T Value	13.5817	-2.5506
Prob Level (T Test)	0.0000	0.0222
Reject H0 (Alpha = 0.0500)	Yes	Yes
Power (Alpha = 0.0500)	1.0000	0.6646
Regression of Y on X	0.1885	-0.0069
Inverse Regression from X on Y	0.2597	-0.0228
Orthogonal Regression of Y and X	0.1885	-0.0069

Notes:
The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model
(.188492546895256) + (-6.90336763117932E-03) * (TOC)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	0.422368	0.422368			
Slope	1	5.102846E-03	5.102846E-03	6.5057	0.0222	0.6646
Error	15	1.176542E-02	7.843616E-04			
Adj. Total	16	1.686827E-02	1.054267E-03			
Total	17	0.4392363				

s = Square Root(7.843616E-04) = 2.800646E-02

Notes:
The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 3/4/2009 1:39:52 PM
Database
Y = Mean_Growth X = TOC

Tests of Assumptions Section

Assumption/Test	**Test Value**	**Prob Level**	**Is the Assumption Reasonable at the 0.2000 Level of Significance?**
Residuals follow Normal Distribution?			
Shapiro Wilk	0.9584	0.602397	Yes
Anderson Darling	0.3777	0.408390	Yes
D'Agostino Skewness	0.8487	0.396056	Yes
D'Agostino Kurtosis	0.3530	0.724072	Yes
D'Agostino Omnibus	0.8449	0.655441	Yes
Constant Residual Variance?			
Modified Levene Test	1.9561	0.182268	No
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?
Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:
A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.
A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say N > 500) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

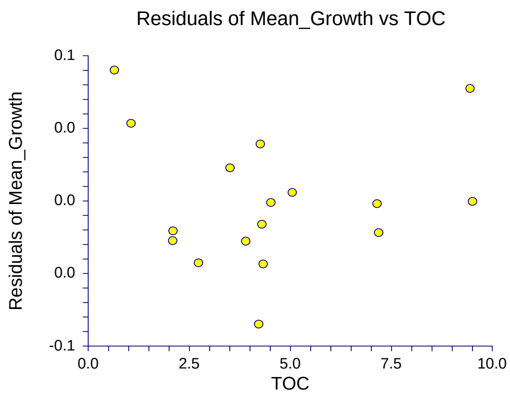
Normality and Constant Residual Variance:
Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

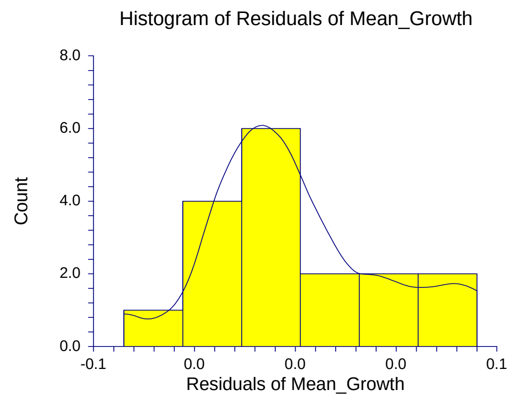
Straight-Line:
Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

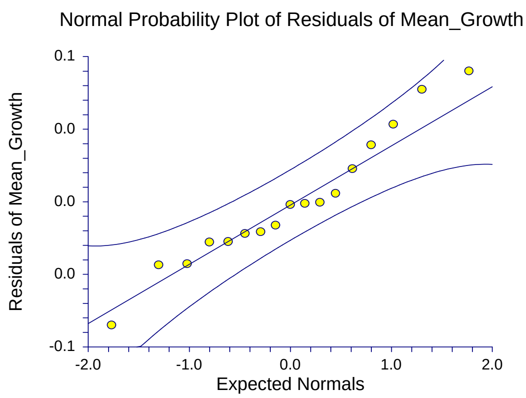
Linear Regression Report

Page/Date/Time 5 3/4/2009 1:39:52 PM
Database
Y = Mean_Growth X = TOC

Residual Plots Section



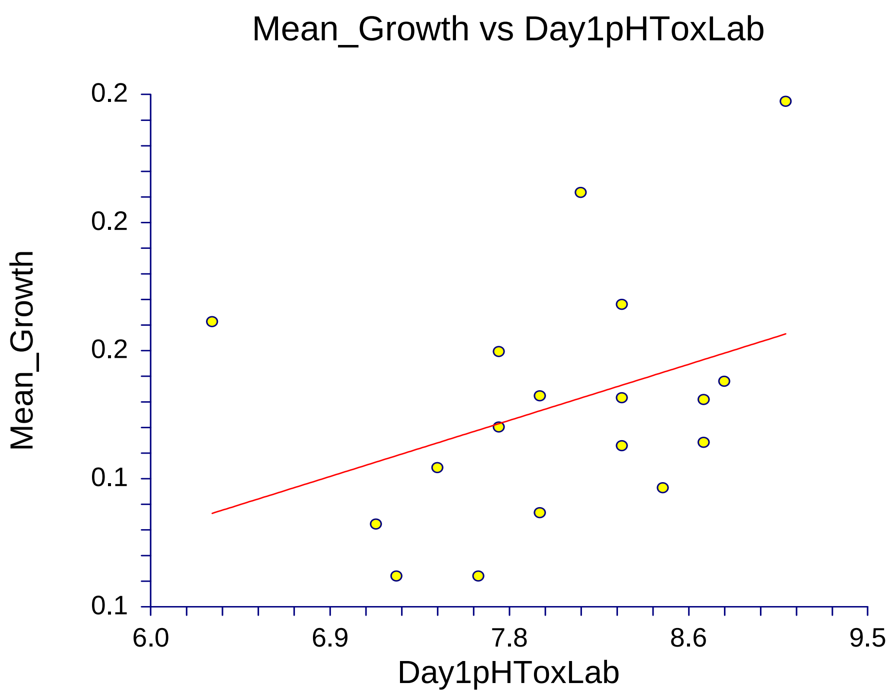




Linear Regression Report

Page/Date/Time 1 4/13/2009 2:40:54 PM
Database
Y = Mean_Growth X = Day1pHToxLab

Linear Regression Plot Section



Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	Mean_Growth	Rows Processed	18
Independent Variable	Day1pHToxLab	Rows Used in Estimation	18
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.0152	Rows Prediction Only	0
Slope	0.0175	Sum of Frequencies	18
R-Squared	0.1346	Sum of Weights	18.0000
Correlation	0.3668	Coefficient of Variation	0.2078
Mean Square Error	1.036161E-03	Square Root of MSE	3.218945E-02

Linear Regression Report

Page/Date/Time 2 4/13/2009 2:40:54 PM
Y = Mean_Growth X = Day1pHToxLab

Summary Statement

The equation of the straight line relating Mean_Growth and Day1pHToxLab is estimated as: Mean_Growth = (0.0152) + (0.0175) Day1pHToxLab using the 18 observations in this dataset. The y-intercept, the estimated value of Mean_Growth when Day1pHToxLab is zero, is 0.0152 with a standard error of 0.0889. The slope, the estimated change in Mean_Growth per unit change in Day1pHToxLab, is 0.0175 with a standard error of 0.0111. The value of R-Squared, the proportion of the variation in Mean_Growth that can be accounted for by variation in Day1pHToxLab, is 0.1346. The correlation between Mean_Growth and Day1pHToxLab is 0.3668.

A significance test that the slope is zero resulted in a t-value of 1.5774. The significance level of this t-test is 0.1343. Since 0.1343 > 0.0500, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0175. The lower limit of the 95% confidence interval for the slope is -0.0060 and the upper limit is 0.0410. The estimated intercept is 0.0152. The lower limit of the 95% confidence interval for the intercept is -0.1732 and the upper limit is 0.2036.

Descriptive Statistics Section

Parameter	**Dependent**	**Independent**
Variable	Mean_Growth	Day1pHToxLab
Count	18	18
Mean	0.1549	7.9778
Standard Deviation	0.0336	0.7034
Minimum	0.1084	6.3000
Maximum	0.2381	9.1000

Linear Regression Report

Page/Date/Time 3 4/13/2009 2:40:54 PM
Database
Y = Mean_Growth X = Day1pHToxLab

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.0152	0.0175
Lower 95% Confidence Limit	-0.1732	-0.0060
Upper 95% Confidence Limit	0.2036	0.0410
Standard Error	0.0889	0.0111
Standardized Coefficient	0.0000	0.3668
T Value	0.1713	1.5774
Prob Level (T Test)	0.8662	0.1343
Reject H0 (Alpha = 0.0500)	No	No
Power (Alpha = 0.0500)	0.0530	0.3170
Regression of Y on X	0.0152	0.0175
Inverse Regression from X on Y	-0.8829	0.1301
Orthogonal Regression of Y and X	0.0149	0.0175

Notes:
The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model
(1.52198150594416E-02) + (.017507265521797) * (Day1pHToxLab)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	0.4318302	0.4318302			
Slope	1	2.578042E-03	2.578042E-03	2.4881	0.1343	0.3170
Error	16	1.657858E-02	1.036161E-03			
Lack of Fit	11	1.501854E-02	1.365322E-03	4.3759	0.0578	
Pure Error	5	1.560037E-03	3.120073E-04			
Adj. Total	17	1.915662E-02	1.12686E-03			
Total	18	0.4509868				

s = Square Root(1.036161E-03) = 3.218945E-02

Notes:
The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 4/13/2009 2:40:54 PM
Database
Y = Mean_Growth X = Day1pHToxLab

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.8969	0.050838	No
Anderson Darling	0.7087	0.064365	No
D'Agostino Skewness	1.7126	0.086782	No
D'Agostino Kurtosis	0.1307	0.895977	Yes
D'Agostino Omnibus	2.9502	0.228760	Yes
Constant Residual Variance?			
Modified Levene Test	0.0817	0.778657	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(11, 5) Test	4.3759	0.057754	No

No Serial Correlation?
Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:
A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.
A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say N > 500) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

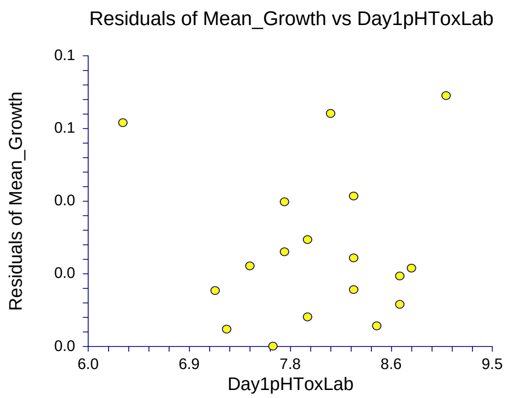
Normality and Constant Residual Variance:
Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

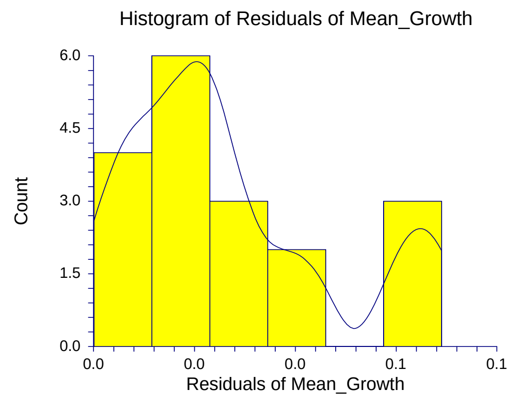
Straight-Line:
Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

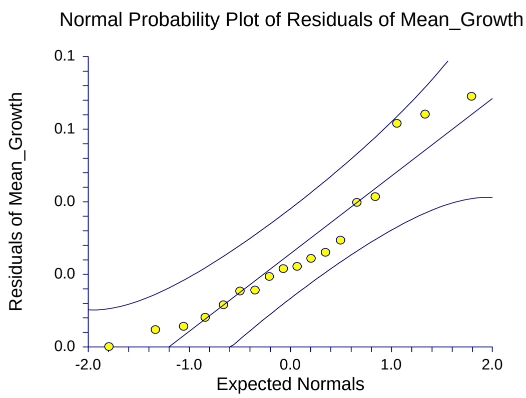
Linear Regression Report

Page/Date/Time 5 4/13/2009 2:40:54 PM
Database
Y = Mean_Growth X = Day1pHToxLab

Residual Plots Section



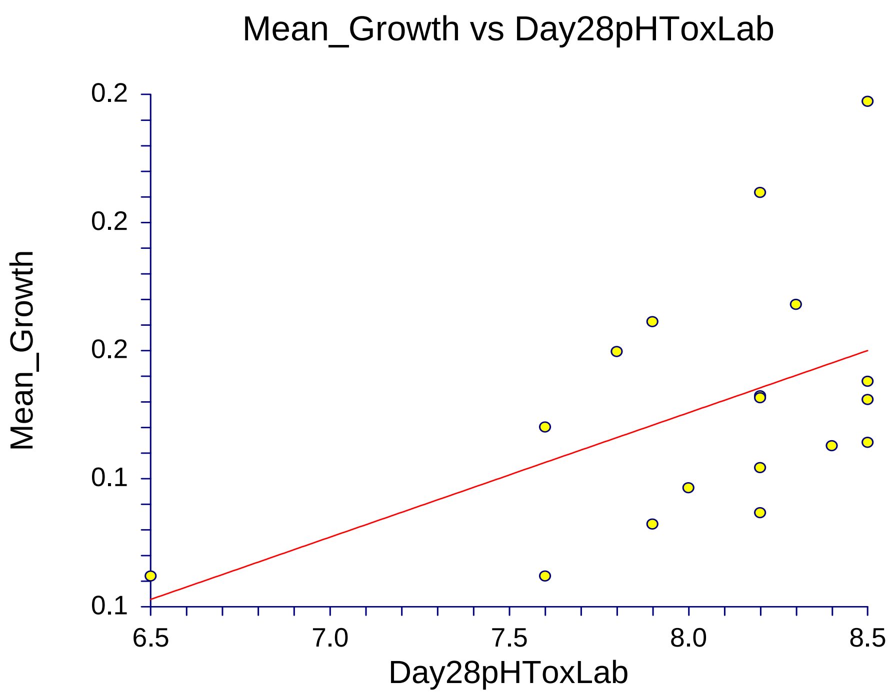




Linear Regression Report

Page/Date/Time 1 4/13/2009 2:41:58 PM
Database
Y = Mean_Growth X = Day28pHToxLab

Linear Regression Plot Section



Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	Mean_Growth	Rows Processed	18
Independent Variable	Day28pHToxLab	Rows Used in Estimation	18
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	-0.1190	Rows Prediction Only	0
Slope	0.0340	Sum of Frequencies	18
R-Squared	0.2428	Sum of Weights	18.0000
Correlation	0.4928	Coefficient of Variation	0.1944
Mean Square Error	9.06565E-04	Square Root of MSE	3.010922E-02

Linear Regression Report

Page/Date/Time 2 4/13/2009 2:41:58 PM
Y = Mean_Growth X = Day28pHToxLab

Summary Statement

The equation of the straight line relating Mean_Growth and Day28pHToxLab is estimated as: Mean_Growth = (-0.1190) + (0.0340) Day28pHToxLab using the 18 observations in this dataset. The y-intercept, the estimated value of Mean_Growth when Day28pHToxLab is zero, is -0.1190 with a standard error of 0.1211. The slope, the estimated change in Mean_Growth per unit change in Day28pHToxLab, is 0.0340 with a standard error of 0.0150. The value of R-Squared, the proportion of the variation in Mean_Growth that can be accounted for by variation in Day28pHToxLab, is 0.2428. The correlation between Mean_Growth and Day28pHToxLab is 0.4928.

A significance test that the slope is zero resulted in a t-value of 2.2652. The significance level of this t-test is 0.0377. Since 0.0377 < 0.0500, the hypothesis that the slope is zero is rejected.

The estimated slope is 0.0340. The lower limit of the 95% confidence interval for the slope is 0.0022 and the upper limit is 0.0658. The estimated intercept is -0.1190. The lower limit of the 95% confidence interval for the intercept is -0.3757 and the upper limit is 0.1378.

Descriptive Statistics Section

Parameter	**Dependent**	**Independent**
Variable	Mean_Growth	Day28pHToxLab
Count	18	18
Mean	0.1549	8.0556
Standard Deviation	0.0336	0.4866
Minimum	0.1084	6.5000
Maximum	0.2381	8.5000

Linear Regression Report

Page/Date/Time 3 4/13/2009 2:41:58 PM
Database
Y = Mean_Growth X = Day28pHToxLab

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	-0.1190	0.0340
Lower 95% Confidence Limit	-0.3757	0.0022
Upper 95% Confidence Limit	0.1378	0.0658
Standard Error	0.1211	0.0150
Standardized Coefficient	0.0000	0.4928
T Value	-0.9824	2.2652
Prob Level (T Test)	0.3405	0.0377
Reject H0 (Alpha = 0.0500)	No	Yes
Power (Alpha = 0.0500)	0.1522	0.5668
Regression of Y on X	-0.1190	0.0340
Inverse Regression from X on Y	-0.9730	0.1400
Orthogonal Regression of Y and X	-0.1200	0.0341

Notes:
The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(-.118979983434542) + (3.39975151849782E-02) * (Day28pHToxLab)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	0.4318302	0.4318302			
Slope	1	4.651578E-03	4.651578E-03	5.1310	0.0377	0.5668
Error	16	1.450504E-02	9.06565E-04			
Lack of Fit	7	2.251582E-03	3.216546E-04	0.2363	0.9649	
Pure Error	9	1.225346E-02	1.361495E-03			
Adj. Total	17	1.915662E-02	1.12686E-03			
Total	18	0.4509868				

s = Square Root(9.06565E-04) = 3.010922E-02

Notes:
The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 4/13/2009 2:41:58 PM
Database
Y = Mean_Growth X = Day28pHToxLab

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.9070	0.076190	No
Anderson Darling	0.5711	0.138580	No
D'Agostino Skewness	1.8402	0.065737	No
D'Agostino Kurtosis	0.5935	0.552823	Yes
D'Agostino Omnibus	3.7387	0.154227	No
Constant Residual Variance?			
Modified Levene Test	0.0308	0.862970	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(7, 9) Test	0.2363	0.964857	Yes

No Serial Correlation?
Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:
A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.
A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say N > 500) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

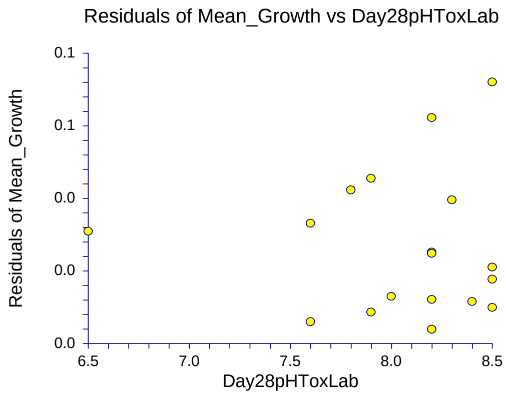
Normality and Constant Residual Variance:
Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

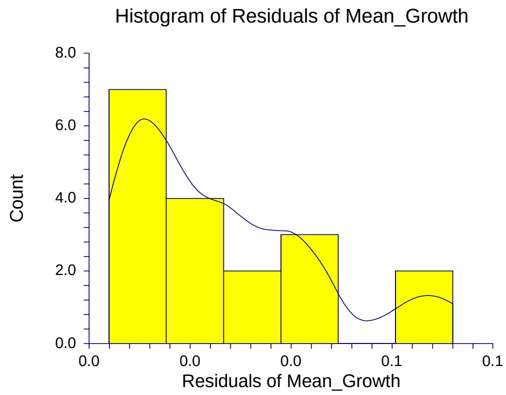
Straight-Line:
Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

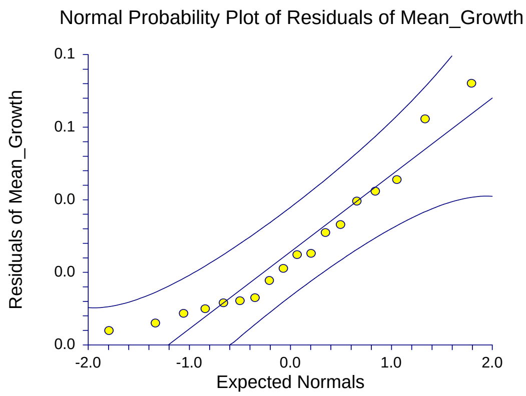
Linear Regression Report

Page/Date/Time 5 4/13/2009 2:41:58 PM
Database
Y = Mean_Growth X = Day28pHToxLab

Residual Plots Section

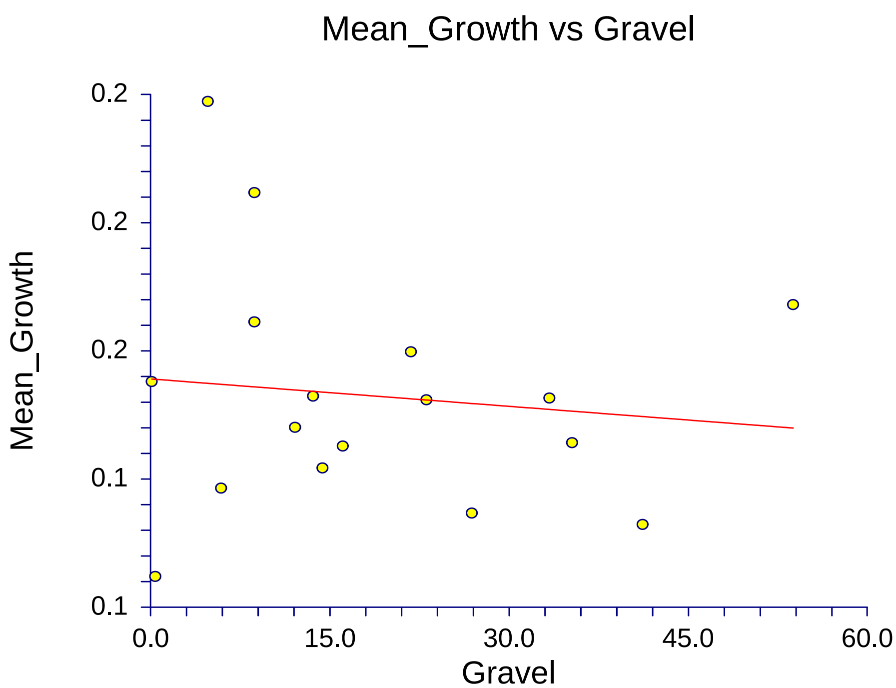






Page/Date/Time 1 4/8/2009 9:08:49 AM
Database
Y = Mean_Growth X = Gravel

Linear Regression Plot Section



Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	Mean_Growth	Rows Processed	17
Independent Variable	Gravel	Rows Used in Estimation	17
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.1623	Rows Prediction Only	0
Slope	-0.0002	Sum of Frequencies	17
R-Squared	0.0135	Sum of Weights	17.0000
Correlation	-0.1161	Coefficient of Variation	0.2113
Mean Square Error	1.109406E-03	Square Root of MSE	3.330775E-02

Linear Regression Report

Page/Date/Time 2 4/8/2009 9:08:49 AM
Y = Mean_Growth X = Gravel

Summary Statement
The equation of the straight line relating Mean_Growth and Gravel is estimated as: Mean_Growth = (0.1623) + (-0.0002) Gravel using the 17 observations in this dataset. The y-intercept, the estimated value of Mean_Growth when Gravel is zero, is 0.1623 with a standard error of 0.0131. The slope, the estimated change in Mean_Growth per unit change in Gravel, is -0.0002 with a standard error of 0.0006. The value of R-Squared, the proportion of the variation in Mean_Growth that can be accounted for by variation in Gravel, is 0.0135. The correlation between Mean_Growth and Gravel is -0.1161.

A significance test that the slope is zero resulted in a t-value of -0.4525. The significance level of this t-test is 0.6574. Since 0.6574 > 0.0500, the hypothesis that the slope is zero is not rejected.

The estimated slope is -0.0002. The lower limit of the 95% confidence interval for the slope is -0.0014 and the upper limit is 0.0009. The estimated intercept is 0.1623. The lower limit of the 95% confidence interval for the intercept is 0.1343 and the upper limit is 0.1903.

Descriptive Statistics Section

Parameter	**Dependent**	**Independent**
Variable	Mean_Growth	Gravel
Count	17	17
Mean	0.1576	18.8412
Standard Deviation	0.0325	15.1214
Minimum	0.1084	0.1000
Maximum	0.2381	53.8000

Linear Regression Report

Page/Date/Time 3 4/8/2009 9:08:49 AM
Database
Y = Mean_Growth X = Gravel

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.1623	-0.0002
Lower 95% Confidence Limit	0.1343	-0.0014
Upper 95% Confidence Limit	0.1903	0.0009
Standard Error	0.0131	0.0006
Standardized Coefficient	0.0000	-0.1161
T Value	12.3442	-0.4525
Prob Level (T Test)	0.0000	0.6574
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	1.0000	0.0709
Regression of Y on X	0.1623	-0.0002
Inverse Regression from X on Y	0.5062	-0.0185
Orthogonal Regression of Y and X	0.1623	-0.0002

Notes:
The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model
(.162318585672821) + (-2.49191247074504E-04) * (Gravel)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	0.422368	0.422368			
Slope	1	2.271793E-04	2.271793E-04	0.2048	0.6574	0.0709
Error	15	1.664109E-02	1.109406E-03			
Lack of Fit	14	1.601805E-02	1.144146E-03	1.8364	0.5273	
Pure Error	1	6.23045E-04	6.23045E-04			
Adj. Total	16	1.686827E-02	1.054267E-03			
Total	17	0.4392363				

s = Square Root(1.109406E-03) = 3.330775E-02

Notes:
The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 4/8/2009 9:08:49 AM
Database
Y = Mean_Growth X = Gravel

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.9449	0.381234	Yes
Anderson Darling	0.4231	0.319817	Yes
D'Agostino Skewness	1.5806	0.113973	No
D'Agostino Kurtosis	1.0627	0.287938	Yes
D'Agostino Omnibus	3.6275	0.163043	No
Constant Residual Variance?			
Modified Levene Test	1.4168	0.252425	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(14, 1) Test	1.8364	0.527258	Yes

No Serial Correlation?
Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:
A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.
A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say N > 500) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

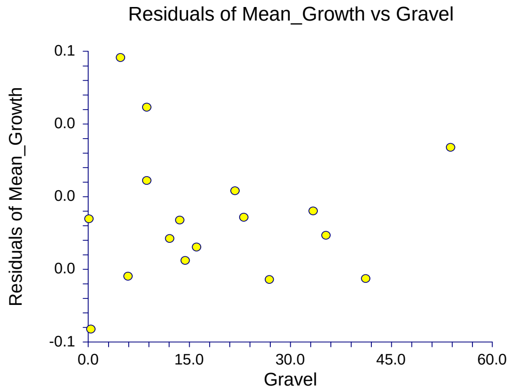
Normality and Constant Residual Variance:
Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

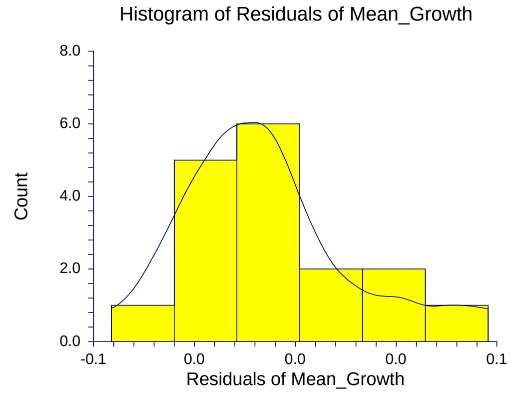
Straight-Line:
Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

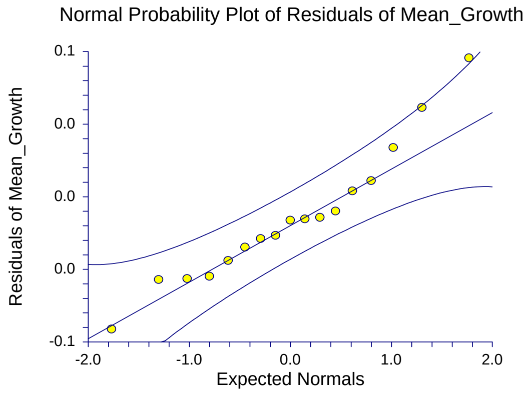
Linear Regression Report

Page/Date/Time 5 4/8/2009 9:08:49 AM
Database
Y = Mean_Growth X = Gravel

Residual Plots Section



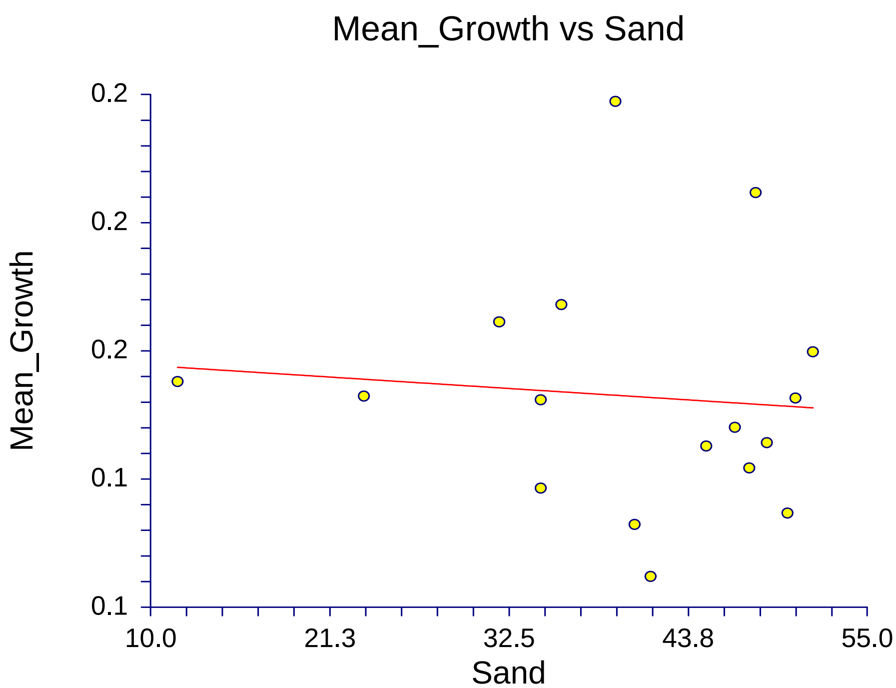




Linear Regression Report

Page/Date/Time 1 3/4/2009 1:41:20 PM
Database
Y = Mean_Growth X = Sand

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Mean_Growth	Rows Processed	17
Independent Variable	Sand	Rows Used in Estimation	17
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.1687	Rows Prediction Only	0
Slope	-0.0003	Sum of Frequencies	17
R-Squared	0.0084	Sum of Weights	17.0000
Correlation	-0.0914	Coefficient of Variation	0.2119
Mean Square Error	1.115152E-03	Square Root of MSE	0.0333939

Linear Regression Report

Page/Date/Time 2 3/4/2009 1:41:20 PM
Y = Mean_Growth X = Sand

Summary Statement

The equation of the straight line relating Mean_Growth and Sand is estimated as: Mean_Growth = (0.1687) + (-0.0003) Sand using the 17 observations in this dataset. The y-intercept, the estimated value of Mean_Growth when Sand is zero, is 0.1687 with a standard error of 0.0323. The slope, the estimated change in Mean_Growth per unit change in Sand, is -0.0003 with a standard error of 0.0008. The value of R-Squared, the proportion of the variation in Mean_Growth that can be accounted for by variation in Sand, is 0.0084. The correlation between Mean_Growth and Sand is -0.0914.

A significance test that the slope is zero resulted in a t-value of -0.3556. The significance level of this t-test is 0.7271. Since 0.7271 > 0.0500, the hypothesis that the slope is zero is not rejected.

The estimated slope is -0.0003. The lower limit of the 95% confidence interval for the slope is -0.0019 and the upper limit is 0.0014. The estimated intercept is 0.1687. The lower limit of the 95% confidence interval for the intercept is 0.1000 and the upper limit is 0.2375.

Descriptive Statistics Section

Parameter	**Dependent**	**Independent**
Variable	Mean_Growth	Sand
Count	17	17
Mean	0.1576	40.0471
Standard Deviation	0.0325	10.7065
Minimum	0.1084	11.7000
Maximum	0.2381	51.6000

Linear Regression Report

Page/Date/Time 3 3/4/2009 1:41:20 PM
Database
Y = Mean_Growth X = Sand

Regression Estimation Section

Parameter	**Intercept B(0)**	**Slope B(1)**
Regression Coefficients	0.1687	-0.0003
Lower 95% Confidence Limit	0.1000	-0.0019
Upper 95% Confidence Limit	0.2375	0.0014
Standard Error	0.0323	0.0008
Standardized Coefficient	0.0000	-0.0914
T Value	5.2302	-0.3556
Prob Level (T Test)	0.0001	0.7271
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	0.9982	0.0628
Regression of Y on X	0.1687	-0.0003
Inverse Regression from X on Y	1.4861	-0.0332
Orthogonal Regression of Y and X	0.1687	-0.0003

Notes:
The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model
(.168726783709757) + (-2.77255174891118E-04) * (Sand)

Analysis of Variance Section

Source	**DF**	**Sum of Squares**	**Mean Square**	**F-Ratio**	**Prob Level**	**Power (5%)**
Intercept	1	0.422368	0.422368			
Slope	1	1.409867E-04	1.409867E-04	0.1264	0.7271	0.0628
Error	15	1.672728E-02	1.115152E-03			
Lack of Fit	14	1.643688E-02	1.174063E-03	4.0428	0.3733	
Pure Error	1	2.90405E-04	2.90405E-04			
Adj. Total	16	1.686827E-02	1.054267E-03			
Total	17	0.4392363				

s = Square Root(1.115152E-03) = 0.0333939

Notes:
The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 3/4/2009 1:41:20 PM
Database
Y = Mean_Growth X = Sand

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.9207	0.151781	No
Anderson Darling	0.5535	0.153594	No
D'Agostino Skewness	1.9575	0.050284	No
D'Agostino Kurtosis	1.3687	0.171106	No
D'Agostino Omnibus	5.7052	0.057694	No
Constant Residual Variance?			
Modified Levene Test	0.5512	0.469312	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(14, 1) Test	4.0428	0.373333	Yes

No Serial Correlation?
Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:
A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.
A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say N > 500) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

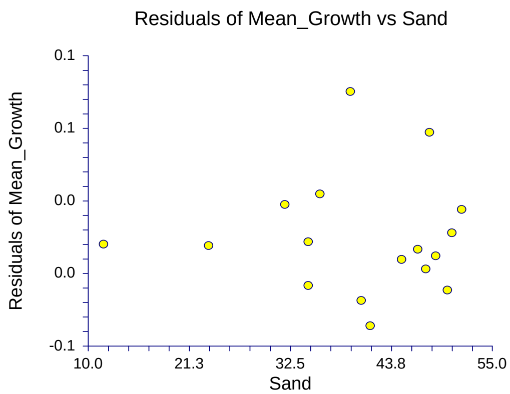
Normality and Constant Residual Variance:
Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

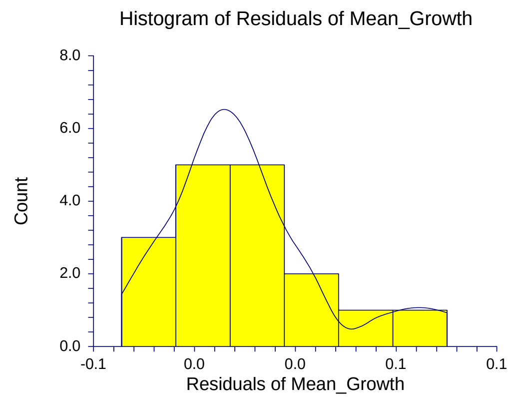
Straight-Line:
Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

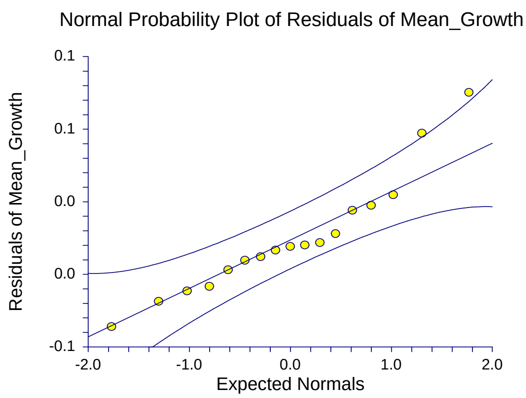
Linear Regression Report

Page/Date/Time 5 3/4/2009 1:41:20 PM
Database
Y = Mean_Growth X = Sand

Residual Plots Section

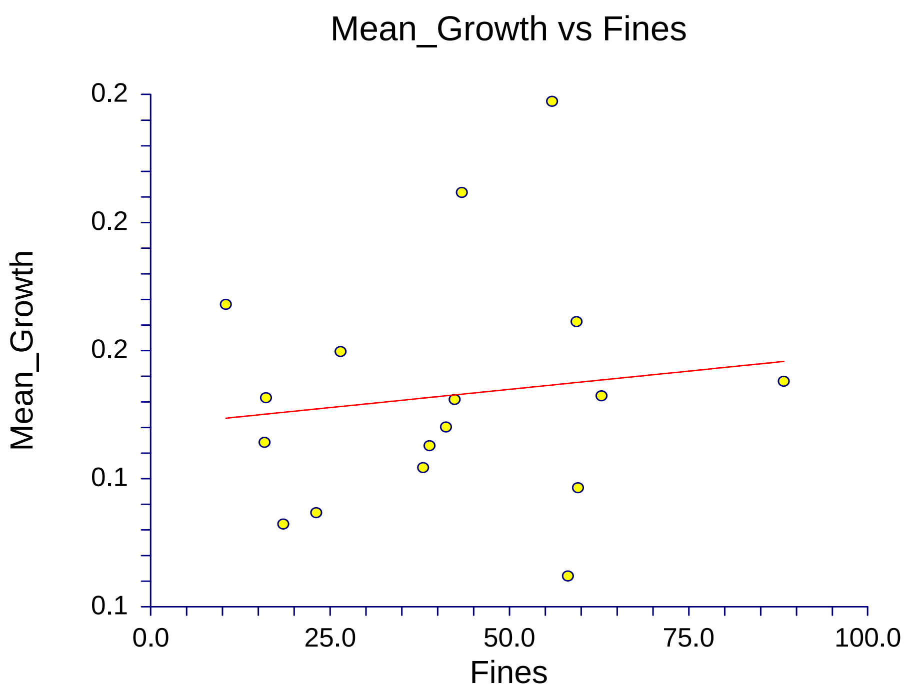






Page/Date/Time 1 4/8/2009 8:13:52 AM
Database
Y = Mean_Growth X = Fines

Linear Regression Plot Section



Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	Mean_Growth	Rows Processed	17
Independent Variable	Fines	Rows Used in Estimation	17
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.1494	Rows Prediction Only	0
Slope	0.0002	Sum of Frequencies	17
R-Squared	0.0168	Sum of Weights	17.0000
Correlation	0.1298	Coefficient of Variation	0.2109
Mean Square Error	1.105604E-03	Square Root of MSE	3.325062E-02

Linear Regression Report

Page/Date/Time 2 4/8/2009 8:13:52 AM
Y = Mean_Growth X = Fines

Summary Statement
The equation of the straight line relating Mean_Growth and Fines is estimated as: Mean_Growth = (0.1494) + (0.0002) Fines using the 17 observations in this dataset. The y-intercept, the estimated value of Mean_Growth when Fines is zero, is 0.1494 with a standard error of 0.0181. The slope, the estimated change in Mean_Growth per unit change in Fines, is 0.0002 with a standard error of 0.0004. The value of R-Squared, the proportion of the variation in Mean_Growth that can be accounted for by variation in Fines, is 0.0168. The correlation between Mean_Growth and Fines is 0.1298.

A significance test that the slope is zero resulted in a t-value of 0.5070. The significance level of this t-test is 0.6195. Since 0.6195 > 0.0500, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0002. The lower limit of the 95% confidence interval for the slope is -0.0006 and the upper limit is 0.0010. The estimated intercept is 0.1494. The lower limit of the 95% confidence interval for the intercept is 0.1109 and the upper limit is 0.1879.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Mean_Growth	Fines
Count	17	17
Mean	0.1576	41.1118
Standard Deviation	0.0325	21.1548
Minimum	0.1084	10.5000
Maximum	0.2381	88.3000

Linear Regression Report

Page/Date/Time 3 4/8/2009 8:13:52 AM
Database
Y = Mean_Growth X = Fines

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.1494	0.0002
Lower 95% Confidence Limit	0.1109	-0.0006
Upper 95% Confidence Limit	0.1879	0.0010
Standard Error	0.0181	0.0004
Standardized Coefficient	0.0000	0.1298
T Value	8.2762	0.5070
Prob Level (T Test)	0.0000	0.6195
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	1.0000	0.0763
Regression of Y on X	0.1494	0.0002
Inverse Regression from X on Y	-0.3285	0.0118
Orthogonal Regression of Y and X	0.1494	0.0002

Notes:
The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model
(.149432894131085) + (1.99228501604742E-04) * (Fines)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	0.422368	0.422368			
Slope	1	2.842105E-04	2.842105E-04	0.2571	0.6195	0.0763
Error	15	1.658406E-02	1.105604E-03			
Adj. Total	16	1.686827E-02	1.054267E-03			
Total	17	0.4392363				

s = Square Root(1.105604E-03) = 3.325062E-02

Notes:
The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.9363	0.276818	Yes
Anderson Darling	0.4828	0.230008	Yes
D'Agostino Skewness	1.7045	0.088282	No
D'Agostino Kurtosis	1.1498	0.250211	Yes
D'Agostino Omnibus	4.2276	0.120781	No
Constant Residual Variance?			
Modified Levene Test	1.9099	0.187210	No
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?
Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:
A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.
A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say N > 500) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

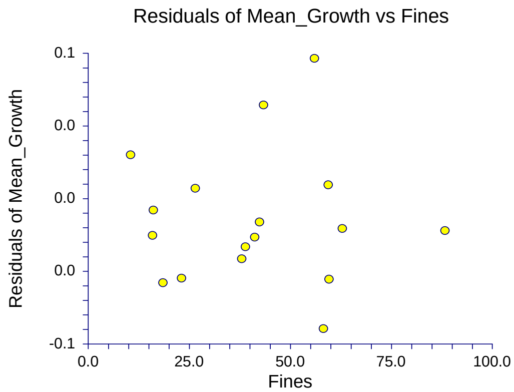
Normality and Constant Residual Variance:
Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

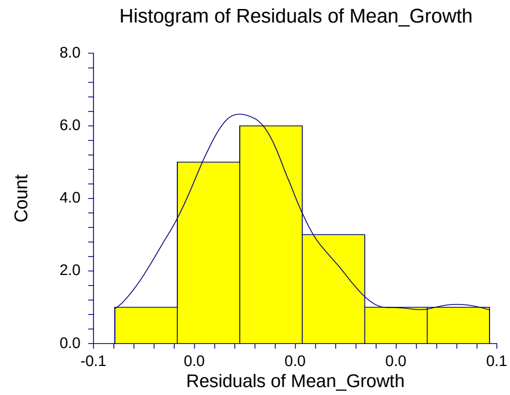
Straight-Line:
Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

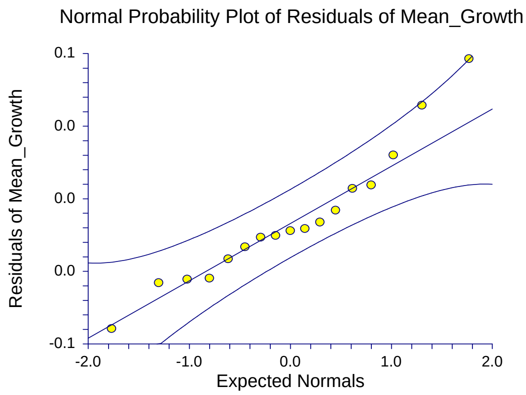
Linear Regression Report

Page/Date/Time 5 4/8/2009 8:13:52 AM
Database
Y = Mean_Growth X = Fines

Residual Plots Section







MULTIPLE REGRESSIONS

All Possible Regression Report

Page/Date/Time 1 5/24/2009 7:50:35 PM
Database C:\Documents and Settings\hg ... U 1 1208\SWMU 1 full data.S0
Dependent AsinSqrt_Surv

All Possible Results Section

Model Size	**R-Squared**	**Root MSE**	**Cp**	**Model**
1	0.353824	0.1098061	73.436840	J (TOC)
1	0.334357	0.1114479	76.040864	K (Day1pHToxLab)
1	0.226548	0.1201346	90.462158	L (Day28pHToxLab)
1	0.124287	0.1278298	104.141327	G (Lead)
1	0.085901	0.1306014	109.276074	D (Antimony)
1	0.070356	0.1317073	111.355520	E (Cadmium)
1	0.065838	0.1320269	111.959824	I (Mercury)
1	0.040417	0.1338112	115.360282	A (DDD)
1	0.036993	0.1340498	115.818352	B (DDE)
1	0.028725	0.134624	116.924354	C (DDT)
1	0.007224	0.1361059	119.800363	H (Zinc)
1	0.004387	0.1363002	120.179937	F (Copper)
2	0.561375	9.364391E-02	47.673437	HJ
2	0.472546	0.1026893	59.555806	JK
2	0.468158	0.1031156	60.142838	JL
2	0.445430	0.1052958	63.183084	GK
2	0.426882	0.1070421	65.664109	DK
2	0.426569	0.1070714	65.705987	BJ
2	0.417071	0.1079544	66.976462	FJ
2	0.416137	0.108041	67.101517	GL
2	0.405604	0.1090111	68.510406	AJ
2	0.403061	0.109244	68.850543	EK
3	0.652892	8.644849E-02	37.431486	AHJ
3	0.649338	8.688992E-02	37.906876	CHJ
3	0.643058	8.766451E-02	38.746915	BHJ
3	0.642320	0.0877552	38.845756	GHJ
3	0.636250	8.849668E-02	39.657713	GHK
3	0.635503	8.858744E-02	39.757571	HJK
3	0.602779	9.247867E-02	44.135025	FHJ
3	0.598265	9.300254E-02	44.738727	HIJ
3	0.598167	9.301393E-02	44.751899	EHJ
3	0.590458	9.390192E-02	45.783119	HJL
4	0.797138	6.878708E-02	20.136220	BGHJ
4	0.764715	7.408034E-02	24.473248	BEHJ
4	0.761430	0.0745957	24.912675	GHJK
4	0.733222	7.888267E-02	28.686083	AGHJ
4	0.730499	7.928416E-02	29.050267	CGHJ
4	0.709158	8.236352E-02	31.904995	BDHJ
4	0.708290	8.248634E-02	32.021114	EHJK
4	0.706084	8.279766E-02	32.316220	AHIJ
4	0.700617	8.356406E-02	33.047436	CHIJ

All Possible Regression Report

Database C:\Documents and Settings\hg ... U 1 1208\SWMU 1 full data.S0
Dependent AsinSqrt_Surv

All Possible Results Section

Model Size	R-Squared	Root MSE	Cp	Model
4	0.700337	8.360322E-02	33.084978	AEHJ
5	0.875413	0.0563036	11.665540	BGHIJ
5	0.845020	6.279688E-02	15.731142	BGHJK
5	0.831400	6.549811E-02	17.553015	BDEHJ
5	0.820678	0.0675487	18.987284	BCGHJ
5	0.818333	6.798892E-02	19.300954	BGHJL
5	0.815341	6.854657E-02	19.701226	ABGHJ
5	0.815261	6.856149E-02	19.711986	DEGIJ
5	0.810120	6.950884E-02	20.399613	BFGHJ
5	0.807694	0.0699515	20.724160	BEHJK
5	0.805989	7.026091E-02	20.952229	BDGHJ
6	0.907971	5.075273E-02	9.310429	BEGHIJ
6	0.902538	5.222937E-02	10.037190	BCGHIJ
6	0.899418	5.305871E-02	10.454509	BGHIJK
6	0.896765	5.375395E-02	10.809410	BDGHIJ
6	0.894595	5.431592E-02	11.099663	ABGHIJ
6	0.886918	5.625923E-02	12.126624	BGHIJL
6	0.885305	5.665899E-02	12.342355	DEGHIJ
6	0.882218	5.741638E-02	12.755277	BFGHIJ
6	0.875732	5.897621E-02	13.622950	BCGHJK
6	0.873459	5.951319E-02	13.927033	AEGHIJ
7	0.944203	4.165647E-02	6.463831	ABCGHIJ
7	0.931892	0.0460231	8.110637	BCGHIJL
7	0.931531	4.614471E-02	8.158846	BCGHIJK
7	0.925039	4.828289E-02	9.027285	BEGHIJK
7	0.924488	4.845994E-02	9.100961	ABGHIJK
7	0.923920	4.864193E-02	9.176972	ABGHIJL
7	0.917687	5.059524E-02	10.010730	BCEGHIJ
7	0.917323	5.070696E-02	10.059413	BDEGHIJ
7	0.916152	5.106486E-02	10.216082	BEGHIJL
7	0.915242	5.134121E-02	10.337807	BDGHIJK
8	0.958743	3.799291E-02	6.518862	ABCGHIJK
8	0.954196	4.003164E-02	7.127045	ABCGHIJL
8	0.952584	4.073007E-02	7.342707	ABCEGHIJ
8	0.950363	4.167279E-02	7.639716	ABCDGHIJ
8	0.947205	4.297802E-02	8.062153	ABCFGHIJ
8	0.946578	4.323249E-02	8.146031	BCGHIJKL
8	0.939855	4.587246E-02	9.045416	BCEGHIJK
8	0.939640	4.595438E-02	9.074177	ABGHIJKL
8	0.938222	4.649084E-02	9.263789	BCEGHIJL

All Possible Regression Report

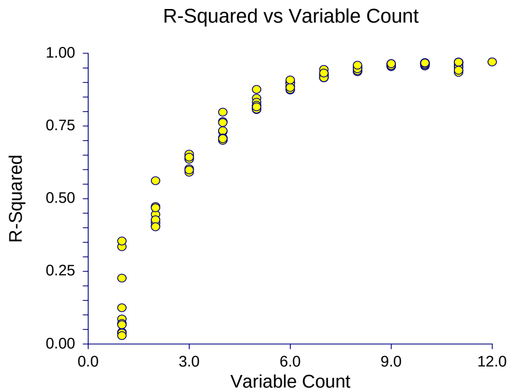
Page/Date/Time 3 5/24/2009 7:50:35 PM
Database C:\Documents and Settings\hg ... U 1 1208\SWMU 1 full data.S0
Dependent AsinSqrt_Surv

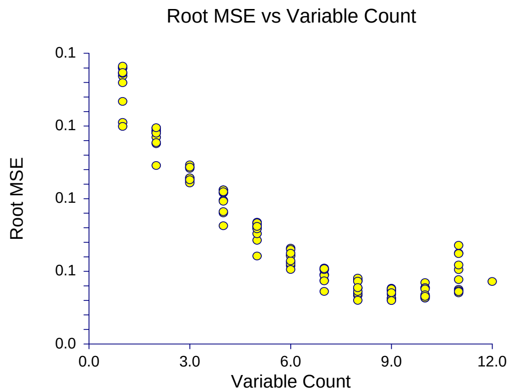
All Possible Results Section

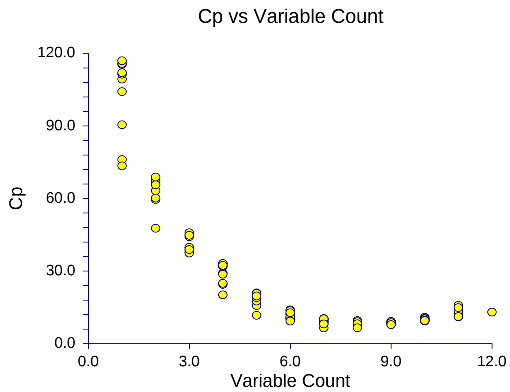
Model Size	R-Squared	Root MSE	Cp	Model
8	0.936453	4.715176E-02	9.500416	BCDGHIJK
9	0.964052	3.791293E-02	7.808695	ABCEGHIJK
9	0.963942	3.797067E-02	7.823351	ABCGHIJKL
9	0.962394	3.877728E-02	8.030454	ABCDGHIJK
9	0.962067	0.0389456	8.074218	ABCFGHIJK
9	0.959159	4.041085E-02	8.463218	ABCEGHIJL
9	0.957705	4.112367E-02	8.657650	ABCDGHIJL
9	0.955721	4.207725E-02	8.923074	ABCEFGHIJ
9	0.955710	4.208241E-02	8.924528	ABCFGHIJL
9	0.954403	4.269885E-02	9.099366	ABCDFGHIJ
9	0.953774	4.299245E-02	9.183536	ABCDEGHIJ
10	0.967514	3.892877E-02	9.345574	ABCEGHIJKL
10	0.967456	0.0389634	9.353307	ABCEFGHIJK
10	0.966532	0.0395128	9.476941	ABCDFGHIJK
10	0.966307	3.964509E-02	9.506967	ABCDGHIJKL
10	0.966030	0.0398079	9.544061	ABCFGHIJKL
10	0.965221	4.027938E-02	9.652337	ABCDEGHIJK
10	0.960983	4.266289E-02	10.219225	ABCEFGHIJL
10	0.960044	4.317312E-02	10.344814	ABCDEGHIJL
10	0.960014	4.318914E-02	10.348781	ABCDFGHIJL
10	0.955987	4.531167E-02	10.887430	ABCDEFGHIJ
11	0.969865	4.107231E-02	11.031091	ABCEFGHIJKL
11	0.969115	4.158003E-02	11.131368	ABCDFGHIJKL
11	0.968457	4.202062E-02	11.219386	ABCDEGHIJKL
11	0.967685	0.0425317	11.322648	ABCDEFGHIJK
11	0.961248	4.657554E-02	12.183705	ABCDEFGHIJL
11	0.954089	5.069562E-02	13.141370	BCDEFGHIJKL
11	0.950569	5.260297E-02	13.612185	ABDEFGHIJKL
11	0.941433	5.725817E-02	14.834285	ABCDEFHIJKL
11	0.941005	5.746734E-02	14.891627	ABCDEFGHJKL
11	0.934218	6.068258E-02	15.799389	ACDEFGHIJKL
12	0.970097	4.574281E-02	13.000000	ABCDEFGHIJKL

Page/Date/Time 4 5/24/2009 7:50:35 PM
Database C:\Documents and Settings\hg ... U 1 1208\SWMU 1 full data.S0
Dependent AsinSqrt_Surv

Plots Section







Multiple Regression Report

Page/Date/Time 1 5/27/2009 9:17:24 AM
Database C:\Documents and Settings\hg ... U 1 1208\SWMU 1 full data.S0
Dependent AsinSqrt_Surv

Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	AsinSqrt_Surv	Rows Processed	18
Number Ind. Variables	5	Rows Filtered Out	0
Weight Variable	None	Rows with X's Missing	1
R2	0.8754	Rows with Weight Missing	0
Adj R2	0.8188	Rows with Y Missing	0
Coefficient of Variation	0.0388	Rows Used in Estimation	17
Mean Square Error	3.170095E-03	Sum of Weights	17.000
Square Root of MSE	0.0563036	Completion Status	Normal Completion
Ave Abs Pct Error	2.467		

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Minimum	Maximum
DDE	17	1674.964	2441.223	0.38	9100
Lead	17	700.3941	819.9776	3.8	2600
Mercury	17	0.5831177	1.331343	0.025	5.7
TOC	17	4.471588	2.586933	0.647	9.51
Zinc	17	1498.765	1701.946	38	5410
AsinSqrt_Surv	17	1.449412	0.1322626	1.06	1.57

Regression Equation Section

Independent Variable	Regression Coefficient b(i)	Standard Error Sb(i)	T-Value to test H0:B(i)=0	Prob Level	Reject H0 at 5%?	Power of Test at 5%
Intercept	1.3206	0.0300	43.977	0.0000	Yes	1.0000
DDE	0.0000	0.0000	-4.029	0.0020	Yes	0.9552
Lead	0.0001	0.0000	4.020	0.0020	Yes	0.9545
Mercury	-0.0349	0.0133	-2.629	0.0235	Yes	0.6683
TOC	0.0507	0.0080	6.358	0.0001	Yes	0.9999
Zinc	-0.0001	0.0000	-6.086	0.0001	Yes	0.9998

Estimated Model

1.32058449464751-2.4894105946469E-05*DDE+ 9.68088473381208E-05*Lead-3.48615475738179E-02*Mercury+
5.06988097727982E-02*TOC-6.91610730612636E-05*Zinc

Multiple Regression Report

Page/Date/Time	2 5/27/2009 9:17:24 AM
Database	C:\Documents and Settings\hg ... U 1 1208\SWMU 1 full data.S0
Dependent	AsinSqrt_Surv

Regression Coefficient Section

Independent Variable	Regression Coefficient	Standard Error	Lower 95% C.L.	Upper 95% C.L.	Standardized Coefficient
Intercept	1.3206	0.0300	1.2545	1.3867	0.0000
DDE	0.0000	0.0000	0.0000	0.0000	-0.4595
Lead	0.0001	0.0000	0.0000	0.0001	0.6002
Mercury	-0.0349	0.0133	-0.0640	-0.0057	-0.3509
TOC	0.0507	0.0080	0.0331	0.0682	0.9916
Zinc	-0.0001	0.0000	-0.0001	0.0000	-0.8900

Note: The T-Value used to calculate these confidence limits was 2.201.

Analysis of Variance Section

Source	DF	R2	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1		35.7135	35.7135			
Model	5	0.8754	0.2450231	4.900461E-02	15.458	0.0001	0.9999
Error	11	0.1246	3.487105E-02	3.170095E-03			
Total(Adjusted)	16	1.0000	0.2798941	1.749338E-02			

Analysis of Variance Detail Section

Model Term	DF	R2	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1		35.7135	35.7135			
Model	5	0.8754	0.2450231	4.900461E-02	15.458	0.0001	0.9999
DDE	1	0.1838	5.145803E-02	5.145803E-02	16.232	0.0020	0.9552
Lead	1	0.1830	5.122562E-02	5.122562E-02	16.159	0.0020	0.9545
Mercury	1	0.0783	0.0219089	0.0219089	6.911	0.0235	0.6683
TOC	1	0.4579	0.1281607	0.1281607	40.428	0.0001	0.9999
Zinc	1	0.4195	0.1174273	0.1174273	37.042	0.0001	0.9998
Error	11	0.1246	3.487105E-02	3.170095E-03			
Total(Adjusted)	16	1.0000	0.2798941	1.749338E-02			

Normality Tests Section

Test Name	Test Value	Prob Level	Reject H0 At Alpha = 20%?
Shapiro Wilk	0.9528	0.501973	No
Anderson Darling	0.3324	0.510808	No
D'Agostino Skewness	-1.4863	0.137199	Yes
D'Agostino Kurtosis	1.2711	0.203708	No
D'Agostino Omnibus	3.8247	0.147734	Yes

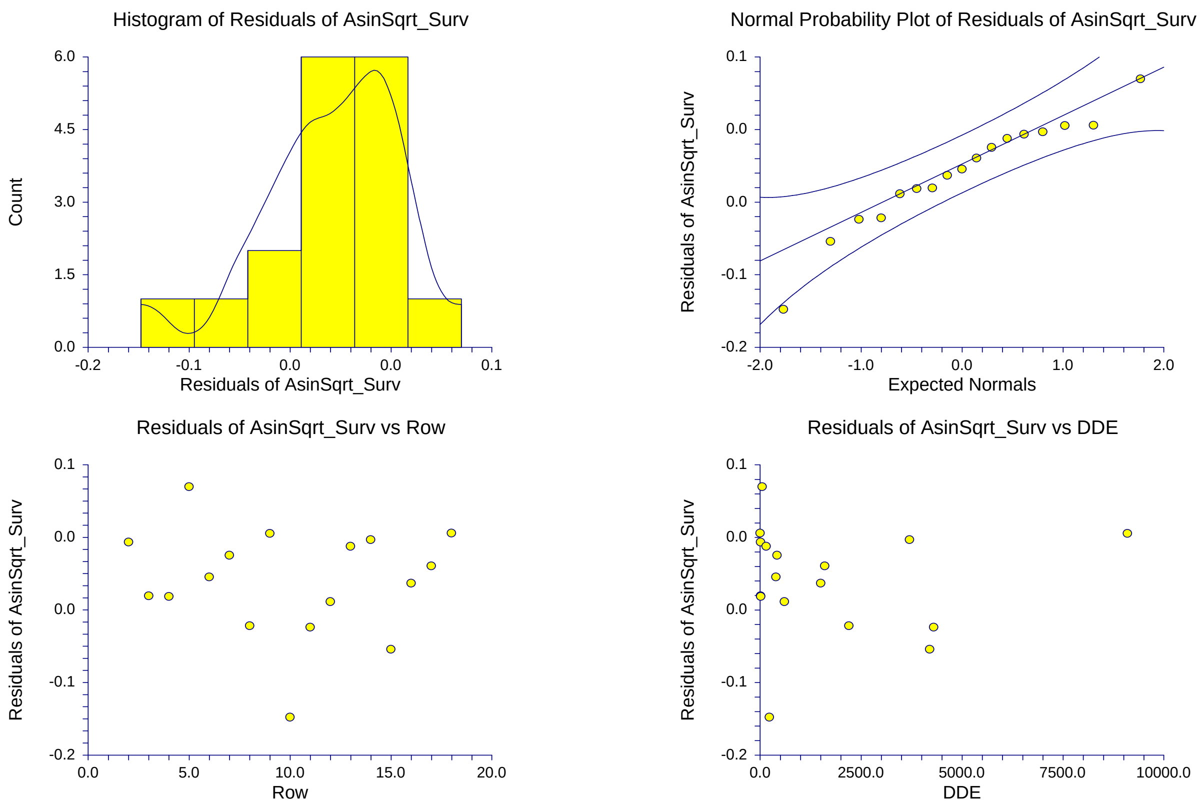
Multiple Regression Report

Page/Date/Time	3 5/27/2009 9:17:24 AM
Database	C:\Documents and Settings\hg ... U 1 1208\SWMU 1 full data.S0
Dependent	AsinSqrt_Surv

Regression Diagnostics Section

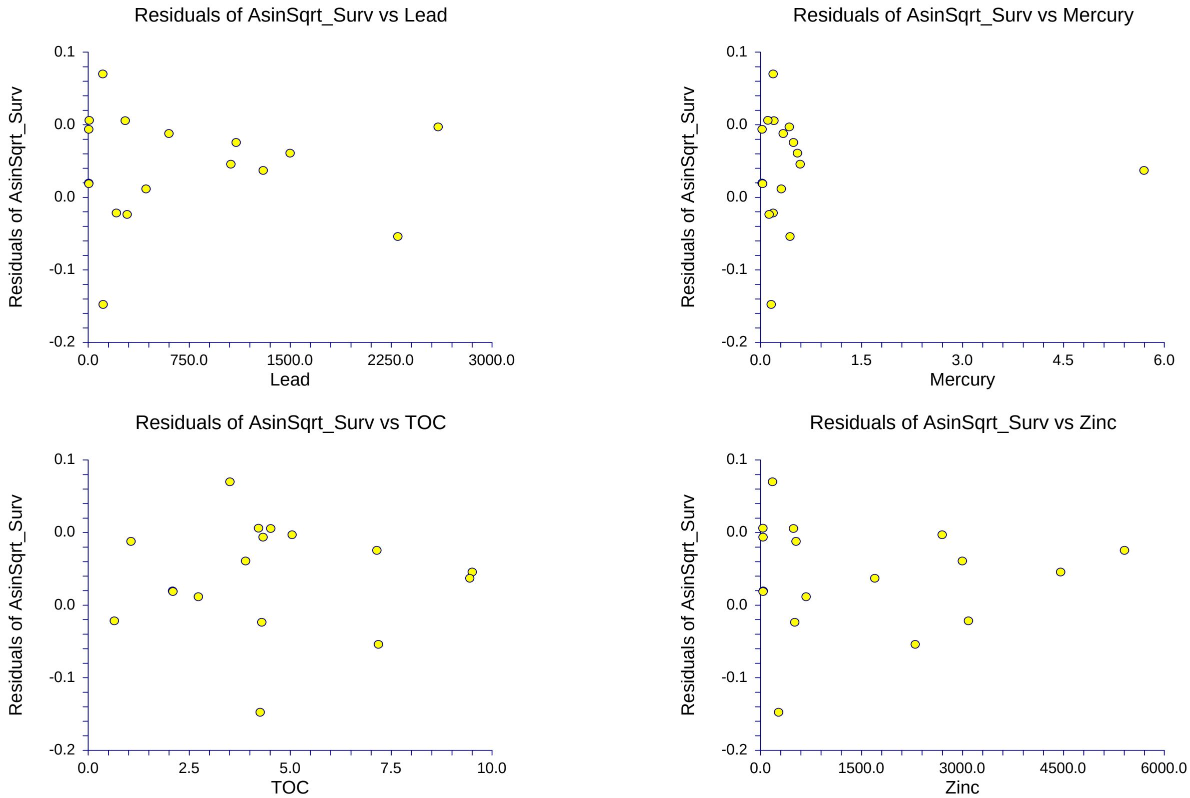
Row	Standardized Residual	RStudent	Hat Diagonal	Cook's D	Dffits	CovRatio
10	-2.2546	-2.9312	0.1457	0.1445	-1.2107	0.0502

Plots Section



Multiple Regression Report

Page/Date/Time	4 5/27/2009 9:17:24 AM
Database	C:\Documents and Settings\hg ... U 1 1208\SWMU 1 full data.S0
Dependent	AsinSqrt_Surv



All Possible Regression Report

Page/Date/Time 1 4/29/2009 11:06:25 AM
Database
Dependent Mean_Growth

All Possible Results Section

Model Size	R-Squared	Root MSE	Cp	Model
1	0.302512	2.800646E-02	5.462333	J (TOC)
1	0.203910	2.992063E-02	8.072294	K (Day28pHToxLab)
1	0.092133	0.0319522	11.030999	D (Antimony)
1	0.087087	3.204087E-02	11.164553	E (Cadmium)
1	0.064100	3.244175E-02	11.773016	F (Copper)
1	0.045355	3.276504E-02	12.269206	G (Lead)
1	0.008848	3.338564E-02	13.235518	H (Zinc)
1	0.004791	0.0334539	13.342913	I (Mercury___7471A__mg_Kg_)
1	0.000804	3.352085E-02	13.448455	C (X4_4__DDT)
1	0.000309	3.352914E-02	13.461540	B (X4_4__DDE)
1	0.000002	0.0335343	13.469674	A (X4_4__DDD)
2	0.511690	0.024256	1.925442	IJ
2	0.407803	2.671188E-02	4.675298	JK
2	0.352642	2.792823E-02	6.135388	EK
2	0.350894	2.796593E-02	6.181671	HJ
2	0.346890	2.805203E-02	6.287637	DK
2	0.314642	2.873624E-02	7.141237	FK
2	0.310634	2.882014E-02	7.247328	GJ
2	0.306481	2.890682E-02	7.357253	DJ
2	0.305270	2.893206E-02	7.389319	BJ
2	0.303075	2.897773E-02	7.447424	AJ
3	0.614893	2.235395E-02	1.193678	HIJ
3	0.609686	2.250458E-02	1.331520	IJK
3	0.524492	2.483949E-02	3.586581	FIJ
3	0.520684	2.493873E-02	3.687358	BIJ
3	0.520303	2.494865E-02	3.697448	GIJ
3	0.519090	2.498018E-02	3.729561	EIJ
3	0.515650	2.506936E-02	3.820610	AIJ
3	0.513440	2.512648E-02	3.879107	CIJ
3	0.512409	2.515309E-02	3.906394	DIJ
3	0.437284	2.702142E-02	5.894933	DJK
4	0.674398	2.139381E-02	1.618596	FHIJ
4	0.655074	0.0220195	2.130089	ACIJ
4	0.654096	0.0220507	2.155982	HIJK
4	0.629683	2.281559E-02	2.802198	AHIJ
4	0.627822	2.287285E-02	2.851462	DHIJ
4	0.627587	2.288006E-02	2.857675	BHIJ
4	0.626871	2.290204E-02	2.876627	DIJK
4	0.626501	0.0229134	2.886425	DEIJ
4	0.626379	2.291714E-02	2.889656	CHIJ
4	0.619086	2.313971E-02	3.082684	EHIJ

All Possible Regression Report

Page/Date/Time 2 4/29/2009 11:06:25 AM
Database
Dependent Mean_Growth

All Possible Results Section

Model Size	R-Squared	Root MSE	Cp	Model
5	0.717075	2.082928E-02	2.488940	FHIJK
5	0.701350	2.140033E-02	2.905192	ACHIJ
5	0.688259	0.0218643	3.251689	DFHIJ
5	0.686649	2.192072E-02	3.294329	DEIJK
5	0.685867	2.194803E-02	3.315012	AFHIJ
5	0.683868	2.201775E-02	3.367919	CFHIJ
5	0.681855	2.208776E-02	3.421220	BFHIJ
5	0.681148	2.211229E-02	3.439936	DHIJK
5	0.680080	2.214929E-02	3.468203	ACIJK
5	0.677460	0.0222398	3.537550	EFHIJ
6	0.746272	2.068806E-02	3.716118	DFHIJK
6	0.731419	2.128497E-02	4.109269	DEFHIJ
6	0.729473	2.136192E-02	4.160767	EFHIJK
6	0.726378	2.148379E-02	4.242707	ACDEIJ
6	0.723641	2.159097E-02	4.315150	ACFHIJ
6	0.722747	2.162585E-02	4.338807	FGHIJK
6	0.717986	2.181077E-02	4.464845	AFHIJK
6	0.717621	2.182486E-02	4.474499	CFHIJK
6	0.717584	2.182628E-02	4.475468	BFHIJK
6	0.712435	2.202435E-02	4.611760	ACDHIJ
7	0.779881	2.031155E-02	4.826498	DEFHIJK
7	0.762032	2.111901E-02	5.298958	ABCDIJK
7	0.760024	2.120792E-02	5.352105	DFGHIJK
7	0.752912	2.151987E-02	5.540347	ABCDHIJ
7	0.751869	2.156525E-02	5.567961	ACDEGIJ
7	0.750891	2.160773E-02	5.593859	BDFHIJK
7	0.746338	2.180427E-02	5.714357	ADFHIJK
7	0.746278	2.180685E-02	5.715950	CDFHIJK
7	0.744647	2.187683E-02	5.759120	DEFGHIJ
7	0.743919	2.190802E-02	5.778407	ACDEIJK
8	0.786595	2.121255E-02	6.648779	DEFGHIJK
8	0.783698	2.135601E-02	6.725446	CDEFHIJK
8	0.783045	2.138822E-02	6.742730	ADEFHIJK
8	0.780668	2.150508E-02	6.805653	BDEFHIJK
8	0.779179	2.157797E-02	6.845078	ABCDHIJK
8	0.774580	2.180151E-02	6.966806	ABCDEIJK
8	0.774555	2.180273E-02	6.967474	BCDFHIJK
8	0.772676	2.189341E-02	7.017217	CDEFGIJK
8	0.772132	2.191956E-02	7.031600	BDEFGIJK
8	0.769177	2.206123E-02	7.109821	ADEFGIJK

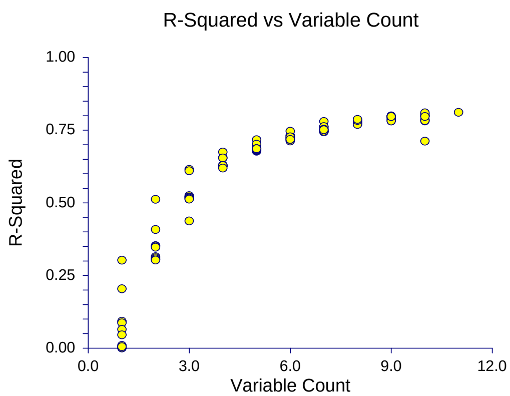
All Possible Regression Report

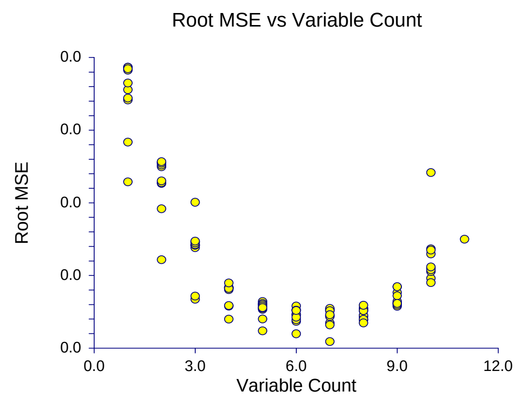
Page/Date/Time 3 4/29/2009 11:06:25 AM
Database
Dependent Mean_Growth

All Possible Results Section

Model Size	R-Squared	Root MSE	Cp	Model
9	0.798958	0.0220105	8.321535	CDEFGHIJK
9	0.797628	2.208317E-02	8.356732	ADEFGHIJK
9	0.796576	2.214051E-02	8.384584	ABCDFHIJK
9	0.796440	2.214791E-02	8.388188	BDEFGHIJK
9	0.795904	2.217702E-02	8.402357	ACDEFGIJK
9	0.794583	2.224871E-02	8.437341	ACDEFHIJK
9	0.789513	2.252157E-02	8.571530	BCDEFHIJK
9	0.786592	2.267732E-02	8.648855	ABDEFHIJK
9	0.781366	2.295329E-02	8.787177	ACDEFGHIJ
9	0.781335	2.295493E-02	8.788006	ABCDEGIJK
10	0.809291	2.315505E-02	10.048026	ACDEFGHIJK
10	0.805903	2.335981E-02	10.137700	ABCDEFHIJK
10	0.800472	2.368437E-02	10.281460	ABCDFGHIJK
10	0.799009	2.377102E-02	10.320174	BCDEFGHIJK
10	0.797709	2.384776E-02	10.354580	ABDEFGHIJK
10	0.796653	2.390997E-02	10.382553	ABCDEFGIJK
10	0.785908	2.453352E-02	10.666959	ABCEFGHIJK
10	0.782648	2.471962E-02	10.753260	ABCDEGHIJK
10	0.781537	2.478271E-02	10.782661	ABCDEFGHIJ
10	0.712050	2.845233E-02	12.621949	ABCDEFGHJK
11	0.811105	2.524414E-02	12.000000	ABCDEFGHIJK

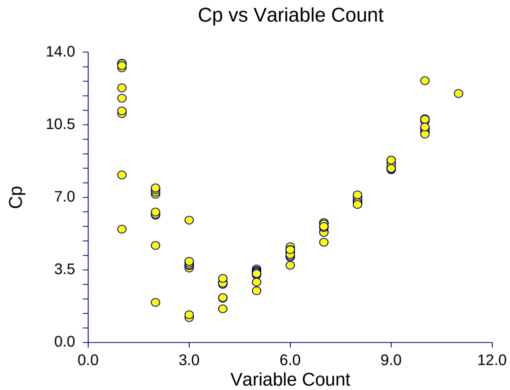
Plots Section





All Possible Regression Report

Page/Date/Time 4 4/29/2009 11:06:25 AM
Database
Dependent Mean_Growth



Multiple Regression Report

Page/Date/Time	1 4/30/2009 10:48:30 AM
Database	C:\Documents and Settings\hg ... U 1 1208\SWMU 1 full data.S0
Dependent	Mean_Growth

Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Mean_Growth	Rows Processed	18
Number Ind. Variables	4	Rows Filtered Out	0
Weight Variable	None	Rows with X's Missing	1
R2	0.6744	Rows with Weight Missing	0
Adj R2	0.5659	Rows with Y Missing	0
Coefficient of Variation	0.1357	Rows Used in Estimation	17
Mean Square Error	4.576951E-04	Sum of Weights	17.000
Square Root of MSE	2.139381E-02	Completion Status	Normal Completion
Ave Abs Pct Error	9.215		

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Minimum	Maximum
Copper	17	452.3882	580.1328	33	2340
Mercury	17	0.5831177	1.331343	0.025	5.7
TOC	17	4.471588	2.586933	0.647	9.51
Zinc	17	1498.765	1701.946	38	5410
Mean_Growth	17	0.1576235	3.246948E-02	0.1084	0.2381

Subset Selection Summary Section

No. Terms	No. X's	R-Squared Value	R-Squared Change
1	1	0.3025	0.3025
2	2	0.5117	0.2092
3	3	0.6149	0.1032
4	4	0.6744	0.0595
0	0	0.0000	-0.6744

Subset Selection Detail Section

Step	Action	No. of Terms	No. of X's	R2	Term Entered	Term Removed
0	Add	0	0	0.0000	Intercept	
1	Add	1	1	0.3025	TOC	
2	Add	2	2	0.5117	Mercury	
3	Add	3	3	0.6149	Zinc	
4	Add	4	4	0.6744	Copper	

Multiple Regression Report

Page/Date/Time	2 4/30/2009 10:48:30 AM
Database	C:\Documents and Settings\hg ... U 1 1208\SWMU 1 full data.S0
Dependent	Mean_Growth

Regression Equation Section

Independent Variable	Regression Coefficient b(i)	Standard Error Sb(i)	T-Value to test H0:B(i)=0	Prob Level	Reject H0 at 5%?	Power of Test at 5%
Intercept	0.1985	0.0112	17.716	0.0000	Yes	1.0000
Copper	0.0000	0.0000	-1.481	0.1644	No	0.2759
Mercury	0.0149	0.0050	2.994	0.0112	Yes	0.7847
TOC	-0.0133	0.0030	-4.487	0.0007	Yes	0.9840
Zinc	0.0000	0.0000	2.350	0.0367	Yes	0.5795

Estimated Model

.198453265930554-2.6804862288048E-05*Copper+ 1.49065673041851E-02*Mercury-1.33222125314183E-02*TOC+ 1.47959410262364E-05*Zinc

Regression Coefficient Section

Independent Variable	Regression Coefficient	Standard Error	Lower 95% C.L.	Upper 95% C.L.	Standardized Coefficient
Intercept	0.1985	0.0112	0.1740	0.2229	0.0000
Copper	0.0000	0.0000	-0.0001	0.0000	-0.4789
Mercury	0.0149	0.0050	0.0041	0.0258	0.6112
TOC	-0.0133	0.0030	-0.0198	-0.0069	-1.0614
Zinc	0.0000	0.0000	0.0000	0.0000	0.7756

Note: The T-Value used to calculate these confidence limits was 2.179.

Analysis of Variance Section

Source	DF	R2	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1		0.422368	0.422368			
Model	4	0.6744	1.137593E-02	2.843982E-03	6.214	0.0060	0.9240
Error	12	0.3256	5.492341E-03	4.576951E-04			
Total(Adjusted)	16	1.0000	1.686827E-02	1.054267E-03			

Multiple Regression Report

Page/Date/Time	3 4/30/2009 10:48:30 AM
Database	C:\Documents and Settings\hg ... U 1 1208\SWMU 1 full data.S0
Dependent	Mean_Growth

Analysis of Variance Detail Section

Model Term	DF	R2	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1		0.422368	0.422368			
Model	4	0.6744	1.137593E-02	2.843982E-03	6.214	0.0060	0.9240
Copper	1	0.0595	1.003747E-03	1.003747E-03	2.193	0.1644	0.2759
Mercury	1	0.2432	4.102712E-03	4.102712E-03	8.964	0.0112	0.7847
TOC	1	0.5462	9.213623E-03	9.213623E-03	20.130	0.0007	0.9840
Zinc	1	0.1499	2.528663E-03	2.528663E-03	5.525	0.0367	0.5795
Error	12	0.3256	5.492341E-03	4.576951E-04			
Total(Adjusted)	16	1.0000	1.686827E-02	1.054267E-03			

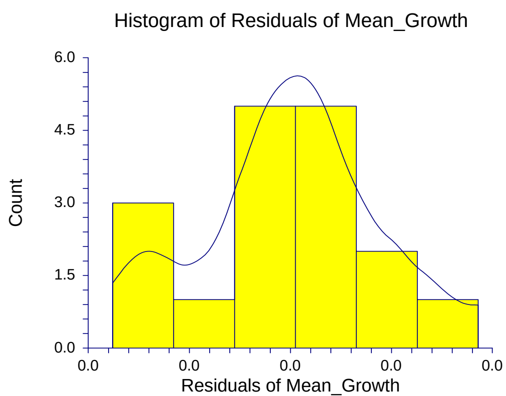
Normality Tests Section

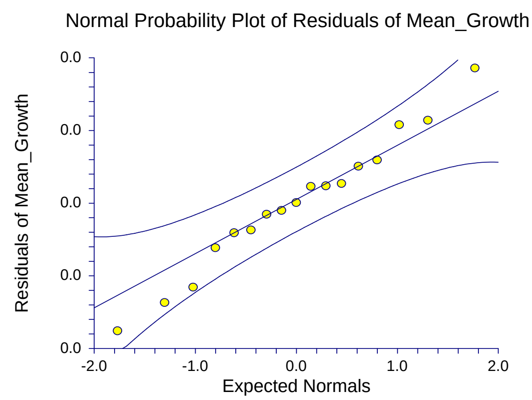
Test Name	Test Value	Prob Level	Reject H0 At Alpha = 20%?
Shapiro Wilk	0.9845	0.986965	No
Anderson Darling	0.1757	0.923685	No
D'Agostino Skewness	-0.0576	0.954079	No
D'Agostino Kurtosis	0.3126	0.754602	No
D'Agostino Omnibus	0.1010	0.950744	No

Regression Diagnostics Section

Row	Standardized Residual	RStudent	Hat Diagonal	Cook's D	Dffits	CovRatio
10	1.8477	2.0913	0.1145	0.0883	0.7519	0.3272

Plots Section

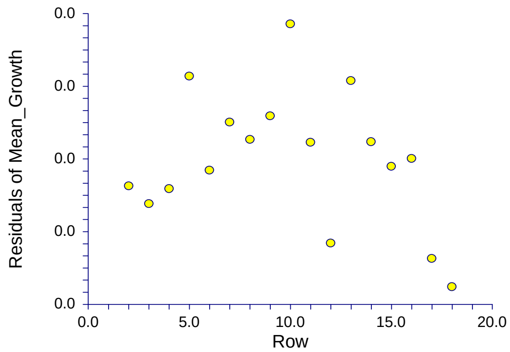




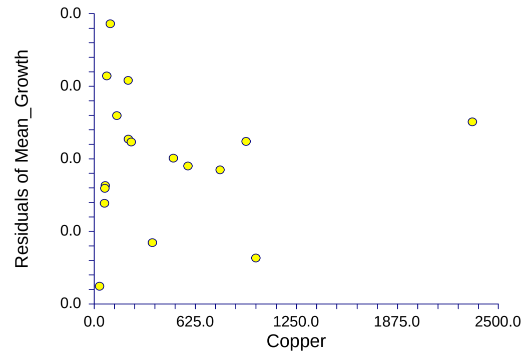
Multiple Regression Report

Page/Date/Time 4 4/30/2009 10:48:30 AM
Database C:\Documents and Settings\hg ... U 1 1208\SWMU 1 full data.S0
Dependent Mean_Growth

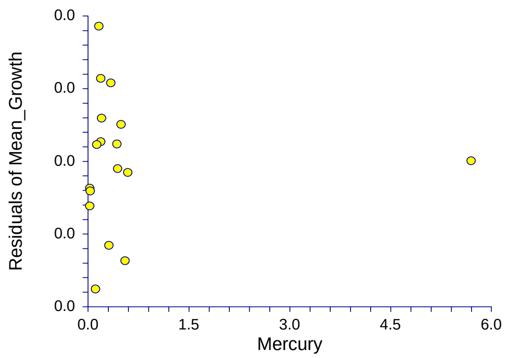
Residuals of Mean_Growth vs Row



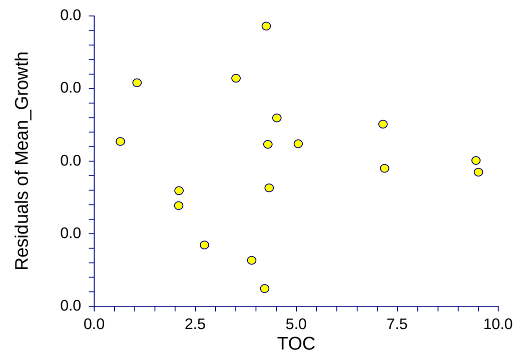
Residuals of Mean_Growth vs Copper



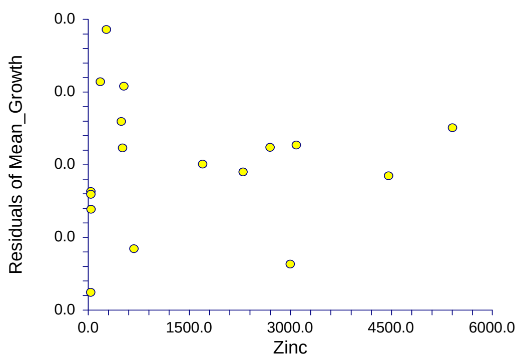
Residuals of Mean_Growth vs Mercury



Residuals of Mean_Growth vs TOC



Residuals of Mean_Growth vs Zinc



APPENDIX I
95 PERCENT UCL OF THE MEAN ECOLOGICAL COC CONCENTRATIONS IN SWMU 1 EARTHWORM TISSUE

4,4'-DDD
SWMU 1 Earthworm Tissue

General Statistics

Number of Valid Data	14	Number of Detected Data	1
Number of Distinct Detected Data	1	Number of Non-Detect Data	13
		Percent Non-Detects	92.86%

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 4,4'-DDD was not processed!

4,4'-DDE
SWMU 1 Earthworm Tissue

General Statistics

Number of Valid Data	14
Number of Distinct Detected Data	7
Number of Detected Data	7
Number of Non-Detect Data	7
Percent Non-Detects	50.00%

Raw Statistics

Minimum Detected	2750
Maximum Detected	48750
Mean of Detected	11098
SD of Detected	16752
Minimum Non-Detect	60.63
Maximum Non-Detect	10625

Log-transformed Statistics

Minimum Detected	7.919
Maximum Detected	10.79
Mean of Detected	8.735
SD of Detected	0.995
Minimum Non-Detect	4.105
Maximum Non-Detect	9.271

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	13
Number treated as Detected	1
Single DL Non-Detect Percentage	92.86%

Warning: There are only 7 Detected Values in this data
Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough tp draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.564
5% Shapiro Wilk Critical Value	0.803

Data not Normal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method	
Mean	6025
SD	12608
95% DL/2 (t) UCL	11992
Maximum Likelihood Estimate(MLE) Method	N/A
MLE method failed to converge properly	

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.665
Theta Star	16699
nu star	9.304
A-D Test Statistic	1.022
5% A-D Critical Value	0.728
K-S Test Statistic	0.728
5% K-S Critical Value	0.32

Data follow Appr. Gamma Distribution at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	2750
Maximum	48750
Mean	10294
Median	4823
SD	14163
k star	0.967
Theta star	10647
Nu star	27.07
AppChi2	16.21
95% Gamma Approximate UCL	17195
95% Adjusted Gamma UCL	18456

Note: DL/2 is not a recommended method.

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.797
5% Shapiro Wilk Critical Value	0.803

Data not Lognormal at 5% Significance Level

Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	7.023
SD	2.286
95% H-Stat (DL/2) UCL	302443
Log ROS Method	
Mean in Log Scale	7.608
SD in Log Scale	1.378
Mean in Original Scale	5905
SD in Original Scale	12595
95% Percentile Bootstrap UCL	12422
95% BCA Bootstrap UCL	15758

Data Distribution Test with Detected Values Only
Data Follow Appr. Gamma Distribution at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	6998
SD	11722
SE of Mean	3387
95% KM (t) UCL	12997
95% KM (z) UCL	12570
95% KM (jackknife) UCL	12627
95% KM (bootstrap t) UCL	59437
95% KM (BCA) UCL	13988
95% KM (Percentile Bootstrap) UCL	13393
95% KM (Chebyshev) UCL	21762
97.5% KM (Chebyshev) UCL	28151
99% KM (Chebyshev) UCL	40700

Potential UCLs to Use
95% KM (t) UCL (ug/kg): 12997

4,4'-DDT
SWMU 1 Earthworm Tissue

General Statistics

Number of Valid Data	14	Number of Detected Data	5
Number of Distinct Detected Data	5	Number of Non-Detect Data	9
		Percent Non-Detects	64.29%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	525	Minimum Detected	6.263
Maximum Detected	27500	Maximum Detected	10.22
Mean of Detected	6205	Mean of Detected	7.437
SD of Detected	11907	SD of Detected	1.585
Minimum Non-Detect	93.75	Minimum Non-Detect	4.541
Maximum Non-Detect	2000	Maximum Non-Detect	7.601

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	13
Number treated as Detected	1
Single DL Non-Detect Percentage	92.86%

Warning: There are only 5 Detected Values in this data
Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough tp draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.572
5% Shapiro Wilk Critical Value	0.762

Data not Normal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method	
Mean	2388
SD	7239
95% DL/2 (t) UCL	5814
Maximum Likelihood Estimate(MLE) Method	N/A
MLE method failed to converge properly	

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.33
Theta Star	18813
nu star	3.298
A-D Test Statistic	1.021
5% A-D Critical Value	0.712
K-S Test Statistic	0.712
5% K-S Critical Value	0.372

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	1.00E-09
Maximum	27500
Mean	5369
Median	2608
SD	7239
k star	0.178
Theta star	30218
Nu star	4.975
AppChi2	1.141
95% Gamma Approximate UCL	23417
95% Adjusted Gamma UCL	29060

Note: DL/2 is not a recommended method.

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.728
5% Shapiro Wilk Critical Value	0.762

Data not Lognormal at 5% Significance Level

Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	5.905
SD	1.71
95% H-Stat (DL/2) UCL	3896
Log ROS Method	
Mean in Log Scale	4.975
SD in Log Scale	2.199
Mean in Original Scale	2247
SD in Original Scale	7280
95% Percentile Bootstrap UCL	6137
95% BCA Bootstrap UCL	8141

Data Distribution Test with Detected Values Only
Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	2565
SD	6919
SE of Mean	2068
95% KM (t) UCL	6227
95% KM (z) UCL	5966
95% KM (jackknife) UCL	5801
95% KM (bootstrap t) UCL	103996
95% KM (BCA) UCL	8285
95% KM (Percentile Bootstrap) UCL	6410
95% KM (Chebyshev) UCL	11577
97.5% KM (Chebyshev) UCL	15477
99% KM (Chebyshev) UCL	23137

Potential UCLs to Use:
97.5% KM (Chebyshev) UCL (ug/kg): 15477

Antimony
SWMU 1 Earthworm Tissue

General Statistics

Number of Valid Data	14	Number of Detected Data	5
Number of Distinct Detected Data	5	Number of Non-Detect Data	9
		Percent Non-Detects	64.29%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	2.875	Minimum Detected	1.056
Maximum Detected	6.125	Maximum Detected	1.812
Mean of Detected	4.638	Mean of Detected	1.491
SD of Detected	1.446	SD of Detected	0.339
Minimum Non-Detect	0.41	Minimum Non-Detect	-0.892
Maximum Non-Detect	2.813	Maximum Non-Detect	1.034

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	9
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	5
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	64.29%

Warning: There are only 5 Detected Values in this data
Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough tp draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.864	Shapiro Wilk Test Statistic	0.848
5% Shapiro Wilk Critical Value	0.762	5% Shapiro Wilk Critical Value	0.762
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	1.994	Mean	0.0101
SD	2.215	SD	1.252
95% DL/2 (t) UCL	3.043	95% H-Stat (DL/2) UCL	3.782
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	1.905	Mean in Log Scale	0.785
SD	2.581	SD in Log Scale	0.594
95% MLE (t) UCL	3.126	Mean in Original Scale	2.621
95% MLE (Tiku) UCL	3.763	SD in Original Scale	1.766
		95% Percentile Bootstrap UCL	3.4
Gamma Distribution Test with Detected Values Only		95% BCA Bootstrap UCL	3.476
k star (bias corrected)	4.781		
Theta Star	0.97	Data Distribution Test with Detected Values Only	
nu star	47.81	Data appear Normal at 5% Significance Level	
A-D Test Statistic	0.52	Nonparametric Statistics	
5% A-D Critical Value	0.679	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.679	Mean	3.504
5% K-S Critical Value	0.358	SD	1.145
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	0.342
		95% KM (t) UCL	4.11
Assuming Gamma Distribution		95% KM (z) UCL	4.067
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	4.029
Minimum	2.875	95% KM (bootstrap t) UCL	4.127
Maximum	6.125	95% KM (BCA) UCL	5.589
Mean	4.521	95% KM (Percentile Bootstrap) UCL	5.491
Median	4.422	95% KM (Chebyshev) UCL	4.996
SD	0.886	97.5% KM (Chebyshev) UCL	5.641
k star	21.08	99% KM (Chebyshev) UCL	6.908
Theta star	0.214		
Nu star	590.2	**Potential UCLs to Use**	
AppChi2	534.9	**95% KM (t) UCL (mg/kg):**	**4.11**
95% Gamma Approximate UCL	4.989	**95% KM (Percentile Bootstrap) UCL (mg/kg):**	**5.491**
95% Adjusted Gamma UCL	5.055		

Note: DL/2 is not a recommended method.

Cadmium
SWMU 1 Earthworm Tissue

General Statistics

Number of Valid Observations	14	Number of Distinct Observations	12

Raw Statistics		Log-transformed Statistics	
Minimum	2.375	Minimum of Log Data	0.865
Maximum	10.63	Maximum of Log Data	2.363
Mean	5.351	Mean of log Data	1.56
Median	4.063	SD of log Data	0.49
SD	2.859		
Coefficient of Variation	0.534		
Skewness	1.093		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.816	Shapiro Wilk Test Statistic	0.908
Shapiro Wilk Critical Value	0.874	Shapiro Wilk Critical Value	0.874
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	6.704	95% H-UCL	7.049
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	8.432
95% Adjusted-CLT UCL	6.847	97.5% Chebyshev (MVUE) UCL	9.781
95% Modified-t UCL	6.742	99% Chebyshev (MVUE) UCL	12.43
Gamma Distribution Test		Data Distribution	
k star (bias corrected)	3.51	Data appear Lognormal at 5% Significance Level	
Theta Star	1.524		
nu star	98.29	Nonparametric Statistics	
Approximate Chi Square Value (.05)	76.42	95% CLT UCL	6.608
Adjusted Level of Significance	0.0312	95% Jackknife UCL	6.704
Adjusted Chi Square Value	73.87	95% Standard Bootstrap UCL	6.58
		95% Bootstrap-t UCL	7.203
Anderson-Darling Test Statistic	0.759	95% Hall's Bootstrap UCL	6.55
Anderson-Darling 5% Critical Value	0.739	95% Percentile Bootstrap UCL	6.567
Kolmogorov-Smirnov Test Statistic	0.262	95% BCA Bootstrap UCL	6.784
Kolmogorov-Smirnov 5% Critical Value	0.23	95% Chebyshev(Mean, Sd) UCL	8.682
Data not Gamma Distributed at 5% Significance Level		97.5% Chebyshev(Mean, Sd) UCL	10.12
		99% Chebyshev(Mean, Sd) UCL	12.95
Assuming Gamma Distribution			
95% Approximate Gamma UCL	6.882	**Potential UCL to Use**	
95% Adjusted Gamma UCL	7.12	**Use 95% Student's-t UCL (mg/kg):**	**6.704**
		or 95% Modified-t UCL (mg/kg):	**6.742**
		or 95% H-UCL (mg/kg):	**7.049**

Copper
SWMU 1 Earthworm Tissue

General Statistics

Number of Valid Observations	14	Number of Distinct Observations	13

Raw Statistics		**Log-transformed Statistics**	
Minimum	10	Minimum of Log Data	2.303
Maximum	168.8	Maximum of Log Data	5.128
Mean	45.63	Mean of log Data	3.526
Median	29.06	SD of log Data	0.771
SD	41.87		
Coefficient of Variation	0.918		
Skewness	2.229		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.746	Shapiro Wilk Test Statistic	0.969
Shapiro Wilk Critical Value	0.874	Shapiro Wilk Critical Value	0.874
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	65.44	95% H-UCL	77.05
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	86.98
95% Adjusted-CLT UCL	71.16	97.5% Chebyshev (MVUE) UCL	105.3
95% Modified-t UCL	66.55	99% Chebyshev (MVUE) UCL	141.4
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.499	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	30.44		
nu star	41.97	**Nonparametric Statistics**	
Approximate Chi Square Value (.05)	28.12	95% CLT UCL	64.03
Adjusted Level of Significance	0.0312	95% Jackknife UCL	65.44
Adjusted Chi Square Value	26.62	95% Standard Bootstrap UCL	63.34
		95% Bootstrap-t UCL	84.05
Anderson-Darling Test Statistic	0.45	95% Hall's Bootstrap UCL	142.4
Anderson-Darling 5% Critical Value	0.747	95% Percentile Bootstrap UCL	64.02
Kolmogorov-Smirnov Test Statistic	0.19	95% BCA Bootstrap UCL	73.3
Kolmogorov-Smirnov 5% Critical Value	0.232	95% Chebyshev(Mean, Sd) UCL	94.4
Data appear Gamma Distributed at 5% Significance Level		97.5% Chebyshev(Mean, Sd) UCL	115.5
		99% Chebyshev(Mean, Sd) UCL	157
Assuming Gamma Distribution			
95% Approximate Gamma UCL	68.1	**Potential UCL to Use:**	
95% Adjusted Gamma UCL	71.93	**Use 95% Approximate Gamma UCL (mg/kg):**	**68.1**

Lead
SWMU 1 Earthworm Tissue

General Statistics			
Number of Valid Observations	14	Number of Distinct Observations	13
Raw Statistics		Log-transformed Statistics	
Minimum	0.88	Minimum of Log Data	-0.128
Maximum	106.3	Maximum of Log Data	4.666
Mean	27.94	Mean of log Data	2.568
Median	10.31	SD of log Data	1.44
SD	31.87		
Coefficient of Variation	1.141		
Skewness	1.436		
Relevant UCL Statistics			
Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.811	Shapiro Wilk Test Statistic	0.956
Shapiro Wilk Critical Value	0.874	Shapiro Wilk Critical Value	0.874
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	43.03	95% H-UCL	153.4
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	93.36
95% Adjusted-CLT UCL	45.44	97.5% Chebyshev (MVUE) UCL	119.8
95% Modified-t UCL	43.57	99% Chebyshev (MVUE) UCL	171.6
Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.661	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	42.27		
nu star	18.51	Nonparametric Statistics	
Approximate Chi Square Value (.05)	9.76	95% CLT UCL	41.95
Adjusted Level of Significance	0.0312	95% Jackknife UCL	43.03
Adjusted Chi Square Value	8.927	95% Standard Bootstrap UCL	41.64
		95% Bootstrap-t UCL	51.93
Anderson-Darling Test Statistic	0.329	95% Hall's Bootstrap UCL	47.41
Anderson-Darling 5% Critical Value	0.769	95% Percentile Bootstrap UCL	42.06
Kolmogorov-Smirnov Test Statistic	0.203	95% BCA Bootstrap UCL	44.93
Kolmogorov-Smirnov 5% Critical Value	0.237	95% Chebyshev(Mean, Sd) UCL	65.07
Data appear Gamma Distributed at 5% Significance Level		97.5% Chebyshev(Mean, Sd) UCL	81.14
		99% Chebyshev(Mean, Sd) UCL	112.7
Assuming Gamma Distribution			
95% Approximate Gamma UCL	52.99	**Potential UCL to Use:**	
95% Adjusted Gamma UCL	57.93	**Use 95% Approximate Gamma UCL (mg/kg):**	**52.99**

Mercury
SWMU 1 Earthworm Tissue

General Statistics			
Number of Valid Observations	14	Number of Distinct Observations	14
Raw Statistics		Log-transformed Statistics	
Minimum	0.0519	Minimum of Log Data	-2.959
Maximum	1.188	Maximum of Log Data	0.172
Mean	0.282	Mean of log Data	-1.678
Median	0.188	SD of log Data	0.912
SD	0.305		
Coefficient of Variation	1.083		
Skewness	2.315		
Relevant UCL Statistics			
Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.721	Shapiro Wilk Test Statistic	0.956
Shapiro Wilk Critical Value	0.874	Shapiro Wilk Critical Value	0.874
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	0.426	95% H-UCL	0.554
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.583
95% Adjusted-CLT UCL	0.47	97.5% Chebyshev (MVUE) UCL	0.718
95% Modified-t UCL	0.435	99% Chebyshev (MVUE) UCL	0.983
Gamma Distribution Test		Data Distribution	
k star (bias corrected)	1.114	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	0.253		
nu star	31.2	Nonparametric Statistics	
Approximate Chi Square Value (.05)	19.44	95% CLT UCL	0.416
Adjusted Level of Significance	0.0312	95% Jackknife UCL	0.426
Adjusted Chi Square Value	18.21	95% Standard Bootstrap UCL	0.407
		95% Bootstrap-t UCL	0.567
Anderson-Darling Test Statistic	0.482	95% Hall's Bootstrap UCL	1.046
Anderson-Darling 5% Critical Value	0.753	95% Percentile Bootstrap UCL	0.421
Kolmogorov-Smirnov Test Statistic	0.178	95% BCA Bootstrap UCL	0.479
Kolmogorov-Smirnov 5% Critical Value	0.233	95% Chebyshev(Mean, Sd) UCL	0.637
Data appear Gamma Distributed at 5% Significance Level		97.5% Chebyshev(Mean, Sd) UCL	0.791
		99% Chebyshev(Mean, Sd) UCL	1.093
Assuming Gamma Distribution			
95% Approximate Gamma UCL	0.452	**Potential UCL to Use:**	
95% Adjusted Gamma UCL	0.483	**Use 95% Approximate Gamma UCL (mg/kg):**	**0.452**

Tin
SWMU 1 Earthworm Tissue

General Statistics

Number of Valid Data	14	Number of Detected Data	13
Number of Distinct Detected Data	9	Number of Non-Detect Data	1
		Percent Non-Detects	7.14%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	350	Minimum Detected	5.858
Maximum Detected	450	Maximum Detected	6.109
Mean of Detected	392.3	Mean of Detected	5.97
SD of Detected	29.22	SD of Detected	0.0736
Minimum Non-Detect	21	Minimum Non-Detect	3.045
Maximum Non-Detect	21	Maximum Non-Detect	3.045

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.942	Shapiro Wilk Test Statistic	0.949
5% Shapiro Wilk Critical Value	0.866	5% Shapiro Wilk Critical Value	0.866
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	365	Mean	5.711
SD	105.8	SD	0.97
95% DL/2 (t) UCL	415.1	95% H-Stat (DL/2) UCL	1011
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	363.7	Mean in Log Scale	5.957
SD	106.8	SD in Log Scale	0.0855
95% MLE (t) UCL	414.3	Mean in Original Scale	387.6
95% MLE (Tiku) UCL	416.2	SD in Original Scale	33.07
		95% Percentile Bootstrap UCL	400.6
		95% BCA Bootstrap UCL	401.9

Gamma Distribution Test with Detected Values Only	
k star (bias corrected)	152.7
Theta Star	2.569
nu star	3971
A-D Test Statistic	0.406
5% A-D Critical Value	0.732
K-S Test Statistic	0.732
5% K-S Critical Value	0.236
Data appear Gamma Distributed at 5% Significance Level	

Assuming Gamma Distribution	
Gamma ROS Statistics using Extrapolated Data	
Minimum	329.9
Maximum	450
Mean	387.9
Median	381.3
SD	32.65
k star	119.6
Theta star	3.242
Nu star	3350
AppChi2	3216
95% Gamma Approximate UCL	403.9
95% Adjusted Gamma UCL	406.1

Note: DL/2 is not a recommended method.

Data Distribution Test with Detected Values Only
Data appear Normal at 5% Significance Level

Nonparametric Statistics	
Kaplan-Meier (KM) Method	
Mean	389.3
SD	29.17
SE of Mean	8.113
95% KM (t) UCL	403.7
95% KM (z) UCL	402.6
95% KM (jackknife) UCL	403.5
95% KM (bootstrap t) UCL	406.5
95% KM (BCA) UCL	404.5
95% KM (Percentile Bootstrap) UCL	403.1
95% KM (Chebyshev) UCL	424.6
97.5% KM (Chebyshev) UCL	440
99% KM (Chebyshev) UCL	470

Potential UCLs to Use

95% KM (t) UCL (mg/kg):	**403.7**
95% KM (Percentile Bootstrap) UCL (mg/kg):	**403.1**

Zinc
SWMU 1 Earthworm Tissue

General Statistics

Number of Valid Observations	14	Number of Distinct Observations	11

Raw Statistics		Log-transformed Statistics	
Minimum	94	Minimum of Log Data	4.543
Maximum	468.8	Maximum of Log Data	6.15
Mean	171	Mean of log Data	5.022
Median	131.3	SD of log Data	0.472
SD	102.6		
Coefficient of Variation	0.6		
Skewness	2.141		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.731	Shapiro Wilk Test Statistic	0.861
Shapiro Wilk Critical Value	0.874	Shapiro Wilk Critical Value	0.874
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	219.6	95% H-UCL	220.5
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	262.8
95% Adjusted-CLT UCL	232.9	97.5% Chebyshev (MVUE) UCL	303.8
95% Modified-t UCL	222.2	99% Chebyshev (MVUE) UCL	384.4
Gamma Distribution Test		Data Distribution	
k star (bias corrected)	3.446	Data do not follow a Discernable Distribution (0.05)	
Theta Star	49.62		
nu star	96.49	Nonparametric Statistics	
Approximate Chi Square Value (.05)	74.83	95% CLT UCL	216.1
Adjusted Level of Significance	0.0312	95% Jackknife UCL	219.6
Adjusted Chi Square Value	72.31	95% Standard Bootstrap UCL	215.3
		95% Bootstrap-t UCL	259.2
Anderson-Darling Test Statistic	0.963	95% Hall's Bootstrap UCL	371.8
Anderson-Darling 5% Critical Value	0.739	95% Percentile Bootstrap UCL	217.9
Kolmogorov-Smirnov Test Statistic	0.251	95% BCA Bootstrap UCL	229.5
Kolmogorov-Smirnov 5% Critical Value	0.23	95% Chebyshev(Mean, Sd) UCL	290.5
Data not Gamma Distributed at 5% Significance Level		97.5% Chebyshev(Mean, Sd) UCL	342.3
		99% Chebyshev(Mean, Sd) UCL	443.9
Assuming Gamma Distribution			
95% Approximate Gamma UCL	220.5	**Potential UCL to Use**	
95% Adjusted Gamma UCL	228.2	**Use 95% Student's-t UCL (mg/kg):**	**219.6**
		or 95% Modified-t UCL (mg/kg):	**222.2**