N00164.AR.001183
NSWC CRANE
5090.3a

DEPARTMENT OF THE NAVY
CRANE DIVISION
NAVAL SURFACE WARFARE CENTER
300 HIGHWAY 361
CRANE INDIANA 47522-5001

2-1-2009

IN REPLY REFER TO:
5090/S4.7.1
Ser 0592/9041

Indiana Department of Environmental Management
OLQ Permits Branch
Attn: Mr. Doug Griffin
Mail Code 64-45 IGCN 1101
100 N. Senate Avenue
Indianapolis, IN 46204
Attention: Chief, Hazardous Waste Permit Section

Dear Mr. Griffin:

Crane Division, Naval Surface Warfare Center submits the Draft Site Investigation (SI) Report for UXO 5 (Building 2044 Drop Tower and Test Rail). One copy is provided for your review as enclosure 1. The permit required Certification Statement is provided as enclosure 2.

If you require any further information, my point of contact is Mr. Thomas J. Brent, PRCR43, at 812-854-6160, email thomas.brent@navy.mil.

Sincerely,

J. M. Hunsicker
J. M. HUNSICKER
Environmental Protection Mgr
By direction of the Commander

Enclosures: 1. Draft UXO 5 SI Report
2. Certification Statement

Copy to:
ADMINISTRATIVE RECORD
NAVFAC MW (Howard Hickey) (w/o encl)
USEPA (Pete Ramanauskas)
TTNUS (Ralph Basinski) (w/o encl)

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

SIGNATURE

Environmental Protection Mgr
TITLE

03/05/09
DATE

Comprehensive Long-term Environmental Action Navy

CONTRACT NUMBER N62467-04-D-0055

Rev. 0
02/09

Site Investigation Report
for
UXO 5
Building 2044 Drop Tower/Test Rail Site

Naval Surface Warfare Center
Crane Division
Crane, Indiana

Contract Task Order F272

February 2009

NAVFAC
Naval Facilities Engineering Command
Midwest
201 Decatur Avenue
Building 1A, Code EV
Great Lakes, Illinois 60088

TETRA TECH NUS, Inc.

REVISION 0
FEBRUARY 2009

SITE INSPECTION REPORT
FOR
UXO 5
BUILDING 2044 DROP TOWER/TEST RAIL SITE

NAVAL SURFACE WARFARE CENTER
CRANE DIVISION
CRANE, INDIANA

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Naval Facilities Engineering Command Midwest
201 Decatur Avenue
Building 1A, Code EV
Great Lakes, Illinois 60088

Submitted by:
Tetra Tech NUS, Inc.
234 Mall Boulevard, Suite 260
King of Prussia, Pennsylvania 19406

CONTRACT NUMBER N62467-04-D-0055
CONTRACT TASK ORDER F272

FEBRUARY 2009

PREPARED UNDER THE SUPERVISION OF:

Richard Barringer

RICK BARRINGER
PROJECT MANAGER
TETRA TECH NUS, INC.
PITTSBURGH, PENNSYLVANIA

APPROVED FOR SUBMITTAL BY:

John Trepanowski

JOHN J. TREPANOWSKI, P.E.
PROGRAM MANAGER
TETRA TECH NUS, INC.
KING OF PRUSSIA, PENNSYLVANIA

TABLE OF CONTENTS

SECTION **PAGE NO.**

EXECUTIVE SUMMARY **ES-1**

ACRONYMS **4**

1.0 INTRODUCTION **1-1**
1.1 PURPOSE AND SCOPE 1-1
1.2 FACILITY DESCRIPTION 1-1
1.3 SITE DESCRIPTION 1-1
1.4 CHEMICALS OF CONCERN SELECTION 1-2
1.5 SITE PHYSICAL CHARACTERISTICS 1-3
1.6 SCOPE OF WORK 1-3
1.7 REPORT ORGANIZATION 1-3

2.0 FIELD INSPECTION ACTIVITIES **2-1**
2.1 OVERVIEW 2-1
2.2 MOBILIZATION/DEMOBILIZATION 2-1
2.3 SITE INSPECTION METHODOLOGIES AND PROCEDURES 2-2
2.3.1 Unexploded Ordnance Clearance 2-2
2.3.2 Hand Augering 2-2
2.3.2 Sample Logging 2-2
2.4 SAMPLING OPERATIONS 2-2
2.4.1 Surface Soil Sample Collection 2-3
2.5 FIELD SAMPLE DOCUMENTATION 2-4
2.6 SAMPLE HANDLING, PACKAGING, AND SHIPPING 2-4
2.7 QUALITY CONTROL SAMPLES 2-5
2.8 GPS SURVEYING 2-5
2.9 DECONTAMINATION 2-5
2.10 INSPECTION-DERIVED WASTE HANDLING 2-6
2.11 SITE MANAGEMENT AND FACILITY SUPPORT 2-6
2.12 RECORDKEEPING 2-6

3.0 DATA REPORT **3-1**
3.1 SOIL 3-1

4.0 DATA QUALITY REVIEW **4-1**
4.1 DATA VALIDATION PROCESS AND DATA QUALITY REVIEW 4-1
4.1.1 Data Validation Process 4-1
4.1.2 Data Validation Outputs 4-2
4.1.3 Data Quality Review 4-2
4.1.4 Completeness 4-3
4.1.5 Sensitivity 4-4
4.1.6 Accuracy 4-4
4.1.7 Precision 4-6
4.1.8 Comparability 4-6
4.1.9 Representativeness 4-7

TABLE OF CONTENTS

SECTION **PAGE NO.**

5.0 HUMAN HEALTH SCREENING EVALUATION 5-1
5.1 SELECTION OF CHEMICALS OF POTENTIAL CONCERN 5-1
5.2 EXPOSURE ASSESSMENT 5-3
5.3 RISK CHARACTERIZATION 5-4
5.3.1 Background Evaluation 5-4
5.3.2 Risk Calculation Evaluation 5-6
5.4 UNCERTAINTY ANALYSIS 5-8
5.5 SUMMARY AND CONCLUSIONS 5-9

6.0 ECOLOGICAL RISK SCREENING EVALUATION 6-1
6.1 SITE DESCRIPTION 6-1
6.2 POTENTIAL ECOLOGICAL RECEPTORS AND EXPOSURE PATHWAYS 6-2
6.3 ECOLOGICAL SCREENING 6-2
6.4 UNCERTAINTY ANALYSIS 6-6
6.5 SUMMARY AND CONCLUSIONS 6-7

7.0 CONCLUSIONS 7-1

REFERENCES R-1

APPENDICES

A FIELD SAMPLE LOGS
B MISCELLANEOUS FIELD DOCUMENTATION
C SITE PHOTOS
D STATISTICAL EVALUATIONS
E ECOLOGICAL RISK SUPPORTING DOCUMENTATION
F DATA VALIDATION REPORTS

TABLES

NAME

2-1 Soil Boring Summary
2-2 Summary of Environmental Samples and Analytical Methods
3-1 Analytical Results
3-2 Summary of Descriptive Statistics
3-3 Background Concentrations
4-1 Summary of Data Qualifications
5-1 Human Health COPC Selection
5-2 Quantitative Risk Estimates
6-1 Ecological Risk Screening Evaluation COPC Selection
6-2 Food Chain Model Results - Soil Invertivorous and herbivorous Receptors

FIGURES

NAME

1-1 General Location Map
1-2 UXO 5 Site Location Map
1-3 UXO 5 2003 Aerial Photograph
2-1 Sample Location Map

ACRONYMS

%R	Percent Recovery
amsl	above mean sea level
bgs	below ground surface
CAD	Cartridge Actuated Device
CLEAN	Comprehensive Long-Term Environmental Action Navy
COPC	Chemical of Potential Concern
CTO	Contract Task Order
CTPB	carboxy terminated polybutadiene
DQI	Data Quality Indicator
DV	Data Validation
DI	Deionized
EEQ	Ecological Effects Quotient
EPC	Exposure Point Concentration
ERSE	Ecological Risk Screening Evaluation
ESL	Ecological Screening Level
FOL	Field Operations Leader
HASP	Health and Safety Plan
HHRSE	Human Health Risk Screening Evaluation
HQ	Hazard Quotient
IDEM	Indiana Department of Environmental Management
IUPPS	Indiana Underground Plant Protection Services
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
MC	Munitions Constituents
MDL	Method Detection Limit
mg/kg	milligram per kilogram
MEC	Munitions and Explosives of Concern
mm	millimeter
MRP	Munitions Response Program
MS	Matrix Spike
MSD	Matrix Spike Duplicate
NAVFAC	Naval Facilities Engineering Command
NSWC	Naval Surface Warfare Center

OPPTS	Office of Prevention, Pesticides, and Toxic Substances
OSWER	Office of Solid Waste and Emergency Response
PA	Preliminary Assessment
PAD	Propellant Actuated Device
PPE	Personal Protective Equipment
PRG	Preliminary Remediation Goal
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RL	Reporting Limit
RPD	Relative Percent Difference
SI	Site Inspection
SOP	Standard Operating Procedure
SSL	Soil Screening Level
SV	Screening Value
TAL	Target Analyte List
Tetra Tech	Tetra Tech NUS, Inc.
TOM	Task Order Manager
TRW	Technical Review Workgroup
TV	Threshold Value
UCL	Upper Confidence Limit
USEPA	United States Environmental Protection Agency
UXO	Unexploded Ordnance

EXECUTIVE SUMMARY

The former Building 2044 Drop Tower/Test Rail Site at UXO 5 is located at the Naval Surface Warfare Center (NSWC) Crane in Crane, Indiana. The drop tower was used to periodically drop 20-mm cartridges onto a thick metal sheet to verify that cartridges would not detonate if mishandled. The test rail was used to test cartridge actuated devices (CADs) and propellant actuated devices (PADs) in ejection seats. The site was used from January 1951 through December 1983, with average actual site usage reported to be approximately 9 days per month. The site is currently not used for any purpose.

This Site Inspection (SI) Report presents the results of the surface soil investigation. The purpose of the surface soil investigation was to evaluate and compare the results to the human health and ecological screening benchmarks. The chemicals of concern (COCs) in soil for this investigation are metals (metallic components and cartridge casings) and explosives.

This SI included surface soil sampling using hand augering methods. The areas within the site that were identified as having the highest probability of containing COCs were the areas immediately adjacent to the base of the drop tower, the area along the length of the test rail, and the drainage area located on the south side of the site. Sampling locations were subsequently identified in these three areas.

A total of 19 sample location grids were laid out and subsequently sampled at depths from ground surface to 2 feet below ground surface (bgs). Each of the 19 grids was divided into four equal quadrants and a portion of the sample from each quadrant was homogenized into a composite sample for explosives analysis, and a portion of a sample from a single quadrant was collected for metals analysis. The samples were then sent to a Navy-approved fixed-base laboratory for chemical analyses.

Under current and anticipated future land use at UXO 5, base personnel engaged in site maintenance activities and potential trespassers were selected as the most likely receptors to be exposed to any chemicals of potential concern (COPCs). A human health risk screening evaluation (HHRSE) for chemicals present in surface soil at UXO 5 was conducted. No risks from cancer and non-cancer causing hazards were found to exist at UXO 5. Based on this assessment no further action (NFA) regarding human health is warranted at this site.

Ecological receptors could be exposed to chemicals in surface soil at UXO 5; therefore, risk screening was performed by comparing maximum and arithmetic mean chemical concentrations to ecological screening benchmarks for surface soil. Based on the ecological screening assessment, all ecological

COPCs were eliminated from quantitative consideration based on comparisons of site concentrations to background concentrations, frequencies of detection, number of ecological screening level exceedances, and lack of suitable ecological habitat. Therefore, ecological risks at UXO 5 from explosives and inorganics are expected to be minimal and NFA regarding ecological risk is warranted at this site.

Based on the analytical results from this SI and the human health and ecological risk screening evaluations, additional soil sampling at UXO 5 is not warranted, and a site status of NFA is recommended.

1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

The purpose of the Site Inspection (SI) was to determine whether specific chemicals of potential concern (COPCs) that may have originated from previous site operations are present and potentially contributing to environmental impacts associated with surface soil at the Building 2044 (B-2044) Drop Tower/Test Rail Site, Naval Surface Warfare Center (NSWC) Crane, located in Crane, Indiana.

This report describes the field activities performed during the SI and the subsequent laboratory analyses. Field activities included the sampling of surface soil that may have been impacted by past operations at the site. This work was performed for the United States Navy (the Navy), Naval Facilities Engineering Command (NAVFAC) Midwest by Tetra Tech NUS, Inc. (Tetra Tech) under Contract Task Order (CTO) 0034 of the Comprehensive Long-Term Environmental Action Navy (CLEAN) IV Contract Number N62467-04-D-0055.

1.2 FACILITY DESCRIPTION

NSWC Crane is located in the southern portion of Indiana, approximately 75 miles southwest of Indianapolis and 71 miles northwest of Louisville, Kentucky, immediately east of Crane Village and Burns City (Figure 1-1). NSWC Crane encompasses 62,463 acres (approximately 98 square miles), most of which are located in the northern portion of Martin County. Smaller portions of NSWC Crane are located in Greene, Daviess, and Lawrence Counties. NSWC Crane is located in a rural, sparsely populated area. Most of NSWC Crane is forested, and the surrounding area is wooded or farmed land.

NSWC Crane provides material, technical, and logistical support to the Navy for equipment, shipboard weapons systems, and nonexpendable ordnance items. In addition, NSWC Crane supports the Crane Army Ammunition Activity (CAAA) with production, renovation, storage, shipment, demilitarization, and disposal of conventional ammunition.

1.3 SITE DESCRIPTION

UXO 5 (B-2044 Drop Tower/Test Rail Site) is located in the north-central part of NSWC Crane (Figure 1-2) and is adjacent to Highway 304 and consists of two areas, the drop tower and test rail. The test site is located east of B-2044 in an area maintained by periodic mowing. UXO 5 is bordered to the north, south, and east by woods and to the west by Highway 45. The test site currently consists of a drop

tower that is approximately 100 feet tall with a 6- by 9-foot by 0.5 inch thick sheet of metal on the southwestern side of the base of the tower. Periodically, 20-millimeter (mm) cartridges were dropped from the top of the tower onto the metal sheet to verify that cartridges would not detonate if mishandled. Therefore, it has been assumed that a relatively small portion (i.e., fewer than 1 percent) of the 20-mm cartridges would have actually detonated. Approximately 75 feet southeast of the drop tower is a test rail that is approximately 97 feet in length from east and west. The test rail was used to test cartridge actuated devices (CADs) and propellant actuated devices (PADs) in ejection seats. CADs and PADs are items that release precise explosive or propellant energy to perform controlled work functions in a variety of applications. The site was used from January 1951 through December 1983, with average actual site usage reported to be approximately 9 days per month.

A Munitions Response Program (MRP) Preliminary Assessment (PA) was conducted, and no evidence was observed indicating munitions and explosives of concern (MEC) on the ground surface. During testing periods, it was the Navy's policy to remove all retrievable MEC after testing. If munitions constituents (MCs) were present, they were expected to consist of trace explosives and metals near the drop tower, test rail, and possibly in the nearby grassy drainageway. Based on the known testing operations conducted at the site, any MCs present would be primarily in surface soil. Site features for UXO 5 are presented on Figure 1-3.

1.4 CHEMICALS OF CONCERN SELECTION

The COCs for this SI were selected based on the known use of the site as a former test area for 20-mm cartridges. The Final PA indicated that black powder and black powder plus carboxy terminated polybutadiene (CTPB), and National N300 Master Part Number N-53 were the primary MCs of CADs and PADs tested at UXO 5 (Malcolm Pirnie, Inc, 2005). Although, not explicitly identified as such, the CTPB appears to have been a binder added to the black powder to slow the combustion for a controlled burning of the MCs. In this capacity, the purpose of the CTPB would have been to provide a uniform matrix throughout which the black powder was dispersed.

Black powder is comprised of potassium nitrate [approximately 75 wgt % (weight percent)], charcoal (approximately 15 wgt %), and sulfur (approximately 10 wgt %), thus potassium accounts for approximately 25 percent of the mass of black powder.

In addition to black powder, other propellants and explosives were used in CADs and PADs to provide the energy that allows the device to function. Therefore, the soils were analyzed using SW-846 Method 8330 for explosives and propellants.

Because other propellants and explosives were used, the ability to detect sulfur compounds that were released from the combusted black powder is limited. Furthermore, most sulfur compounds probably transformed through oxidation into sulfates; which naturally occur in native soil. Nevertheless, the combustion products containing sulfur that were added to the native soil from the testing at UXO 5 will be less significant than that for potassium compounds. All other black powder constituents that remain after combustion are considered insignificant. Because metals may have been released from projectiles or cartridge casings during testing, metals analyses were performed to determine if they significantly added to the native soil concentrations.

1.5 SITE PHYSICAL CHARACTERISTICS

The physical characteristics of the site are discussed in Sections 1.3.2 through 1.3.6 of the Quality Assurance Project Plan (QAPP) (Tetra Tech, 2004).

1.6 SCOPE OF WORK

The SI was conducted to identify COCs (i.e., explosives and metals) that may exist as a result of past operations at the site. If contaminants were present at concentrations posing a risk to human or ecological receptors, further investigation may be warranted. Surface soil samples [0 to 2 feet below ground surface (bgs)] were collected within defined grid areas that were placed around the drop tower and the test rail. Samples for explosive analyses consisted of composite soil samples and samples for Target Analyte List (TAL) metals analysis were grab samples collected from a single location within each grid.

Because surface water and sediment are not present at the site, no sampling of these media occurred during the SI.

1.7 REPORT ORGANIZATION

The following information is contained in the remainder of this document:

- Section 2.0 discusses the field activities associated with this SI.
- Section 3.0 presents the analytical data from this SI.
- Section 4.0 presents the data quality review.

- Section 5.0 presents the Human Health Risk Assessment (HHRA) based on data from this SI.
- Section 6.0 presents the Ecological Risk Assessment (ERA) based on data from this SI.

The following appendices are included in this report and provide the technical information compiled during the SI at UXO 5:

- Appendix A - Field Soil Sample Log sheets
- Appendix B - Miscellaneous Field Documentation
- Appendix C - Site Photos
- Appendix D - Statistical Evaluations
- Appendix E - Ecological Risk Supporting Documentation
- Appendix F - Data Validation Reports

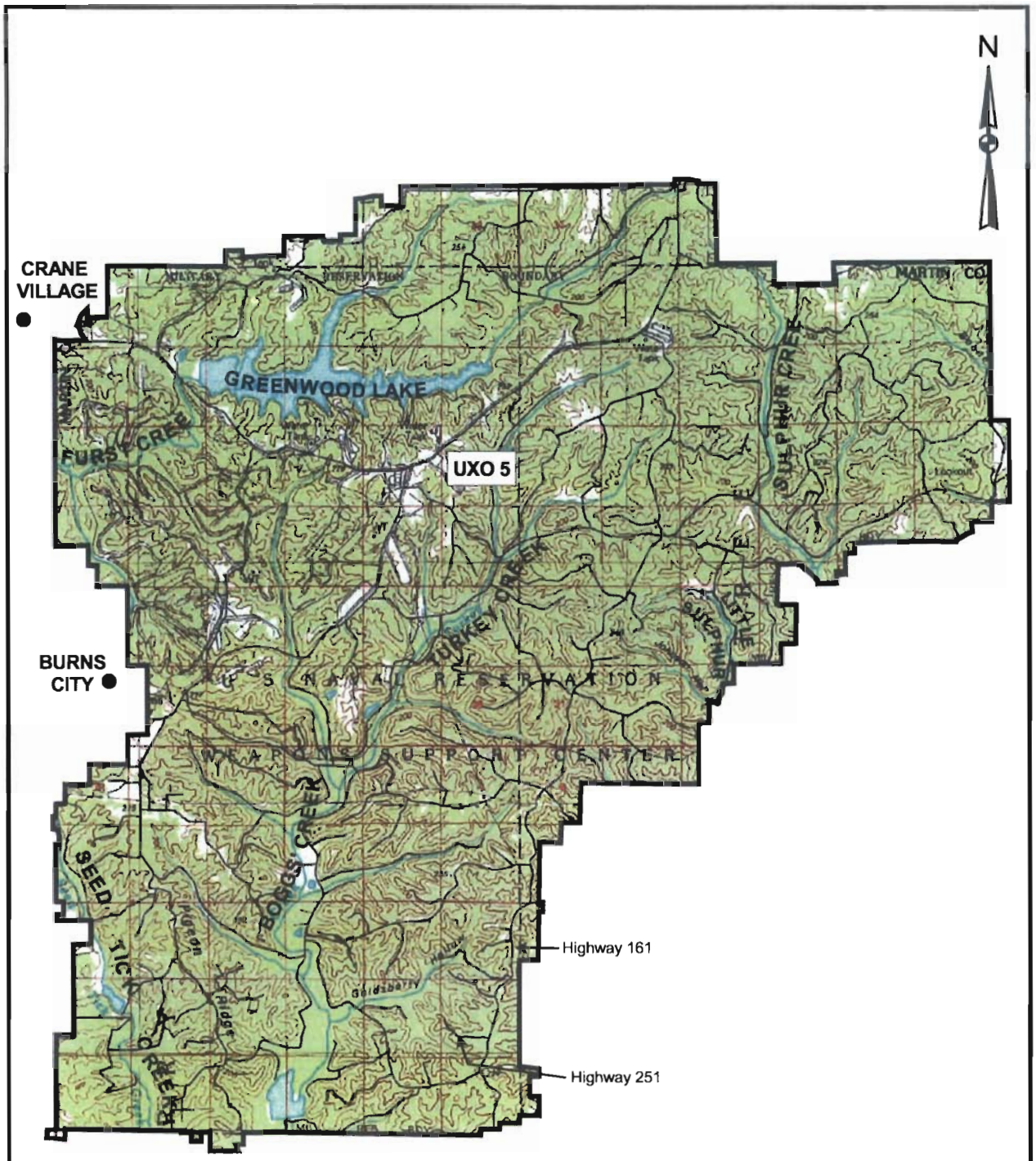
DRAWN BY	DATE
J. LAMEY	3/09/00
CHECKED BY	DATE
J. GOERDT	2/25/09
COST/SCHEDULE-AREA	
SCALE	
AS NOTED	

NAVFAC

GENERAL LOCATION MAP
UXO 5- SITE INSPECTION REPORT
NSWC CRANE
CRANE, INDIANA

CONTRACT NUMBER	
CTO F272	
APPROVED BY	DATE
APPROVED BY	DATE
DRAWING NO.	REV
FIGURE 1 - 1	0

P:\GIS\NSWC_CRANE\APR\0087.APR GENERAL LOCATION MAP 2/25/09 SS



SOURCE: "Initial Assessment of Study of Naval Weapons Support Center Crane, Indiana." Naval Energy and Environmental Support Activity, May 1983.

2 0 2 Miles

DRAWN BY J. LAMEY	DATE 8/27/01	SITE LOCATION UXO 5 - SITE INSPECTION REPORT NSWC CRANE CRANE, INDIANA	CONTRACT NUMBER CTO F272
CHECKED BY J. GOERDT	DATE 02/26/09		APPROVED BY — DATE —
COST/SCHEDULE-AREA			APPROVED BY — DATE —
SCALE AS NOTED			DRAWING NO. 1 - 2 REV 0

P:\GIS\CRANE_NSWC\SURFICIALCSMR.APR SWMU01 LOCATION LAYOUT 02/26/09 SS

P:\GIS\CRANE_NSWC\MAPDOCS\APR\SWMU17.APR UXO 5 AERIAL LAYOUT 2/26/09 SS

DRAWN BY S. STROZ	DATE 2/26/09	NAVFAC	UXO 5 2005 AERIAL PHOTOGRAPH UXO 5 - SITE INSPECTION REPORT NSWC CRANE CRANE, INDIANA	CONTRACT NO. F272
CHECKED BY J. GOERDT	DATE 2/26/09			APPROVED BY ___ DATE ___
COST/SCHED-AREA				APPROVED BY ___ DATE ___
SCALE AS NOTED				DRAWING NO. FIGURE 1 - 3 / REV –

2.0 FIELD INSPECTION ACTIVITIES

This section describes the sampling activities, procedures, and documentation utilized during the SI fieldwork performed in October 2007 at NSWC Crane, UXO 5.

2.1 OVERVIEW

This SI was completed at UXO 5 in areas where metals and explosives contamination were presumed to have been released to the environment during site operations at drop tower and the test rail. Surface soil samples (0 to 2 feet bgs) were collected from 19 separate 10- by 10-feet grid areas within UXO 5.

All work performed for this SI was conducted in accordance with the procedures and methodologies described in the United States Environmental Protection Agency (USEPA)-approved QAPP Addendum No. 2 (Tetra Tech, 2007). Standard Operating Procedures (SOPs) that governed the field work are included in Appendix A of the approved QAPP. Select photographs of UXO 5, copies of all field forms, records, field logbooks, and health and safety documentation associated with the SI are provided in Appendices A through F of this document.

2.2 MOBILIZATION/DEMOBILIZATION

Following approval of the QAPP, Tetra Tech began mobilization activities. All field team members reviewed the approved QAPP, associated appendices, and the Health and Safety Plan (HASP) prior to the start of project activities. In addition, the Field Operations Leader (FOL) held field team orientation meetings to ensure that personnel were familiar with the scope of field activities. Health and safety documentation is contained in Appendix B.

Prior to the initiation of fieldwork, the FOL arrived at the site and began on-site mobilization activities. These activities included coordination with base personnel and utility clearance of all proposed boring locations through the Indiana Underground Plant Protection Services (IUPPS). The equipment required for the field activities was shipped to the site. At the conclusion of the field activity, the FOL completed the decontamination and demobilization of all equipment.

2.3 SITE INSPECTION METHODOLOGIES AND PROCEDURES

2.3.1 Unexploded Ordnance Clearance

Prior to sampling activities at UXO 5, all sample grids were measured and the four corners of each grid were marked with colored pin flags. A UXO Technician then cleared each sample grid using a Schoenstadt 72x Magnetometer. If an anomaly was detected within a sample grid, that specific location was marked with a different colored pin flag and those locations were avoided by a minimum of 12 inches laterally when sampling the grid. No UXO was observed on the ground surface or in any soil sample material during field activities at UXO 5.

2.3.2 Hand Augering

All borings at UXO 5 were completed by hand auger techniques during this field inspection. Hand augering involved manually turning a 2½ inch stainless steel auger bucket into the ground to the desired sample depth. All hand augered soil borings at UXO 5 were advanced to a maximum depth of 2 feet bgs. Sample depths for all UXO 5 soil samples are listed in Table 2-1.

The auger bucket was decontaminated in the field between each sample location as outlined in Section 2.9 and in accordance with SOP CTO0034-04. Soil sample collection information is provided in Section 2.4.1.

2.3.2 Sample Logging

Individual soil sample log sheets were maintained for sample locations that were collected at UXO 5. The sample log sheets can be found in Appendix A and contain the following information as appropriate:

- Boring identification
- Name of person(s) collecting the sample
- Sample number, depth, date, and time
- Brief soil description

2.4 SAMPLING OPERATIONS

This section discusses the methodology for the soil sampling activities performed at UXO 5. Table 2-2 provides a summary of samples collected and analyses performed.

During the SI field activities, surface soil samples were collected from the ground surface to a maximum depth of 2 feet bgs or until refusal was reached using a hand auger. Nineteen sample grids were laid out at UXO 5. Each grid was approximately 10 by 10 feet and was divided into four equal quadrants. Within each quadrant, a soil sample was collected and homogenized with samples from the other three quadrants to comprise a composite sample for explosives analysis. A grab sample was collected from one of the four quadrants within each grid for metal analyses. Soil samples were collected in accordance with SOP CTO0034-05 (Tetra Tech, 2007). See Figure 2-1 for soil boring locations. Soil sample log sheets are included in Appendix A of this document.

2.4.1 Surface Soil Sample Collection

Building 2044/Drop Tower

Seven sample grids were measured with the 4 corners of each grid marked by pushing a colored pin flag in the area of the Drop Tower. Section 1.3.1 of the approved QAPP (Tetra Tech, 2007) states that an 8- by 8-foot concrete pad existed on the southwestern side of the base of the tower where the 20-mm cartridges were dropped from the tower to verify the cartridges would not detonate if mishandled. However, field observations determined that the concrete pad was actually a large sheet of steel measuring 6 feet wide by 9 feet long and having a thickness of 0.5 inch. This steel "pad" is located directly southwest of the base of the tower. Sample grid X5-SB001 was located directly north of the steel pad, and grid X5-SB002 was located directly south. Sample grid X5-SB003 was located northeast of the steel test pad and partially within the footprint of the tower base. All three locations were covered with heavy gravel down to 6 to 8 inches bgs. Sample grids X5-SB004, X5-SB005, X5-SB006, and X5-SB007 were located northeast, east, southeast, and southwest of the drop tower, respectively. There was still a large amount of gravel in these locations although not as much as the previous three sample grids. See Figure 2-1 for sample grid locations.

Test Rail

Seven sample grids (X5-SB012 through X5-SB018) were positioned along the entire length of the test rail. These sample grids, X5-SB012 through X5-SB018, were parallel to the test rail and positioned alternately on either side of the test rail. Each grid overlapped the underside of the test rail by approximately 1 foot to allow for adequate coverage (Figure 2-1). Sample grids X5-SB012, X5-SB013, and X5-SB014 were heavily graveled to a depth of approximately 2 feet bgs. Sampling of these locations required manual digging with a pick ax prior to sample collection at a total depth of 4 feet bgs. The direction that the testing materials traveled down the test rail was west to east.

Drainageway

Five sample grids were positioned in the drainage areas at UXO 5 to determine if surface water runoff had transported any contaminants downgradient that were associated with past operations at the site (Figure 2-1). Sample grid X5-SB008 was located just north of the western end of the test rail in an area downgradient of the drop tower. Sample grids X5-SB009, X5-SB-010, X5-SB011, and X5-SB019 were established downgradient (south and southwest) of the test rail.

2.5 FIELD SAMPLE DOCUMENTATION

Sample documentation consisted of the completion of sample log sheets, sample bottle tags, chain-of-custody records, field logbooks, and health and safety documentation. Field documentation was conducted in accordance with SOP CTO0034-03. The sample log sheets contain information such as sample location and sample identification number, container requirements and analyses to be performed, sample type, time, and date. Any unusual circumstances encountered during sample collection were noted on the form. Sample log sheets can be found in Appendix A of this document. Chain-of-custody records (found in Appendix B) were used to track each sample from collection to receipt and analysis at the laboratory.

2.6 SAMPLE HANDLING, PACKAGING, AND SHIPPING

Sample handling activities included field-related considerations concerning the selection of sample containers, allowable holding times, sample custody, and maintaining samples at the appropriate storage temperature. All sample containers sent to the fixed-base laboratory were sealed in Ziploc® plastic bags to minimize the possibility of breakage during transport. The sample containers were then placed in a cooler lined with a large plastic garbage bag. Samples were cooled immediately after collection with ice placed over the sample containers. A temperature blank was placed in each cooler prior to shipment. The plastic garbage bag was sealed with a knot and the chain-of-custody form was sealed in a Ziploc® bag and taped to the inside of the cooler lid. A signed and dated custody seal was applied to each end of the cooler and then covered with strapping tape to provide a tamper-evident seal. A Federal Express® airbill was applied to the shipping cooler. Tetra Tech maintained custody of the samples until they were relinquished to Federal Express®. The Federal Express® tracking number (airbill number) was recorded on the chain-of-custody form and the sender's copy of the airbill was maintained for shipment tracking, if needed. All samples were shipped to the laboratory for overnight delivery and were received within sample holding times.

2.7 QUALITY CONTROL SAMPLES

Quality assurance (QA)/quality control (QC) samples were generated and collected during sampling activities to monitor both field and laboratory procedures. These procedures are detailed in the approved QAPP. QA/QC samples included field duplicates, equipment rinsate blanks, and temperature blanks. These types of QA/QC samples are briefly described below:

- Field Duplicates - Field duplicates consisted of a single sample split into two portions. Field duplicates were collected at the rate of 1 in 20 during the SI to assess the overall precision of the sampling and analysis program. One duplicate sample was collected in the field during the SI.

- Equipment Rinsate Blanks - Equipment rinsate blanks were obtained under representative field conditions by collecting the rinse water generated by running analyte-free water through or over sample collection equipment after decontamination and before use. When pre-cleaned, dedicated, or disposable sampling equipment was used (no decontamination was required), one equipment rinsate blank was collected as a batch blank. Equipment rinsate blanks were analyzed for the same chemical constituents as the associated environmental samples.

- Temperature blanks - Temperature blanks were used to determine if samples were adequately cooled during shipment. Temperature blanks consisted of analyte-free water poured into a clean sample container at the site or supplied by the fixed-based laboratory. One temperature blank was submitted to the laboratory in each cooler, and the temperature was checked upon receipt at the laboratory.

2.8 GPS SURVEYING

Northing and easting coordinates of the center of each sample grid were logged by Tetra Tech personnel utilizing a Trimble XT Global Positioning Unit. This information is retained in the Tetra Tech main database and can be used as a reference if repeat sampling is required at any of the SI sample locations.

2.9 DECONTAMINATION

The non-dedicated, non-disposable equipment involved in field sampling activities was decontaminated before beginning work, during sampling activities, and at the completion of field activities in accordance with SOP CTO034-04. The equipment included two hand augers.

The following decontamination steps were taken in the field between all sample locations:

- Potable water and phosphate-free detergent wash (scrub if necessary)
- Potable water rinse
- Deionized (DI) water rinse
- Air dry (if possible)
- Wrap in aluminum foil (if not to be used immediately)

2.10 INSPECTION-DERIVED WASTE HANDLING

The field inspection generated potentially contaminated wastes including personal protective equipment (PPE) and decontamination fluids. Management of each residue was performed as follows:

PPE – Used PPE was double bagged and then placed in NSWC Crane trash receptacles (i.e., dumpsters).

Sampling Equipment Decontamination Fluids – All equipment decontamination fluids were collected and discharged to the NSWC Crane permitted waste treatment plant.

All soil removed from a sample location not used as part of that sample, was returned to its original boring.

2.11 SITE MANAGEMENT AND FACILITY SUPPORT

The FOL was designated as the lead in coordinating all day-to-day activities during the inspection. The FOL was responsible for ensuring that all field team members (including subcontractors) were familiar with the approved QAPP and HASP that was in effect during this SI. Additionally, the FOL was responsible for all sampling operations, QA/QC, field documentation requirements, and field change orders. The FOL reported to the Task Order Manager (TOM) on a daily basis regarding the status of fieldwork.

All site preparation, mobilization/demobilization, and sampling activities were coordinated through NSWC Crane personnel through pre-visit communication and daily status meetings during the field work.

2.12 RECORDKEEPING

Electronic records were maintained for each field activity in accordance with SOP CTO034-03. Information recorded daily included field activities, weather conditions, identity and arrival and departure times of personnel, management issues, etc. Copies of daily activity records are included in Appendix B.

TABLE 2-1

SOIL BORING SUMMARY
UXO 5 - BUILDING 2044 DROP TOWER/TEST RAIL SITE
NSWC CRANE
CRANE, INDIANA

Boring No.	Total Depth (feet bgs)	Drilling Method[1]	Date Drilled	Depth Interval(s) of Soil Sample (feet bgs)
X5SB001	2.0	HA	10/8/2007	0-2
X5SB002	2.0	HA	10/8/2007	0-2
X5SB003	2.0	HA	10/8/2007	0-2
X5SB004	2	HA	10/8/2007	0-2
X5SB005	2	HA	10/8/2007	0-2
X5SB006	2	HA	10/8/2007	0-2
X5SB007	2	HA	10/8/2007	0-2
X5SB008	2	HA	10/8/2007	0-2
X5SB009	2	HA	10/8/2007	0-2
X5SB010	2	HA	10/8/2007	0-2
X5SB011	2	HA	10/8/2007	0-2
X5SB012	2	HA	10/8/2007	0-2
X5SB013	2	HA	10/8/2007	0-2
X5SB014	2	HA	10/8/2007	0-2
X5SB015	2	HA	10/8/2007	0-2
X5SB016	2	HA	10/8/2007	0-2
X5SB017	2	HA	10/8/2007	0-2
X5SB018	2	HA	10/8/2007	0-2
X5SB019	2	HA	10/8/2007	0-2

1) HA = Hand auger.
2) bgs - Below ground surface.

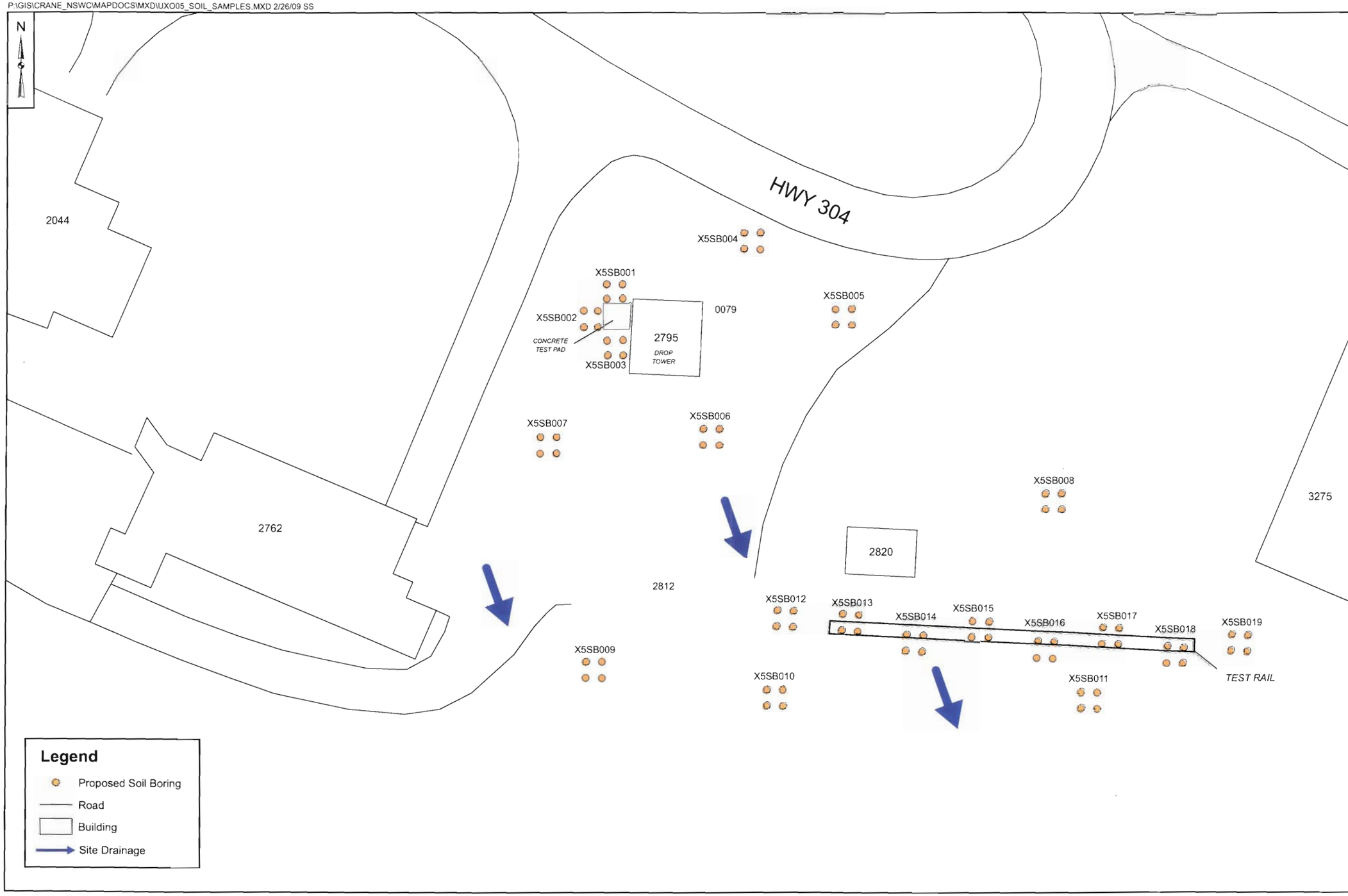
TABLE 2-2

SUMMARY OF ENVIRONMENTAL SAMPLES AND ANALYTICAL METHODS
UXO 5 - BUILDING 2044 DROP TOWER/TEST RAIL SITE
NSWC CRANE
CRANE, INDIANA

Sample Number	Analytical Fraction	
	Nitroaromatics and Nitramines SW-846 8330	TAL Metals SW-3050/6020
X5SS001	X	X
X5SS002	X	X
X5SS003	X	X
X5SS004	X	X
X5SS005	X	X
X5SS006	X	X
X5SS007	X	X
X5SS008	X	X
X5SS009	X	X
X5SS010	X	X
X5SS011	X	X
X5SS012	X	X
X5SS013	X	X
X5SS014	X	X
X5SS015	X	X
X5SS016	X	X
X5SS017	X	X
X5SS018	X	X
X5SS019	X	X
SURFACE SOIL TOTALS	**19**	**19**

X = Sample was collected as proposed.
TAL = Target Analyte List

P:\GIS\CRANE_NSWC\MAPDOCS\MXD\UXO05_SOIL_SAMPLES.MXD 2/26/09 SS



CONTRACT NO. CTO F272

APPROVED BY ____ DATE ____

APPROVED BY ____ DATE ____

DRAWING NO. FIGURE 2 - 1

REV 0

SURFACE SOIL SAMPLE LOCATIONS
UXO 5 - SITE INSPECTION REPORT
NSWC CRANE
CRANE, INDIANA

NAVFAC

DRAWN BY K. MOORE DATE 01/17/07

CHECKED BY J. GOERDT DATE 02/26/09

COST/SCHED-AREA

SCALE AS NOTED

3.0 DATA REPORT

This section presents a summary of the nature and extent of contamination in surface soil at UXO 5 for the October 2007 SI field sampling event based on the analytical results for the event. Nineteen soil samples were collected to determine the characteristics of surface soil at the site. Surface soil samples were collected from three main areas within UXO 5 including:

1) The area around the base of the drop tower,
2) The area underneath and alongside the Test Rail, and.
3) The drainage pathway leading off site.

All sample locations are shown on Figure 2-1. As shown in Table 3-1, all collected samples were analyzed for explosives and TAL metals.

To determine if the analytical results from the soil samples collected during the 2007 SI represent site conditions or background/anthropogenic conditions, soil results were compared to the facility-wide background concentrations for NSWC Crane (Tetra Tech, 2006b). The comparison of site soil data to facility-wide background data consisted of determining if the site soil concentrations are within the range of established background concentrations, which are summarized in Table 3-3. Additionally, concentrations of chemicals in site media were compared to appropriate human health (Section 4.0) and ecological (Section 5.0) screening criteria.

For better understanding of the nature and extent of contamination discussion, the following presents the site data comparison to human health and ecological criteria. Table 3-2 lists the criteria used for comparison to the site data and provides descriptions of the criteria presented.

3.1 SOIL

This section contains a summary of contamination detected in surface soil at UXO 5. Surface soil samples were collected at 19 locations throughout the site. Surface soil samples were collected from a maximum depth of 2 feet bgs. All sample locations are presented on Figure 2-1. All analytical results for soil samples collected during the SI are provided in Table 3-1. Concentrations for parameters detected at least once in soil samples and summary statistics such as frequencies and ranges of detections, ranges of non-detections, and average concentrations are provided in Table 3-2. Background concentrations used in comparisons to the analytical data are presented in Table 3-3.

Only one explosive parameter (2, 4-dinitrotoluene) was detected in soil samples at UXO 5. 2,4-Dinitrotoluene was detected in 2 of the 19 soil samples at concentrations of 0.90 (X5-SB013) and 1.5 (X5-SB014) milligrams per kilogram (mg/kg). Both locations are along the eastern end of the test rail (see Figure 2-1).

Twenty-two inorganic chemicals were detected in surface soil samples at UXO 5. Of these 22 inorganics, 13 (aluminum, antimony, arsenic, barium, cadmium, chromium, cobalt, lead, manganese, nickel, selenium, thallium, and zinc) were detected at concentrations greater than screening levels. Detected concentrations of antimony, cobalt, and manganese were less than background concentrations. Only concentrations of barium and zinc significantly exceeded facility background levels, by a factor of 8 and 145, respectively. Both of these exceedances were detected at one sample location (X5-SB003). The chromium concentration exceeded background by a factor of two at one sample location (X5-SB003). Aluminum, arsenic, and thallium were less than a factor of 2 times the NSWC Crane facility background concentrations.

Lead was detected in all 19 samples collected at UXO 5. However, 18 of the sample locations had lead concentrations less than 24 mg/kg. Only sample location X5-SB003 had a lead concentration (597 mg/kg) above the screening value of 400 mg/kg. This sample location also exhibited higher levels of copper and zinc which are metals commonly associated with lead at firing ranges or ammunition test sites. Sample X5-SB003 was located directly south of the steel drop pad (see Figure 2-1).

Nickel concentrations slightly exceeded background concentrations by a factor of two at sample locations X5-SB003, X5-SB005, and X5-SB007.

Selenium concentrations ranged from 0.165 to 0.909 mg/kg. Excluding the maximum detected concentration (0.909 mg/kg) that was detected at X5-SB003, the selenium concentrations were consistent throughout the site, with an average concentration of 0.382 mg/kg.

Cadmium exceeded facility background concentrations by a factor just greater than two at one sample location (X5-SB003).

Seven of the inorganics detected at concentrations exceeding screening levels (barium, cadmium, chromium, lead, nickel, selenium, and zinc) had maximum detections at location X5-SB003 at UXO 05. This sample is located adjacent to the southern edge of the steel test pad and was the only location with a lead concentration (597 mg/kg) greater than the action level of 400 mg/kg.

Aluminum was detected in all 19 samples; however, 14 samples had concentrations less than or equal to background concentrations in all but five samples. Of the five samples that exceeded background, the concentrations were only slightly greater than background.

Arsenic, barium, and thallium were also detected in all 19 samples, but concentrations of each parameter only slightly exceeded background levels at two sample locations.

TABLE 3-1

ANALYTICAL RESULTS
UXO 5 - BUILDING 2044 DROP TOWER/TEST RAIL SITE
NSWC CRANE
CRANE, INDIANA

LOCATION SAMPLE DATE	X5-SB001 10/8/2007	X5-SB002 10/8/2007	X5-SB003 10/8/2007	X5-SB004 10/8/2007	X5-SB005 10/8/2007	X5-SB006 10/8/2007	X5-SB007 10/8/2007	X5-SB008 10/8/2007
Explosives (mg/kg)								
1,3,5-TRINITROBENZENE	0.029 U	0.029 U	0.029 U	0.029 U	0.029 U	0.029 U	0.029 U	0.029 U
1,3-DINITROBENZENE	0.0081 U	0.0081 U	0.0081 U	0.0081 U	0.0081 U	0.0081 U	0.0081 U	0.0081 U
2,4,6-TRINITROTOLUENE	0.016 U	0.016 U	0.016 U	0.016 U	0.016 U	0.016 U	0.016 U	0.016 U
2,4-DINITROTOLUENE	0.013 U	0.013 U	0.013 U	0.013 U	0.013 U	0.013 U	0.013 U	0.013 U
2,6-DINITROTOLUENE	0.040 U	0.040 U	0.040 U	0.040 U	0.040 U	0.040 U	0.040 U	0.040 U
2-AMINO-4,6-DINITROTOLUENE	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U
2-NITROTOLUENE	0.021 U	0.021 U	0.021 U	0.021 U	0.021 U	0.021 U	0.021 U	0.021 U
3-NITROTOLUENE	0.012 U	0.012 U	0.012 U	0.012 U	0.012 U	0.012 U	0.012 U	0.012 U
4-AMINO-2,6-DINITROTOLUENE	0.024 U	0.024 U	0.024 U	0.024 U	0.024 U	0.024 U	0.024 U	0.024 U
4-NITROTOLUENE	0.016 U	0.016 U	0.016 U	0.016 U	0.016 U	0.016 U	0.016 U	0.016 U
HMX	0.037 U	0.037 U	0.037 U	0.037 U	0.037 U	0.037 U	0.037 U	0.037 U
NITROBENZENE	0.0067 U	0.0067 U	0.0067 U	0.0067 U	0.0067 U	0.0067 U	0.0067 U	0.0067 U
RDX	0.041 U	0.041 U	0.041 U	0.041 U	0.041 U	0.041 U	0.041 U	0.041 U
TETRYL	0.029 U	0.029 U	0.029 U	0.029 U	0.029 U	0.029 U	0.029 U	0.029 U
Inorganics (mg/kg)								
ALUMINUM	12300	15500	5700	3760	4350	3340	7110	10400
ANTIMONY	0.25 U	0.38 U	0.51 U	0.19 U	0.69 U	0.13 U	0.29 U	1.6
ARSENIC	5.72	5.79	4.29	1.99	6.60	7.87	5.08	11.8
BARIUM	68.5	78.6	1170	55.1	378	73.2	115	78.0
BERYLLIUM	0.466	0.470	0.188	0.108	0.448	0.344	0.382	0.763
CADMIUM	2.04	2.40	38.4	1.82	2.23	2.12	2.85	2.68
CALCIUM	56400	93900	177000	142000	199000	198000	191000	3020
CHROMIUM	23.2	19.6	85.6	8.40	17.9	24.5	14.7	34.4
COBALT	5.75	5.98	11.7	1.75	15.1	7.23	10.9	11.1
COPPER	10.5	12.7	64.8	4.37	156	5.57	12.6	17.4
IRON	24500	18100	18100	7020	24000	24300	19500	41100
LEAD	13.4	12.4	597	5.50	23.3	7.77	8.25	24.2
MAGNESIUM	9450	9960	20000	4630	23100	24200	33300	1720
MANGANESE	238	205	395	98.1	1120	516	567	620
NICKEL	15.5	20.6	34.1	9.75	31.5	23.4	29.3	19.7
POTASSIUM	792	1150	732	380	589	489	699	685
SELENIUM	0.173	0.0626 U	0.909	0.235	0.412	0.349	0.425	0.492
SILVER	0.0698	0.0814	0.422	0.0444	0.0611	0.110	0.105	0.190
SODIUM	152	123	158	57.8	196	205	229	29.5 U
THALLIUM	0.162	0.214	0.0949	0.0588	0.0923	0.0476	0.0926	0.171
VANADIUM	31.9	35.3	22.5	11.6	18.5	21.9	23.4	37.4
ZINC	97.4	103	8750	31.0	140	50.6	59.8	91.1

mg/kg - Milligrams per kilogram.

TABLE 3-1

ANALYTICAL RESULTS
UXO 5 - BUILDING 2044 DROP TOWER/TEST RAIL SITE
NSWC CRANE
CRANE, INDIANA

LOCATION SAMPLE DATE	X5-SB009 10/8/2007	X5-SB010 10/8/2007	X5-SB010 10/8/2007	X5-SB011 10/8/2007	X5-SB012 10/8/2007	X5-SB013 10/8/2007	X5-SB014 10/8/2007	X5-SB015 10/8/2007
Explosives (mg/kg)								
1,3,5-TRINITROBENZENE	0.029 U	0.029 U	0.029 U	0.029 U	0.029 U	0.029 U	0.029 U	0.029 U
1,3-DINITROBENZENE	0.0081 U	0.0081 U	0.0081 U	0.0081 U	0.0081 U	0.0081 U	0.0081 U	0.0081 U
2,4,6-TRINITROTOLUENE	0.016 U	0.016 U	0.016 U	0.016 U	0.016 U	0.016 U	0.016 U	0.016 U
2,4-DINITROTOLUENE	0.013 U	0.013 U	0.013 U	0.013 U	0.013 U	0.90	1.5	0.013 U
2,6-DINITROTOLUENE	0.040 U	0.040 U	0.040 U	0.040 U	0.040 U	0.040 U	0.040 U	0.040 U
2-AMINO-4,6-DINITROTOLUENE	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U
2-NITROTOLUENE	0.021 U	0.021 U	0.021 U	0.021 U	0.021 U	0.021 U	0.021 U	0.021 U
3-NITROTOLUENE	0.012 U	0.012 U	0.012 U	0.012 U	0.012 U	0.012 U	0.012 U	0.012 U
4-AMINO-2,6-DINITROTOLUENE	0.024 U	0.024 U	0.024 U	0.024 U	0.024 U	0.024 U	0.024 U	0.024 U
4-NITROTOLUENE	0.016 U	0.016 U	0.016 U	0.016 U	0.016 U	0.016 U	0.016 U	0.016 U
HMX	0.037 U	0.037 U	0.037 U	0.037 U	0.037 U	0.037 U	0.037 U	0.037 U
NITROBENZENE	0.0067 U	0.0067 U	0.0067 U	0.0067 U	0.0067 U	0.0067 U	0.0067 U	0.0067 U
RDX	0.041 U	0.041 U	0.041 U	0.041 U	0.041 U	0.041 U	0.041 U	0.041 U
TETRYL	0.029 U	0.029 U	0.029 U	0.029 U	0.029 U	0.029 U	0.029 U	0.029 U
Inorganics (mg/kg)								
ALUMINUM	13800	14000	13500	11500	11300	3830	3250	3640
ANTIMONY	0.57 U	0.30 U	0.38 U	1.4	0.50 U	0.62 U	1.2	2.1
ARSENIC	5.28	5.50	4.89	6.26	5.96	1.01	2.62	1.94
BARIUM	88.1	51.3	46.0	78.9	85.0	17.6	25.6	25.5
BERYLLIUM	0.574	0.349	0.345	0.467	0.633	0.117	0.141	0.139
CADMIUM	2.78	1.86	0.366	2.46	1.89	1.96	2.12	2.18
CALCIUM	2310	550	600	1310	24200	225000	241000	234000
CHROMIUM	18.5	19.8	19.1	17.1	17.7	12.7	10.4	12.2
COBALT	10.6	4.12	3.50	16.6	10.7	2.10	3.09	2.68
COPPER	12.7	12.6	11.4	11.3	12.6	3.99	9.53	9.25
IRON	15300	20000	17100	17900	22100	4850	9460	6150
LEAD	21.3	12.6	10.8	19.9	15.5	6.49	16.4	21.3
MAGNESIUM	1910	1850	1740	1510	2110	102000	21700	35400
MANGANESE	570	120	89.0	793	549	140	175	189
NICKEL	14.6	11.1	9.85	14.2	15.3	20.3	18.0	19.6
POTASSIUM	902	810	860	664	615	1220	397	617
SELENIUM	0.426	0.270	0.234	0.406	0.473	0.340	0.480	0.445
SILVER	0.133	0.0789	0.0642	0.0964	0.0872	0.0648	0.920	0.554
SODIUM	61.3 U	43.6 U	17.7 U	28.8 U	28.0 U	636	190	322
THALLIUM	0.259	0.207	0.170	0.210	0.169	0.0530	0.0527	0.0590
VANADIUM	30.4	33.0	29.4	28.3	26.2	14.4	12.6	12.8
ZINC	61.5	36.4	31.3	54.1	50.9	44.0	49.8	69.4

mg/kg - Milligrams per kilogram.

TABLE 3-1

ANALYTICAL RESULTS
UXO 5 - BUILDING 2044 DROP TOWER/TEST RAIL SITE
NSWC CRANE
CRANE, INDIANA

LOCATION SAMPLE DATE	X5-SB016 10/8/2007	X5-SB017 10/8/2007	X5-SB018 10/8/2007	X5-SB019 10/8/2007
Explosives (mg/kg)				
1,3,5-TRINITROBENZENE	0.029 U	0.029 U	0.029 U	0.029 U
1,3-DINITROBENZENE	0.0081 U	0.0081 U	0.0081 U	0.0081 U
2,4,6-TRINITROTOLUENE	0.016 U	0.016 U	0.016 U	0.016 U
2,4-DINITROTOLUENE	0.013 U	0.013 U	0.013 U	0.013 U
2,6-DINITROTOLUENE	0.040 U	0.040 U	0.040 U	0.040 U
2-AMINO-4,6-DINITROTOLUENE	0.025 U	0.025 U	0.025 U	0.025 U
2-NITROTOLUENE	0.021 U	0.021 U	0.021 U	0.021 U
3-NITROTOLUENE	0.012 U	0.012 U	0.012 U	0.012 U
4-AMINO-2,6-DINITROTOLUENE	0.024 U	0.024 U	0.024 U	0.024 U
4-NITROTOLUENE	0.016 U	0.016 U	0.016 U	0.016 U
HMX	0.037 U	0.037 U	0.037 U	0.037 U
NITROBENZENE	0.0067 U	0.0067 U	0.0067 U	0.0067 U
RDX	0.041 U	0.041 U	0.041 U	0.041 U
TETRYL	0.029 U	0.029 U	0.029 U	0.029 U
Inorganics (mg/kg)				
ALUMINUM	4430	14000	2980	12900
ANTIMONY	0.24 U	0.96	0.38 U	1.4
ARSENIC	3.67	6.32	2.64	13.6
BARIUM	25.4	88.1	31.3	86.0
BERYLLIUM	0.162 J	0.642	0.150 J	0.935
CADMIUM	2.28	1.61	1.90	2.77
CALCIUM	99900	3910	121000	9210
CHROMIUM	9.08	20.2	9.57	29.8
COBALT	4.10	11.1	2.61	12.9
COPPER	6.94	15.2	8.64	15.5
IRON	10100	21800	7550	47200
LEAD	8.44	19.3	21.7	22.3
MAGNESIUM	21700	2730	26000	3250
MANGANESE	366	527	219	704
NICKEL	12.5	16.7	11.6	21.4
POTASSIUM	516	905	365	863
SELENIUM	0.165	0.447	0.394	0.566
SILVER	0.505	0.215	0.171	0.130
SODIUM	188	34.4 U	182	31.8 U
THALLIUM	0.0803	0.233	0.0595	0.218
VANADIUM	15.6	34.0	13.4	38.9
ZINC	43.9	58.1	59.3	92.9

mg/kg - Milligrams per kilogram.

TABLE 3-2

SUMMARY OF DESCRIPTIVE STATISTICS
UXO 5 - BUILDING 2044 DROP TOWER/TEST RAIL SITE
NSWC CRANE
CRANE, INDIANA

CASRN	PARAMETER	FREQUENCY OF DETECTION	MINIMUM CONCENTRATION	MAXIMUM CONCENTRATION	RANGE OF BACKGROUND CONCENTRATIONS	LOCATION OF MAXIMUM CONCENTRATION	SAMPLE CONTAINING MAXIMUM CONCENTRATION	RANGE OF NON-DETECTIONS	AVERAGE OF DETECTED CONCENTRATIONS	AVERAGE OF ALL RESULTS	USEPA REGION 9 PRG (RESIDENTIAL)[1]	USEPA REGION 9 PRG (INDUSTRIAL)[1]	IDEM DIRECT CONTACT CRITERION (RESIDENTIAL)[2]	IDEM DIRECT CONTACT CRITERION (INDUSTRIAL)[2]	USEPA SSL SOIL TO GROUNDWATER[3]	IDEM MIGRATION TO GROUNDWATER[2]	ECOLOGICAL SCREENING LEVEL[4]
Explosives (mg/kg)																	
121-14-2	2,4-Dinitrotoluene	2/19	0.9	1.5	NA	X5-SB014	X5SS-014C0002	0.013 - 0.013	1	0.1	120 N	1,200 N	NA	NA	0.000049	NA	1.28 [10]
Inorganics (mg/kg)																	
7429-90-5	Aluminum	19/19	2,980	15,500	8240 - 12300	X5-SB002	X5SS-002G0002	-	8321	8321	75,000 N	100,000 max	NA	NA	8.3	NA	pH [9, 11]
7440-36-0	Antimony	6/19	0.96	2.1	1-4 - 5.6	X5-SB015	X5SS-015G0002	0.13 - 0.69	1	0.6	31 N	410 N	140	620	0.27	5.4	0.27 [9]
7440-38-2	Arsenic	19/19	1.01	13.6	3.7 - 10.2	X5-SB019	X5SS-019G0002	-	5	5	0.39 C	1.6 C	3.9	20	0.29	5.8	18 [9]
7440-39-3	Barium	19/19	17.6	1170	65.2 - 153	X5-SB003	X5SS-003G0002	-	138	138	15,000 N	100,000 max	63,000	230,000	82	1,600	330 [9]
7440-41-7	Beryllium	19/19	0.108	0.935	ND	X5-SB019	X5SS-019G0002	-	0.4	0.4	150 N	1,900 N	680	2,900	3.2	63	21 [9]
7440-43-9	Cadmium	19/19	1.61	38.4	0.72 - 3.6	X5-SB003	X5SS-003G0002	-	4	4	37 N	450 N	12	990	0.38	7.5	0.36 [9]
7440-70-2	Calcium	19/19	550	241,000	286 - 35300	X5-SB014	X5SS-014G0002	-	106458	106458	NA	NA	NA	NA	NA	NA	NA
7440-47-3	Chromium	19/19	8.4	85.6	9.2 - 17.8	X5-SB003	X5SS-003G0002	-	21	21	30 C	64 C	430	650	2.1	38	26 [9]
7440-48-4	Cobalt	19/19	1.75	16.6	8.4 - 27.1	X5-SB011	X5SS-011G0002	-	8	8	900 C	1,900 C	NA	NA	0.17	NA	13 [9]
7440-50-8	Copper	19/19	3.99	156	6.5 - 8.1	X5-SB005	X5SS-005G0002	-	21	21	3,100 N	41,000 N	14,000	62,000	560	920	28 [9]
7439-89-6	Iron	19/19	4,850	47,200	9340 - 20900	X5-SB019	X5SS-019G0002	-	18896	18896	55,000 N	100,000 max	NA	NA	NA	NA	pH [9, 12]
7439-92-1	Lead	19/19	5.5	597	12.3 - 20.6	X5-SB003	X5SS-003G0002	-	46	46	400	800	400	1,300	NA	81	11 [9]
7439-95-4	Magnesium	19/19	1,510	102,000	876 - 1330	X5-SB013	X5SS-013G0002	-	18238	18238	NA	NA	NA	NA	NA	NA	NA
7439-96-5	Manganese	19/19	98.1	1120	666 - 3040	X5-SB005	X5SS-005G0002	-	427	427	1,800 N	19,000 N	NA	NA	110	NA	220 [9]
7440-02-0	Nickel	19/19	9.75	34.1	8.8 - 14.2	X5-SB003	X5SS-003G0002	-	19	19	1,600 N	20,000 N	6,900	31,000	14	950	38 [9]
7440-09-7	Potassium	19/19	365	1220	584 - 1340	X5-SB013	X5SS-013G0002	-	705	705	NA	NA	NA	NA	NA	NA	NA
7782-49-2	Selenium	18/19	0.165	0.909	ND	X5-SB003	X5SS-003G0002	0.0626 - 0.0626	0.4	0.4	390 N	5,100 N	1,700	7,800	0.26	5.2	0.52 [9]
7440-22-4	Silver	19/19	0.0444	0.92	0.05 - 0.06	X5-SB014	X5SS-014G0002	-	0.2	0.2	390 N	5,100 N	1,700	7,800	1.6	31	4.2 [9]
7440-23-5	Sodium	12/19	57.8	636	9.4 - 23.7	X5-SB013	X5SS-013G0002	28 - 61.3	220	146	NA	NA	NA	NA	NA	NA	NA
7440-28-0	Thallium	19/19	0.0476	0.259	0.15 - 0.22	X5-SB009	X5SS-009G0002	-	0.1	0.1	5.2 N	67 N	24	110	0.056	2.8	0.0569 [10]
7440-62-2	Vanadium	19/19	11.6	38.9	16.9 - 37.4	X5-SB019	X5SS-019G0002	-	24	24	78 N	1,000 N	NA	NA	260	NA	7.8 [9]
7440-66-6	Zinc	19/19	31	8,750	28.1 - 60.2	X5-SB003	X5SS-003G0002	-	523	523	23,000 N	100,000 max	100,000	470,000	680	14,000	46 [9]

Shading indicates an exceedance of the criteria.

CASRN - Chemical Abstracts Service Registry Number.
COPC - Chemical of potential concern.
DAF - Dilution Attenuation Factor.
Eco-SSL - Ecological Soil Screening Level.
IDEM - Indiana Department of Environmental Management.
mg/kg - Milligrams per kilograms.
PRG - Preliminary Remediation Goal.
RBC - Risk-Based Concentration.
RISC - Risk Integrated System of Closure.
USEPA - United States Environmental Protection Agency.

Notes:

1 - USEPA Region 9 PRG. The noncarcinogenic values (denoted with a "N" flag) are the PRG divided by 10 to correspond to a target hazard quotient of 0.1. (USEPA Region 9, October 2004, Updated December 28, 2004).
2 - IDEM RISC residential closure levels for soil (IDEM, January 2006).
3 - USEPA Soil Screening Levels. US EPA Internet Site at http://risk.lsd.ornl.gov/calc_start.htm. Values are based on a DAF of 1.
4 - Sources of Ecological Screening Levels Eco-SSL (in order of preference):
USEPA Ecological Soil Screening Levels (2003, 2005, 2006, 2007); individual documents available at http://www.epa.gov/ecotox/ecossl/
USEPA Region 5 Ecological Screening Levels, August 22, 2003 available at http://www.epa.gov/reg5rcra/ca/edql.htm.
5 - Naphthalene is used as a surrogate for 2-methylnaphthalene.
6 - Acenaphthene is used as a surrogate for acenaphthylene.
7 - The toxicity criteria in the October 2004 PRG table is outdated. Value was updated using toxicity criteria from the October 2007 USEPA Region 3 RBC Table.
8 - Pyrene have been used as surrogates for benzo(g,h,i)perylene and phenanthrene.
9 - USEPA Eco-SSL.
10 - USEPA Region 5 .
11 - Aluminum is considered a COPC only when the soil pH is less than 5.5.
12 - Iron is not expected to be toxic to plants with a soil pH between 5 and 8.

TABLE 3-3

BACKGROUND CONCENTRATIONS
UXO 5 - BUILIDNG 2044 DROP TOWER/TEST RAIL SITE
NSWC CRANE
CRANE, INDIANA

site	BASEWIDE BACKGROUND	BASEWIDE BACKGROUND	BASEWIDE BACKGROUND	BASEWIDE BACKGROUND	BASEWIDE BACKGROUND
location	BG3SBA01	BG3SBA03	BG3SBA05	BG3SBM02	BG3SBM04
matrix	SO	SO	SO	SO	SO
submatrix	SS	SS	SS	SS	SS
Inorganics (mg/kg)					
ALUMINUM	8240 J	9600 J	9800 J	10400	9900
ANTIMONY	0.71 U	0.71 U	0.41 U	0.38 U	5.6 J
ARSENIC	3.7	4.8	8	5.9 J	5.5 J
BARIUM	74.3 J	105 J	128 J	71.8 J	118 J
BERYLLIUM	0.64 U	0.69 U	0.73 U	0.65 U	0.94 U
CADMIUM	0.2 U	0.29 U	0.28 U	3.6 J	1.2 J
CALCIUM	334	957 J	595 J	303 J	424 J
CHROMIUM	9.2 J	15 J	11.1 J	17.8 J	12.2 J
COBALT	8.8	14.4	8.7	15.2	13.5
COPPER	6.5	8 J	7.5	7.6	8.1 J
IRON	9340 J	16900 J	10700 J	15700	12400
LEAD	12.3 J	19 J	12.3 J	16.6 J	14.2 J
LITHIUM	8.2 J	10.2 J	11.5 J	13.8 J	14.8 J
MAGNESIUM	876 J	1310 J	1000 J	1210 J	1310 J
MANGANESE	721 J	1560 J	1430 J	851 J	1380 J
MERCURY	0.05 U	0.05	0.05 U	0.05 U	0.05 U
NICKEL	8.8 J	13.2 J	12.8 J	11.2 J	13.8 J
POTASSIUM	584	1060	821	688	801
SELENIUM	0.64 U	1 U	0.73 U	0.98 U	0.94 U
SILVER	0.05 J	0.06 J	0.06 J	0.05 J	0.06 J
SODIUM	2.5 U	2.9 U	2.8 U	9.4 J	2.8 U
STRONTIUM	7.4 J	10.1 J	9.9 J	8.6 J	13.3 J
THALLIUM	0.15 J	0.17 J	0.22 J	0.16 J	0.22 J
THORIUM	4.8 J	6.4 J	5.3 J	7.1 J	7.3 J
TIN	0.66 U	0.82 U	0.56 U	0.65 U	0.59 U
VANADIUM	16.9	23.5	19.4 J	26.9	23.1
ZINC	34.1 J	37.7 J	30.2 U	35.1 J	37.2 J

U - Nondetect
J - Estimated

TABLE 3-3

BACKGROUND CONCENTRATIONS
UXO 5 - BUILIDNG 2044 DROP TOWER/TEST RAIL SITE
NSWC CRANE
CRANE, INDIANA

site	BASEWIDE BACKGROUND	BASEWIDE BACKGROUND	BASEWIDE BACKGROUND
location	BG3SBM06	BG3SBM07	BG3SBM08
matrix	SO	SO	SO
submatrix	SS	SS	SS
Inorganics (mg/kg)			
ALUMINUM	9320	12300	8450
ANTIMONY	0.44 U	1.4 J	0.36 U
ARSENIC	7.8 J	10.2 J	4.6 J
BARIUM	153 J	143 J	65.2 J
BERYLLIUM	0.77 U	1.2 U	0.61 U
CADMIUM	0.83 J	0.72 J	0.83 J
CALCIUM	35300 J	286 J	370 J
CHROMIUM	13.1 J	16.4 J	17.6 J
COBALT	13.7	27.1	8.4
COPPER	7.6	7.1 J	7.9 J
IRON	15000	20900	13200
LEAD	17.8 J	20.6 J	14.3 J
LITHIUM	13.9 J	15.9 J	11.2 J
MAGNESIUM	1330 J	1110 J	1040 J
MANGANESE	1690 J	3040 J	666 J
MERCURY	0.05 U	0.05 U	0.05
NICKEL	14.2 J	13.6 J	10.2 J
POTASSIUM	1340	791	630
SELENIUM	1 U	1.3 U	0.72 U
SILVER	0.06 J	0.06 J	0.06 J
SODIUM	23.7 J	13.7 U	4.4 U
STRONTIUM	63.2 J	11.1 J	7.4 J
THALLIUM	0.18 J	0.22 J	0.17 J
THORIUM	5.9 J	7.8 J	5.8 J
TIN	1.2 U	1.2 U	0.52 U
VANADIUM	21.6	37.4	22.3
ZINC	40.2 J	60.2 J	28.1 J

U - Nondetect
J - Estimated

4.0 DATA QUALITY REVIEW

4.1 DATA VALIDATION PROCESS AND DATA QUALITY REVIEW

This section contains a description of the data review processes used to determine whether analytical laboratory data were of acceptable technical quality for use in decision making. The review began with data validation (DV), which is a comparison of data quality indicators (DQIs) to prescribed acceptance criteria. The DQIs used are measures to assess the bias and precision of the analytical calibrations and sample analyses. The output of this review was a set of alphabetic flags such as "U," "J," "R," or combinations thereof, that may have been assigned to individual results based on the validation effort. These flags were used to infer the general quality of the data. Also evaluated were the measures of data completeness, sensitivity, comparability and representativeness. DV letters are provided in Appendix F.

4.1.1 Data Validation Process

All from analytical laboratory results were validated according to several specifications. Assignment of data qualification flags conformed to USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review (USEPA, 1999) and Inorganic Data Review (USEPA, 2004) to the greatest extent practicable for non-Contract Laboratory Program Data. DV specifications require that various data qualifiers be assigned when a deficiency is detected or when a result is less than its detection limit. If no qualifier is assigned to a result that has been validated, the data user is assured that no technical deficiencies were identified during validation. The qualification flags used are defined below:

U – Indicates that the chemical was not detected at the numerical detection limit (sample-specific detection limit) noted. Non-detected results from the laboratory are reported in this manner. This qualifier is also added to a positive result (reported by the laboratory) if the detected concentration is determined to be attributable to contamination introduced during field sampling or laboratory analysis.

UJ – Indicates that the chemical was not detected; however, the detection limit (sample-specific detection limit) is considered to be estimated based on problems encountered during laboratory analysis. The associated numerical detection limit is regarded as inaccurate or imprecise.

J – Indicates that the chemical was detected; however, the associated numerical result is not a precise representation of the concentration that is actually present in the sample. The laboratory reported concentration is considered to be an estimate of the true concentration.

UR – Indicates that the chemical may or may not be present. The non-detected analytical result reported by the laboratory is considered to be unreliable and unusable. This qualifier is applied in cases of gross technical deficiencies (i.e., holding times missed by a factor of two times the specified time limit, severe calibration non-compliances, and extremely low analyte recoveries).

R – Indicates that the chemical may or may not be present. The positive analytical result reported by the laboratory is considered to be unreliable and unusable. This qualifier is applied in cases of gross technical deficiencies.

The preceding data qualifiers may be categorized as indicative of major or minor problems. Major problems are defined as issues that result in the rejection of data and qualification with UR or R DV qualifiers. These data are considered invalid and are not used for decision making purposes unless they are used in a qualitative way and the use is justified and documented. Minor problems are defined as issues resulting in the estimation of data, and qualification with U, J, and UJ DV qualifiers. Estimated analytical results are considered to be suitable for decision-making purposes unless the data use requirements are very stringent and the qualifier indicates a deficiency that is incompatible with the intended data use. A U qualifier does not necessarily indicate that a data deficiency exists because all non-detect values are flagged with the U qualifier regardless of whether a quality deficiency has been detected. No data from the SI at UXO 5 at NSWC Crane have been rejected and considered unusable.

4.1.2 Data Validation Outputs

After data were validated, a list was developed of non-conformities requiring data qualifier flags used to alert the data user to inaccurate or imprecise data. For situations in which several QC criteria were out of specification, the data validator made professional judgements and or comments on the validity of the overall data package. The reviewer then prepared a technical memorandum presenting qualification of the data, if necessary, and the rationale for making such qualifications. The net result was a data package that had been carefully reviewed for its adherence to prescribed technical requirements. Pertinent quality estimates are summarized in a more quantitative format in the following section.

4.1.3 Data Quality Review

DQIs are parameters monitored to help establish the quality of data generated during an investigation. Some of the DQIs are generated from analysis of field samples (e.g., field duplicates) and some are generated from the analysis of laboratory samples (e.g., laboratory duplicates). Individually, field and laboratory DQIs provide measures of the performance of the respective investigative operations (field or

laboratory). During DV, individual QC results were evaluated. If individual QC results were acceptable, no validation flag was assigned to an analytical result; otherwise, a flag indicating the type of QC deficiency was assigned to the result. Samples from NSWC Crane UXO 5 were analyzed by Laucks Laboratories at the same time samples collected from UXO 7 were analyzed. Consequently, samples from more than one UXO but of a similar matrix may have arrived at the analytical laboratory within a similar time frame. Depending on sample arrival dates, samples from different UXOs may have been combined into the same sample preparation or analysis groups for metals only. Explosives were only analyzed at UXO 5 and Polycyclic Aromatic Hydrocarbons (PAHs) were only analyzed at UXO 7. Table 4-1 lists all the data that were qualified and the reason for the qualification. The sample results given the qualification code "A" were analytes with concentrations less than five times the blank action level. Sample results given the qualification code "C" were samples that were associated with a continuing calibration that had a percent recovery (%R) greater than 110.

4.1.4 Completeness

Completeness is a measure of the number of valid samples or measurements that are available relative to the number of samples or measurements that were intended to be generated. For this project, completeness was measured on two different bases:

(1) Samples collected.

- Measure of the usable samples collected as compared to those intended to be collected.

(2) Laboratory measurements.

- Measure of the amount of usable, valid laboratory measurements per matrix obtained for each target analyte.

Usable, valid samples (or results) were those judged, after data assessment, to represent the sampling populations and to have not been disqualified for use through DV or additional data review. Completeness was determined using the following equation:

$$\%C = \frac{V}{T} \times 100$$

where %C = percent completeness
V = number of samples (or results) determined to be valid
T = total number of planned samples (or results)

All samples proposed for collection at UXO 5 were collected (100 percent completeness). The UXO 5 percent completeness for laboratory measurement was 100 percent.

4.1.5 Sensitivity

Sensitivity reflects the ability of an analytical method to quantify low concentrations of an analyte. The analytical method detection limit (MDL) is often used as a measure of sensitivity. The lower the MDL, the greater the sensitivity of the method.

The antimony and 2,4-dinitrotoluene threshold values (TVs) reported by the laboratory were less than the human health criteria for UXO 5. Antimony exceeded the USEPA Soil Screening Level (SSL) for migration to groundwater at UXO 5. 2,4-Dinitrotoluene exceeded the USEPA SSL for migration to groundwater at UXO 5. The impact of these exceedances is discussed in the human health risk assessment.

To understand the impact of not having achieved screening values (SVs) on data analyses, it is important to understand the convention used for reporting non-detection values. Concentrations of organic analytes that were less than their MDLs were reported as the TV, which is similar to the MDL, followed by a U qualifier. The TVs were generally less than laboratory reporting limits (RLs) but were typically greater than MDLs. The TVs represent detection limits as they apply to project-specific sample matrices, as opposed to MDLs, which are determined on ideal matrices. This convention was used to try to measure concentrations as low as the project SVs. If a measured organic analyte concentration exceeded the TV but was less than the RL, the reported concentration was the measured concentration followed by a J qualifier. The J qualifier signified that the reported concentration had a high degree of uncertainty even though there was a high level of confidence that the analyte was detected in the sample. Concentrations less than TVs for inorganics were reported as TVs with a U qualifier. Concentrations of inorganics between the TV and RL were reported with no qualifier. Concentrations of organics and inorganics that exceeded RLs were not qualified unless a data quality deficiency was identified.

4.1.6 Accuracy

Accuracy requirements for field measurements are typically ensured through control over sample collection and handling and through routine instrument calibration. Field accuracies were monitored through the use of blanks to detect cross-contamination and by monitoring adherence to procedures that prevent sample contamination or degradation. An equipment rinsate blank was collected for this

investigation to assess cross-contamination via sample collection equipment. The blank was obtained under representative field conditions by collecting the rinse water generated by running analyte-free water through sample collection equipment after decontamination and before use. The rinsate blank was analyzed for the same chemical constituents as the associated environmental samples.

Accuracy in the laboratory was measured through the comparison of a spiked sample or laboratory control sample (LCS) result to a known or calculated value and was expressed as a %R. It was also assessed by monitoring the analytical recovery of select surrogate compounds added to samples that are analyzed by organic chromatographic methods. LCSs were used to assess the accuracy of laboratory operations with minimal sample matrix effects. Matrix spike (MS) and surrogate compound analyses measure the combined accuracy effects of the sample matrix, sample preparation, and sample measurement. LCS and MS analyses were performed at a frequency of one per 20 associated samples of like matrix as required by the QAPP (Tetra Tech, 2004). The LCS and MS analyses met accuracy limits as specified by the laboratory. Laboratory accuracy was assessed by comparing calculated %R values to accuracy control limits specified by the laboratory using SW-846 Methods.

Percent recovery is calculated using the following equation:

$$\%R = \frac{Ss - So}{S} \times 100$$

where	%R	=	percent recovery
	Ss	=	result of spiked sample
	So	=	result of non-spiked sample
	S	=	concentration of spiked amount.

All matrix spike duplicates (MSDs), LCS duplicate (LCSD), and surrogate recoveries met accuracy limits as specified by the laboratory.

The analyte beryllium had two continuing calibration %Rs outside of the 90 to 110 percent QC limit. The out of control %Rs were 111.5 and 114.1. There is a slight high bias for the beryllium results for samples X5SS-016G0002 and X5SS-018G0002. The impact on data quality is not expected to be significant because only two results are associated with the continuing calibration non-compliance.

4.1.7 Precision

Precision is a measure of the degree to which two or more measurements are in agreement and describes the reproducibility of measurements of the same parameter for samples analyzed under similar conditions.

Precision for chemical parameters is expressed as a Relative Percent Difference (RPD), which is defined as the ratio of the difference to the mean for the two values being evaluated. RPDs, typically expressed as percentages, are used to evaluate both field and laboratory duplicate precision and are calculated as follows:

$$RPD = \frac{|V1 - V2|}{(V1 + V2)/2} \times 100$$

where RPD = relative percent difference
V1, V2 = two results obtained by analyzing duplicate samples

The precision estimates obtained from duplicate field samples encompass the combined uncertainty associated with sample collection, homogenization, splitting, handling, laboratory and field storage (as applicable), preparation for analysis, and analysis. In contrast, precision estimates obtained from analyzing duplicate laboratory samples incorporate only homogenization, subsampling, preparation for analysis, laboratory storage (if applicable), and analysis uncertainties.

All field duplicate, LCS/LCSD, and MS/MSD RPDs met QC limits.

4.1.8 Comparability

Comparability is defined as the confidence with which one data set can be compared with another (e.g., among sampling points and among sampling events). Comparability was achieved by using standardized sampling and analysis methods, as well as standardized data reporting formats. Comparability of field data was ensured by following the QAPP (Tetra Tech, 2004) and Addendum No. 2 (Tetra Tech, 2007). Comparability of laboratory measurements was achieved primarily through the use and documentation of standard sampling and analytical methods. Results were reported in units that ensured comparability with previous data and with current state and federal standards and guidelines. Comparability of laboratory measurements was assessed primarily through the use of QC samples and through adherence to the QA plan.

4.1.9 Representativeness

Representativeness is an expression of the degree to which data accurately and precisely depict the actual characteristics of a population or environmental condition existing at the site. The QAPP (Tetra Tech, 2004) and Addendum No. 2 (Tetra Tech, 2007) and the use of standardized sampling, sample handling, sample analysis, and data reporting procedures were designed so that the final data would be accurate representations of actual site conditions. It is believed that all reported data are adequately representative of site conditions.

TABLE 4-1

SUMMARY OF DATA QUALIFICATIONS
UXO 5 - BUILDING 2044 DROP TOWER/TEST RAIL SITE
NSWC CRANE
CRANE, INDIANA

SAMPLE NUMBER	PARAMETER	SAMPLE RESULT (mg/kg)	QUALIFICATION CODE
X5SS-001G0002	ANTIMONY	0.25 U	A
X5SS-002G0002	ANTIMONY	0.38 U	A
X5SS-003G0002	ANTIMONY	0.51 U	A
X5SS-004G0002	ANTIMONY	0.19 U	A
X5SS-005G0002	ANTIMONY	0.69 U	A
X5SS-006G0002	ANTIMONY	0.13 U	A
X5SS-007G0002	ANTIMONY	0.29 U	A
X5SS-008G0002	SODIUM	29.5 U	A
X5SS-009G0002	SODIUM	61.3 U	A
X5SS-009G0002	ANTIMONY	0.57 U	A
X5SS-010G0002	SODIUM	43.6 U	A
X5SS-010G0002	ANTIMONY	0.3 U	A
X5SS-010G0002-D	ANTIMONY	0.38 U	A
X5SS-010G0002-D	SODIUM	17.7 U	A
X5SS-011G0002	SODIUM	28.8 U	A
X5SS-012G0002	ANTIMONY	0.5 U	A
X5SS-012G0002	SODIUM	28 U	A
X5SS-013G0002	ANTIMONY	0.62 U	A
X5SS-016G0002	ANTIMONY	0.24 U	A
X5SS-016G0002	BERYLLIUM	0.162 J	C
X5SS-017G0002	SODIUM	34.4 U	A
X5SS-018G0002	ANTIMONY	0.38 U	A
X5SS-018G0002	BERYLLIUM	0.15 J	C
X5SS-019G0002	SODIUM	31.8 U	A

A - Laboratory blank contamination where analytes concentrations were less than 5 times the blank action level.
C - Calibration non-conmpliance where samples associated with a continuing calibration had a percent recovery greater than 110 percent.
D - Duplicate sample.
J - estimated.
mg/kg - milligrams per kilogram.
U - non-detection.

5.0 HUMAN HEALTH SCREENING EVALUATION

This section presents the results of the Human Health Risk Screening Evaluation (HHRSE) of chemical concentrations detected in soil samples collected at UXO 5 in October 2007. As detailed in Section 2.4, soil samples were collected from a total of 19 sample location grids at UXO 5 at depths to 2 feet bgs at three separate areas: (1) B-2044/drop tower; (2) test rail; and (3) drainageway. Soil samples were analyzed for explosives and metals. Basic descriptive statistics (frequency of detection, minimum, maximum, and average concentrations, location of maximum concentration) for the target analytes (explosives and metals) are presented in Table 5-1.

Information on the selection of COPCs, exposure assessment, characterization of estimated potential human health risks, uncertainty analysis, and summary and conclusions for the risk screening are presented in Sections 5.1, 5.2, 5.3, 5.4, and 5.5, respectively.

5.1 SELECTION OF CHEMICALS OF POTENTIAL CONCERN

COPCs are the target analytes detected in environmental media that are selected for further evaluation in a risk assessment. COPCs are selected on the basis of comparison to available screening concentrations. Generally, a chemical is designated as a COPC if it is detected at least once at concentrations greater than the limit of detection for that chemical and its maximum concentration exceeds a screening concentration. The following were used as screening concentrations in this HHRSE:

- USEPA Region 9 residential Preliminary Remediation Goals (PRGs) (http://www.epa.gov/region09/waste/sfund/prg/index.html).
- USEPA Region 9 industrial PRGs (http://www.epa.gov/region09/waste/sfund/prg/index.html).
- Indiana Department of Environmental Management (IDEM) residential Direct Contact Criteria (2006).
- IDEM industrial Direct Contact Criteria (2006).
- USEPA SSLs for migration to groundwater (i.e., leaching) (http://risk.lsd.ornl.gov/calc_start.htm).
- IDEM migration to groundwater concentrations (2006).

These screening concentrations are listed in Table 5-1 along with the summary statistics described above.

Of the 14 explosive chemicals for which soil samples were analyzed, only one (2,4-dinitrotoluene), was detected. Table 5-1 indicates that the maximum soil concentration for 2,4-dinitrotoluene exceeded the

USEPA SSL for migration to groundwater (USEPA SSL Soil to Groundwater); therefore, it was selected as a COPC.

Arsenic, cadmium, chromium, and lead were selected as COPCs because detected concentrations exceeded USEPA Region 9 PRGs (Table 5-1). PRGs are chemical concentrations corresponding to fixed levels of risk (i.e., a Hazard Quotient [HQ] of 1 for non-carcinogenic chemicals or an excess lifetime cancer risk of 1E-06 for carcinogenic chemicals). One-tenth of the PRG is typically recommended by USEPA Region 5 as the COPC screening criterion for a non-carcinogenic chemical to account for the potential cumulative effects of multiple chemicals affecting the same target organ. The non-carcinogenic PRGs in Table 5-1 (denoted with an "N" flag) are the PRG divided by 10 to correspond to a target HQ of 0.1.

Aluminum, antimony, barium, cobalt, manganese, nickel, selenium, thallium, and zinc were selected as COPCs because their concentrations exceeded USEPA SSLs (Table 5-1) for migration to groundwater. SSLs are not national cleanup standards, nor do exceedances of SSLs alone trigger the need for response actions or define "unacceptable" levels of contaminants in soil (http://www.epa.gov/superfund/health/conmedia/soil/pdfs/part_1.pdf). In the SSL guidance, "screening" refers to the process of identifying and defining areas, contaminants, and conditions at a particular site that may require further attention.

Lead was selected as a COPC (Table 5-1) because the maximum detected concentration exceeds the USEPA Office of Solid Waste and Emergency Response (OSWER) screening level of 400 mg/kg (USEPA, 1994). Guidance from the Office of Prevention, Pesticides, and Toxic Substances (OPPTS) and OSWER recommends 400 mg/kg as a screening level for lead-contaminated soil in a residential setting where children are frequently present (USEPA, 1994). OPPTS also identifies 2,000 to 5,000 mg/kg as an appropriate range of lead concentrations for areas where contact with soil by children in a residential setting is less frequent. Guidance from the USEPA Technical Review Workgroup (TRW) for Lead indicates that "a reasonable screening level for lead in soils at commercial/industrial (i.e., non-residential) sites is 800 mg/kg" for a typical non-contact intensive worker (USEPA, 2007).

Beryllium, iron, and silver were not selected as COPCs because the maximum detected concentrations of these constituents did not exceed any of the screening criteria (Table 5-1). Even though there are no available screening concentrations for calcium, magnesium, potassium, and sodium, they are generally not considered COPCs at sites because they are believed by USEPA to be "essential nutrients" (1989).

The table below lists the COPCs selected for further evaluation in this screening evaluation.

Explosives		
2,4-dinitrotoluene		
Inorganics		
aluminum	cadmium	nickel
antimony	chromium	selenium
arsenic	cobalt	thallium
barium	lead	Zinc
	manganese	

5.2 EXPOSURE ASSESSMENT

This section presents the exposure assessment for the UXO 5 B-2044/drop tower, test rail, and drainageway areas. The methodology used to determine exposure point concentrations (EPCs) (i.e., the concentrations of COPCs to which a receptor is exposed) is presented. These three areas within UXO 5 were considered as one area for the purpose of the exposure assessment.

As described in more detail in Section 1.0, UXO 5 [Building 2044 (B-2044) Drop Tower/Test Rail Site] consists of two main areas, the drop tower and test rail. UXO 5 is located in an area that is maintained by periodic mowing and is bordered to the north, south, and east by woods and to the west by Highway 45. UXO 5 currently consists of a drop tower approximately 100 feet tall with an 8- by 8-foot by 0.5- inch-thick sheet of metal on the southwestern side of the base of the tower. Approximately 75 feet southeast of drop tower is a test rail approximately 97 feet in length from east to west. UXO 5 is located on a hilly area at an elevation of approximately 790 feet above mean sea level (amsl). The area surrounding the site slopes upward to the northwest to an elevation of 810 feet amsl. To the southeast, the land slopes downward into a valley to an elevation of 750 feet amsl. UXO 5 is a lightly wooded area with young trees and sparse undergrowth. The area immediately surrounding the test rail and the drop tower is grass covered. The northern, southern, and eastern sides of the site are wooded. UXO 5 is located within the central portion of NSWC Crane and within the central drainage basin. Surface water runoff from the site drains south into an unnamed tributary that flows southwest into Boggs Creek. Boggs Creek eventually empties into the East Fork of the White River south of NSWC Crane.

There are no current plans to develop UXO 5. Consequently, under current and future anticipated future land use, the following receptors are the most likely individuals to be exposed to COPCs in soil at the site:

- Base personnel engaged in site maintenance activities (e.g., cutting grass, etc.)
- Trespassers

These receptors may be exposed to COPCs in surface soil at UXO 5 via direct contact (i.e., incidental ingestion, dermal contact) or via inhalation of airborne soil particulates from the site. However, for the purpose of this risk screening, this exposure assessment will assume that a hypothetical future resident or typical industrial worker may be exposed to COPCs in site soils. The exposure assessment assumptions (e.g., soil ingestion rates, etc.) are those specified in the calculation of the Region 9 PRGS for the hypothetical future resident and the typical industrial worker. The exposure assessment methodology for the Region 9 PRGs is presented in Appendix D.

The EPC is the COPC concentration to which the receptor is exposed. Per USEPA guidance, the arithmetic mean concentration is recommended as the EPC for lead and the 95 percent upper confidence limit (UCL) on the arithmetic mean is recommended as the EPC for other chemicals. EPCs are calculated following USEPA's Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites (2002) and using USEPA Pro-UCL software.

5.3 RISK CHARACTERIZATION

The risk characterization for COPCs in soil was conducted using the simple risk-ratio technique described in the following paragraphs. The risk characterization for lead is conducted by a comparison of arithmetic mean lead concentrations in soil to the aforementioned USEPA risk benchmarks (400 mg/kg and 800 mg/kg for residential and industrial land use scenarios, respectively). For the 13 inorganic COPCs listed in Section 5.1, comparisons of site concentrations to background concentrations were performed to determine if site concentrations were statistically significantly greater than background concentrations and thus would merit quantitative consideration in this risk screening.

5.3.1 Background Evaluation

For aluminum, a comparison of background and site soil concentration summary statistics (e.g., arithmetic mean, median, maximum), box plots, 95 percent confidence intervals, normal probability plots, and nonparametic statistical tests (Appendix D.1) indicates that site aluminum concentrations (arithmetic mean = 7,200 mg/kg) are less than background aluminum concentrations (arithmetic mean = 9,700 mg/kg). Therefore, although aluminum concentrations exceeded the SSL, it can be excluded as a COPC on the basis of comparison of site concentrations to background concentrations.

For antimony, a comparison of background and site soil concentration summary statistics (Appendix D.2) indicates that site antimony concentrations (arithmetic mean = 0.57 mg/kg) are less than background

antimony concentrations (arithmetic mean = 1.0 mg/kg). Therefore, although antimony concentrations exceed the SSL, it can be excluded as a COPC on the basis of comparison of site concentrations to background concentrations.

For arsenic, a comparison of background and site soil concentration summary statistics (Appendix D.3) indicates that site arsenic concentrations (arithmetic mean = 5.45 mg/kg) are statistically indistinguishable from background arsenic concentrations (arithmetic mean = 6.31 mg/kg). Therefore, although arsenic concentrations exceed the SSL, it can be excluded as a COPC on the basis of comparison of site concentrations to background concentrations.

For barium, a comparison of background and site soil concentration summary statistics (Appendix D.4) indicates that site barium concentrations (arithmetic mean = 138 mg/kg) are statistically indistinguishable from background barium concentrations (arithmetic mean = 107 mg/kg). Therefore, although barium concentrations exceed the SSL, it can be excluded as a COPC on the basis of comparison of site concentrations to background concentrations.

For cadmium, a comparison of background and site soil concentration summary statistics (Appendix D.5) indicates that site cadmium concentrations (arithmetic mean = 4.1 mg/kg) exceed background cadmium concentrations (arithmetic mean = 0.95 mg/kg). Therefore, cadmium was evaluated in the quantitative risk assessment.

For chromium, a comparison of background and site soil concentration summary statistics (Appendix D.6) indicates that site chromium concentrations (arithmetic mean = 21 mg/kg) are statistically indistinguishable from background chromium concentrations (arithmetic mean = 14 mg/kg). Therefore, although chromium concentrations exceed the SSL, it can be excluded as a COPC on the basis of comparison of site concentrations to background concentrations.

For cobalt, a comparison of background and site soil concentration summary statistics (Appendix D.7) indicates that site cobalt concentrations (arithmetic mean = 7.9 mg/kg) are less than background cobalt concentrations (arithmetic mean = 13.7 mg/kg). Therefore, although cobalt concentrations exceed the SSL, it can be excluded as a COPC on the basis of comparison of site concentrations to background concentrations.

For lead, a comparison of background and site soil concentration summary statistics (Appendix D.9) indicates that site lead concentrations (median = 16.4 mg/kg) are statistically indistinguishable from background lead concentrations (median = 15.5 mg/kg). Therefore, although lead concentrations exceed

the SSL, it can be excluded as a COPC on the basis of comparison of site concentrations to background concentrations.

For manganese, a comparison of background and site soil concentration summary statistics (Appendix D.10) indicates that site manganese concentrations (arithmetic mean = 426 mg/kg) are less than background manganese concentrations (arithmetic mean = 1,075 mg/kg). Therefore, although manganese concentrations exceed the SSL, it can be excluded as a COPC on the basis of comparison of site concentrations to background concentrations.

For nickel, a comparison of background and site soil concentration summary statistics (Appendix D.11) indicates that site nickel concentrations (arithmetic mean = 18.9 mg/kg) exceed background nickel concentrations (arithmetic mean = 12.3 mg/kg). Therefore, nickel was evaluated in the quantitative risk assessment.

For selenium, a comparison of background and site soil concentration summary statistics (Appendix D.12) indicates that site selenium concentrations (arithmetic mean = 0.39 mg/kg) are statistically indistinguishable from background selenium concentrations (arithmetic mean = 0.46 mg/kg). Therefore, although selenium concentrations exceed the SSL, it can be excluded as a COPC on the basis of comparison of site concentrations to background concentrations.

For thallium, a comparison of background and site soil concentration summary statistics (Appendix D.13) indicates that site thallium concentrations (arithmetic mean = 0.13 mg/kg) are statistically indistinguishable from background thallium concentrations (arithmetic mean = 0.19 mg/kg). Therefore, although thallium concentrations exceed the SSL, it can be excluded as a COPC on the basis of comparison of site concentrations to background concentrations.

For zinc, a comparison of background and site soil concentration summary statistics (Appendix D.15) indicates that site zinc concentrations (arithmetic mean = 523 mg/kg) exceed background zinc concentrations (arithmetic mean = 36 mg/kg). Therefore, zinc was evaluated in the quantitative risk assessment.

5.3.2 Risk Calculation Evaluation

The risk characterization results for COPC concentrations detected in UXO 5 soil are presented in Table 5-2. Non-cancer hazard estimates were developed for the hypothetical future resident and typical industrial worker using the EPCs calculated for COPC concentrations in soil (as described above) and

available Region 9 PRGs. As previously noted, the USEPA Region 9 PRGs represent an HQ of 1 for non-carcinogens. Thus, hazard estimates were developed using the following simple ratio, where X represents the HQ for each COPC:

$$\frac{\text{USEPA Region 9 PRG}}{\text{EPC for COPC}} = \frac{\text{Hazard Quotient of 1}}{X}$$

HQs for the hypothetical future resident and the typical industrial worker are summarized below:

COPC	Hazard Quotient	
	Residential	**Industrial**
2,4-Dinitrotoluene	8.E-03	8.E-04
Cadmium	3.E-01	3.E-02
Nickel	1.E-02	1.E-03
Zinc	1.E-01	3.E-02
Sum =	**5.E-01**	**5.E-02**

HQs for all COPCs under both residential and industrial scenarios are less than 1 (1.E+00). Total hazard indices (i.e., the sum of HQs for all COPCs) under both residential and industrial scenarios are also less than one.

The arithmetic mean concentration for lead, 46 mg/kg, is almost 10 and 20 times less than the OSWER screening level of 400 mg/kg and the USEPA TRW screening level of 800 mg/kg for a typical non-contact intensive worker, respectively. OSWER recommends 400 mg/kg as a screening level for lead-contaminated soil in a residential setting where children are frequently present, and the TRW lead concentration represents a reasonable level in soil at commercial/industrial sites.

Cancer risk estimates were developed for the hypothetical future resident and typical industrial worker using the EPCs calculated for COPC concentrations in soil (as described above) and available Region 9 PRGs. As previously noted, the USEPA Region 9 PRGs represent an excess lifetime cancer risk of 1E-06 for carcinogens. Thus, risk estimates were developed using the following simple ratio, where X represents the cancer risk for each COPC:

$$\frac{\text{USEPA Region 9 PRG}}{\text{EPC for COPC}} = \frac{\text{Cancer Risk of 1.E-06}}{X}$$

Cancer risks for the only remaining carcinogenic COPC, arsenic, for the hypothetical future resident and the typical industrial worker are summarized below.

COPC	Cancer Risk	
	residential	industrial
Arsenic	2.E-05	4.E-06

Cancer risks for arsenic were within the USEPA's target risk range of 1.E-04 to 1.E-06. However, the cancer risk under the residential scenario exceeds the State of Indiana's cumulative cancer risk goal of 1.E-05. For perspective, the UXO 5-specific background soil concentration for arsenic was compared to site soil concentrations. A comparison of background and site soil concentration summary statistics (e.g., arithmetic mean, median, maximum), box plots, 95 percent confidence intervals, normal probability plots, and nonparametic statistical tests (Appendix D.3) indicates that site arsenic concentrations (arithmetic mean = 5.5 mg/kg) are less than background arsenic concentrations (arithmetic mean = 6.3 mg/kg). Therefore, the arsenic site cancer risk would be less than the arsenic background cancer risk.

5.4 UNCERTAINTY ANALYSIS

As described previously, 95 percent UCL on the arithmetic mean was used as EPCs for all COPCs except lead. EPCs are calculated using USEPA Pro-UCL software; however, the reliability of 95 percent UCL values calculated with this software can be questioned when the number of detected concentrations that comprise the 95 percent UCL is small. In UXO 5 soil, only 2 of 19 samples had concentrations of 2,4-dinitrotoluene were reported greater than the detection limit. Documentation that accompanies the ProUCL software package states that statistics such as the 95 percent UCL concentration based on only a few detected values (e.g., less than 4 to 6) cannot be considered reliable enough to estimate the EPC. The documentation suggests that when the number of detected data is small, it is preferable to use simple *ad hoc* methods or surrogate concentrations (e.g., the sample median or mode) rather than using statistical methods to compute the EPC.

An alternative to the 95 percent UCL concentration is the maximum reported site concentration. The maximum concentration for 2,4-dinitrotoluene is 1.5 mg/kg, which is only slightly larger than the 95 percent UCL concentration of 1 mg/kg used in the hazard calculations reported above. Using the maximum concentrations in place of the 95 percent UCL concentration does not appreciably increase the HQs for 2,4-dinitrotoluene nor does it increase the total hazard indices above 1.E+00.

5.5 SUMMARY AND CONCLUSIONS

A total of 14 chemicals (2,4-dinitrotoluene, aluminum, antimony, arsenic, barium, cadmium, chromium, cobalt, lead, manganese, nickel, selenium, thallium, and zinc) were detected in UXO 5 soil at concentrations exceeding screening levels typically recommended by USEPA Region 5 to select COPCs for human health risk assessment. However, only six chemicals were retained in the quantitative risk assessment because the concentrations of all of the other COPCs were not statistically significantly greater than background concentrations.

Two human receptors (hypothetical future residents and typical industrial worker) were evaluated for health risks potentially resulting from exposure to these six chemicals. HQs for all COPCs under both residential and industrial scenarios were less than one (1.E+00). Total hazard indices (i.e., the sum of HQs for all COPCs) under both residential and industrial scenarios were also less than one.

The arithmetic mean concentration for lead, 46 mg/kg, is almost 10 and 20 times less than the OSWER screening level of 400 mg/kg and the USEPA TRW screening level of 800 mg/kg for a typical non-contact intensive worker, respectively.

Cancer risks for arsenic were within the USEPA's target risk range of 1.E-04 to 1.E-06, but the arsenic cancer risk under the residential scenario was greater than the State of Indiana's cumulative cancer risk goal of 1.E-05. However, this cancer risk is less than the risk for arsenic at background concentrations in soil at UXO 5.

Based on this assessment, which shows there to be no risk from cancer and non-cancer hazards at UXO 5, no further action (NFA) regarding human health risk is warranted at this site.

TABLE 5-1

HUMAN HEALTH COPC SELECTION
UXO 5 - BUILDING 2044 DROP TOWER\TEST RAIL SITE
NSWC CRANE
CRANE, INDIANA

PARAMETER	FREQUENCY OF DETECTION	MINIMUM CONCENTRATION	MAXIMUM CONCENTRATION	LOCATION OF MAXIMUM CONCENTRATION	SAMPLE CONTAINING MAXIMUM CONCENTRATION	RANGE OF NON-DETECTIONS	AVERAGE OF DETECTED CONCENTRATIONS	AVERAGE OF ALL RESULTS	USEPA REGION 9 PRG (RESIDENTIAL)(1)	USEPA REGION 9 PRG (INDUSTRIAL)(1)	IDEM DIRECT CONTACT CRITERION (RESIDENTIAL) (2)	IDEM DIRECT CONTACT CRITERION (INDUSTRIAL)(2)	USEPA SSL SOIL TO GROUNDWATER(3)	IDEM MIGRATION TO GROUNDWATER(2)
Explosives (mg/kg)														
2,4-Dinitrotoluene	2/19	0.9	1.5	X5-SB014	X5SS-014C0002	0.013 - 0.013	1	0.1	120 N	1,200 N	NA	NA	0.000049	NA
Inorganics (mg/kg)														
Aluminum	19/19	2,980	15,500	X5-SB002	X5SS-002G0002	-	8,321	8,321	75,000 N	100,000 max	NA	NA	8.3	NA
Antimony	6/19	0.96	2.1	X5-SB015	X5SS-015G0002	0.13 - 0.69	1	0.6	31 N	410 N	140	620	0.27	5.4
Arsenic	19/19	1.01	13.6	X5-SB019	X5SS-019G0002	-	5	5	0.39 C	1.6 C	3.9	20	0.29	5.8
Barium	19/19	17.6	1170	X5-SB003	X5SS-003G0002	-	138	138	15,000 N	100,000 max	63,000	230,000	82	1,600
Beryllium	19/19	0.108	0.935	X5-SB019	X5SS-019G0002	-	0.4	0.4	150 N	1,900 N	680	2,900	3.2	63
Cadmium	19/19	1.61	38.4	X5-SB003	X5SS-003G0002	-	4	4	37 N	450 N	12	990	0.38	7.5
Calcium	19/19	550	241,000	X5-SB014	X5SS-014G0002	-	106,458	106,458	NA	NA	NA	NA	NA	NA
Chromium	19/19	8.4	85.6	X5-SB003	X5SS-003G0002	-	21	21	30 C	64 C	430	650	2.1	38
Cobalt	19/19	1.75	16.6	X5-SB011	X5SS-011G0002	-	8	8	900 C	1,900 C	NA	NA	0.17	NA
Copper	19/19	3.99	156	X5-SB005	X5SS-005G0002	-	21	21	3,100 N	41,000 N	14,000	62,000	560	920
Iron	19/19	4,850	47,200	X5-SB019	X5SS-019G0002	-	18,896	18,896	55,000 N	100,000 max	NA	NA	NA	NA
Lead	19/19	5.5	597	X5-SB003	X5SS-003G0002	-	46	46	400	800	400	1,300	NA	81
Magnesium	19/19	1,510	102,000	X5-SB013	X5SS-013G0002	-	18,238	18,238	NA	NA	NA	NA	NA	NA
Manganese	19/19	98.1	1,120	X5-SB005	X5SS-005G0002	-	427	427	1,800 N	19,000 N	NA	NA	110	NA
Nickel	19/19	9.75	34.1	X5-SB003	X5SS-003G0002	-	19	19	1,600 N	20,000 N	6,900	31,000	14	950
Potassium	19/19	365	1220	X5-SB013	X5SS-013G0002	-	705	705	NA	NA	NA	NA	NA	NA
Selenium	18/19	0.165	0.909	X5-SB003	X5SS-003G0002	0.0626 - 0.0626	0.4	0.4	390 N	5,100 N	1,700	7,800	0.26	5.2
Silver	19/19	0.0444	0.92	X5-SB014	X5SS-014G0002	-	0.2	0.2	390 N	5,100 N	1,700	7,800	1.6	31
Sodium	12/19	57.8	636	X5-SB013	X5SS-013G0002	28 - 61.3	220	146	NA	NA	NA	NA	NA	NA
Thallium	19/19	0.0476	0.259	X5-SB009	X5SS-009G0002	-	0.1	0.1	5.2 N	67 N	24	110	0.056	2.8
Vanadium	19/19	11.6	38.9	X5-SB019	X5SS-019G0002	-	24	24	78 N	1,000 N	NA	NA	260	NA
Zinc	19/19	31	8,750	X5-SB003	X5SS-003G0002	-	523	523	23,000 N	100,000 max	100,000	470,000	680	14,000

DAF - Dilution Attenuation Factor.
IDEM - Indiana Department of Environmental Management.
mg/kg - Milligrams per kilograms.
PRG - Preliminary Remediation Goal.
RBC - Risk-Based Concentration.
RISC - Risk Integrated System of Closure.
USEPA - United States Environmental Protection Agency.

Notes:

1 - USEPA Region IX Preliminary Remediation Goal (PRG). The noncarcinogenic values (denoted with a "N" flag) are the PRG divided by 10 to correspond to a target hazard quotient of 0.1. (USEPA Region IX, October 2004, Updated December 28, 2004).
2 - Indiana Department of Environmental Management (IDEM), Risk Integrated System of Closure (RISC) residential closure levels for soil (IDEM, January 2006).
3 - USEPA Soil Screening Levels. EPA Internet Site at http://risk.lsd.ornl.gov/calc_start.htm. Values are based on a DAF of 1.
4 - Sources of Ecological Screening Levels (in order of preference):
USEPA Ecological Soil Screening Levels (2003, 2005, 2006, 2007) individual documents available at http://www.epa.gov/ecotox/ecossl/
USEPA Region 5 Ecological Screening Levels, August 22, 2003 available at http://www.epa.gov/reg5rcra/ca/edql.htm.
5 - Naphthalene is used as a surrogate for 2-methylnaphthalene.
6 - Acenaphthene have been used as surrogates for acenaphthylene.
7 - The toxicity criteria in the October 2004 PRG table is outdated. Value was updated using toxicity criteria from the October 2007 USEPA Region 3 RBC Table.
8 - 8 - Pyrene have been used as surrogates for benzo(g,h,i)perylene and phenanthrene.

TABLE 5-2

QUANTITATIVE RISK ESTIMATES
UXO 5 - BUILDING 2044 DROP TOWER\TEST RAIL SITE
NSWC CRANE
CRANE, INDIANA

COPC	EPC (mg/kg)	N or C?	USEPA Region 9 PRG (mg/kg)		Risk Ratio	
			Residential	Industrial	Residential	Industrial
Explosives						
2,4-dinitrotoluene	1.007	N	120	1200	8.E-03	8.E-04
Inorganics						
Aluminum	12959	N	76000	100000	2.E-01	1.E-01
Antimony	1.458	N	31	410	5.E-02	4.E-03
Arsenic	7.021	C	0.39	1.6	2.E-05	4.E-06
Barium	399.4	N	5400	67000	7.E-02	6.E-03
Cadmium	12.43	N	37	450	3.E-01	3.E-02
Chromium	27.41	C	30	64	9.E-07	4.E-07
Cobalt	9.773	C	900	1900	1.E-08	5.E-09
Lead	179.7	-	400	800	~ 2 x below	~ 4 x below
Manganese	535.4	N	1800	19000	3.E-01	3.E-02
Nickel	21.62	N	1600	20000	1.E-02	1.E-03
Selenium	0.473	N	390	5100	1.E-03	9.E-05
Thallium	0.17	N	5.2	67	3.E-02	3.E-03
Zinc	2516	N	23000	100000	1.E-01	3.E-02
				Sum(C) =	**2.E-05**	**5.E-06**
				Sum (NC) =	**1.E+00**	**2.E-01**
			Sum (2,4-DNT, Cd, Ni, Zn) =		**5.E-01**	**5.E-02**

Notes:

C - Carcinogen
NC - Non-carcinogen
COPC - Chemical of potential concern
EPC - Exposure point concentration
PRG - Preliminary Remediation Goal

6.0 ECOLOGICAL RISK SCREENING EVALUATION

This section presents the results of the Ecological Risk Screening Evaluation (ERSE) of chemical concentrations detected in soil samples collected at UXO 5 in October 2007. As detailed in Section 2.4, soil samples were collected from a total of 19 sample location grids at UXO 5 at depths to 2 feet bgs at three separate areas: (1) B-2044/drop tower; (2) test rail; and (3) drainageway. Soil samples were analyzed for explosives and metals. Basic descriptive statistics, ecological screening levels (ESLs), and ecological effects quotients (EEQs) for the target analytes (explosives and metals) are presented in Table 6-1.

This ERSE is limited to a comparison of maximum and arithmetic mean metals concentrations to ecological screening benchmarks typically used in ecological risk assessments prepared for regulatory review within USEPA Region 5. This ERSE also includes limited food-chain modeling with a summary of the resultant EEQs for the meadow vole, bobwhite quail, short-tailed shrew, and American woodcock (see Table 6-2). Food-chain modeling methodology, calculations, and supporting documentation are presented in Appendix E. The objective of this assessment was to determine if chemical concentrations of explosives and metals in UXO 5 soil are at levels that warrant further ecological evaluation as COPCs. A brief site description and discussion of potential ecological receptors of concern and exposure pathways are presented in Sections 6.1 and 6.2, respectively. The analytical results for soil samples collected at UXO 5 are presented in Section 3.0. The comparison of maximum and arithmetic mean chemical concentrations to ecological screening benchmarks and the results of the limited food-chain modeling are presented in Section 6.3 . An uncertainty analysis is presented in Section 6.4. An ERSE summary and conclusions are presented in Section 6.5.

6.1 SITE DESCRIPTION

As described in more detail in Section 1.0, UXO 5 (B-2044 drop tower/test rail site) consists of two main areas, the drop tower and the test rail. UXO 5 is located in an area maintained by periodic mowing and is bordered to the north, south, and east by woods and to the west by Highway 45. UXO 5 currently consists of a drop tower approximately 100 feet tall with an 8- by 8-foot by 0.5-inch-thick sheet of metal on the southwestern side of the base of the tower. Approximately 75 feet southeast of the drop tower is a test rail approximately 97 feet in length from east to west. UXO 5 is located on a hilly area at an elevation of approximately 790 feet above msl. The area surrounding the site slopes upward to the northwest to an elevation of 810 feet above msl. To the southeast, the land slopes downward into a valley to an elevation of 750 feet above msl. The area immediately surrounding the test rail and drop tower is grass covered.

The northern, southern, and eastern sides of the site are wooded. UXO 5 is located within the central portion of NSWC Crane and within the central drainage basin. Surface water runoff from the site drains south into an unnamed tributary that flows southwest into Boggs Creek. Boggs Creek eventually empties into the East Fork of the White River south of NSWC Crane.

6.2 POTENTIAL ECOLOGICAL RECEPTORS AND EXPOSURE PATHWAYS

Based on the description of the site, ecological receptors could be directly exposed to chemicals in surface soil at UXO 5 (i.e., plants and soil invertebrates), or indirectly exposed via the food-chain (i.e., through the ingestion of plants and invertebrates). The primary ecological receptors of concern are as follows:

- Soil invertebrates
- Terrestrial plants
- Small insectivorous mammals
- Small herbivorous mammals

Large herbivorous, omnivorous, or predatory mammals and birds may visit and feed at the site; however, the portion of UXO 5 considered in this ERSE is small and unlikely to sustain such animals. In addition, although small invertivorous and herbivorous mammals and birds may consume some food items from UXO 5, the home range of most small mammals and birds is much larger than the portion of UXO 5 under consideration.

6.3 ECOLOGICAL SCREENING

The risk screening summarized in Table 6-1 was performed by comparing maximum and arithmetic mean chemical concentrations to the following ecological screening benchmarks for surface soil:

- USEPA Ecological Soil Screening Levels (Eco-SSLs) (http://www.epa.gov/ecotox/ecossl/) – The Eco-SSLs were developed for invertebrates, plants, mammals, and birds for each chemical for which data were available. For some chemicals, adequate data were only available to develop Eco-SSLs for some receptors.

- USEPA Region 5 ESLs for Ecological Receptors (http://www.epa.gov/reg5rcra/ca/edql.htm) – These levels were developed to be protective of soil invertebrates, plants, and terrestrial wildlife regarding

exposure to chemical concentrations in soil. The lower of the screening values for protection of each of these receptors was selected as the ESL.

The USEPA Region 5 ESLs and USEPA Eco-SSLs are conservative and are considered the initial COPC screening levels for this assessment. However, site chemical concentrations greater than these screening levels are not necessarily indicative of a potential for ecological risk at a site because of the following:

- They generally represent the lowest screening levels found in the literature for any receptor and are not always applicable to site-specific receptors and conditions.

- The ESLs and Eco-SSLs for wildlife are often less than site-specific background concentrations. For example, the arithmetic mean vanadium background concentration at NSWC Crane, 23.9 mg/kg, exceeds the ESL for vanadium of 7.8 mg/kg.

2,4-Dinitrotoluene, antimony, barium, cadmium, chromium, cobalt, copper, lead, manganese, selenium, thallium, vanadium, and zinc were selected as UXO 5 ecological COPCs because their concentrations exceeded available ecological screening levels (Table 6-1).

The Eco-SSLs for iron and aluminum are pH dependent. Iron is not expected to be toxic to plants when soil pH is between 5 and 8. Aluminum is not considered to be toxic at a pH greater than 5.5. The average soil pH at NSWC Crane is above 5.5; therefore, iron and aluminum were not selected as COPCs.

For 2,4-dinitrotoluene, the maximum site concentration (1.5 mg/kg) only marginally exceeded the ESL (1.28 mg/kg). Additionally, 2,4-dinitrotoluene was reported infrequently in soil at UXO 5. Only 2 of 19 soil samples, X5-SB013 (0.9 mg/kg) and X5-SB014 (1.5 mg/kg), contained 2,4-dinitrotoluene at concentrations greater than the detection limit (0.013 mg/kg) in samples. Therefore, due to generally low concentrations compared to the ESL and infrequent detection in site soil, 2,4-dinitrotoluene was eliminated from consideration in the quantitative ecological risk assessment.

For the 12 inorganic chemicals listed above, comparisons of site to background concentrations were performed to determine if site concentrations were statistically greater than background concentrations and thus would merit quantitative consideration in this risk screening.

For antimony, a comparison of background and site soil concentration summary statistics (e.g., arithmetic mean, median, maximum), box plots, 95 percent confidence intervals, normal probability plots, and

nonparametic statistical tests (Appendix D.2) indicates that site antimony concentrations (arithmetic mean = 0.57 mg/kg) are less than background antimony concentrations (arithmetic mean = 1.0 mg/kg). Therefore, although antimony concentrations exceed the ESL, it can be excluded as a COPC on the basis of comparison of site concentrations to background concentrations.

For barium, a comparison of background and site soil concentration summary statistics (Appendix D.4) indicates that site barium concentrations (arithmetic mean = 138 mg/kg) are statistically indistinguishable from background barium concentrations (arithmetic mean = 107 mg/kg). Therefore, although barium concentrations exceed the ESL, it can be excluded as a COPC on the basis of comparison of site concentrations to background concentrations.

For cadmium, a comparison of background and site soil concentration summary statistics (Appendix D.5) indicates that site cadmium concentrations (arithmetic mean = 4.1 mg/kg) exceed background cadmium concentrations (arithmetic mean = 0.95 mg/kg). The maximum detected cadmium concentration (38.4 mg/kg) is less than the Eco-SSL for soil invertebrates (140 mg/kg) and only slightly greater than the Eco-SSL for plants (32 mg/kg). Therefore, although cadmium concentrations exceed the ESL, risks to these receptors are not expected, and cadmium is excluded as a COPC for plants and invertebrates. Risks to wildlife from cadmium are discussed below.

For chromium, a comparison of background and site soil concentration summary statistics (Appendix D.6) indicates that site chromium concentrations (arithmetic mean = 21 mg/kg) are statistically indistinguishable from background chromium concentrations (arithmetic mean = 14 mg/kg). Therefore, although chromium concentrations exceed the ESL, it can be excluded as a COPC on the basis of comparison of site concentrations to background concentrations.

For cobalt, a comparison of background and site soil concentration summary statistics (Appendix D.7) indicates that site cobalt concentrations (arithmetic mean = 7.9 mg/kg) are less than background cobalt concentrations (arithmetic mean = 13.7 mg/kg). Therefore, although cobalt concentrations exceed the ESL, it can be excluded as a COPC on the basis of comparison of site concentrations to background concentrations.

For copper, a comparison of background and site soil concentration summary statistics (Appendix D.8) indicates that site copper concentrations (arithmetic mean = 21.1 mg/kg) exceed background copper concentrations (arithmetic mean = 7.5 mg/kg). Only 2 of the 19 detections, 64.8 mg/kg (X5-SB003) and 156 mg/kg (X5-SB005) exceed the ESL. Furthermore, the average detected concentration of copper (21.1 mg/kg) is significantly less than the ESL (28 mg/kg). Therefore, although copper concentrations

exceed the ESL, it can be excluded as a COPC based on the limited number of exceedances and the average detected concentration being less than the ESL.

For lead, a comparison of background and site soil concentration summary statistics (Appendix D.9) indicates that site lead concentrations (median = 16.4 mg/kg) are statistically indistinguishable from background lead concentrations (median = 15.5 mg/kg). Therefore, although lead concentrations exceed the ESL, it can be excluded as a COPC on the basis of comparison of site concentrations to background concentrations.

For manganese, a comparison of background and site soil concentration summary statistics (Appendix D.10) indicates that site manganese concentrations (arithmetic mean = 426 mg/kg) are less than background manganese concentrations (arithmetic mean = 1,075 mg/kg). Therefore, although manganese concentrations exceed the ESL, it can be excluded as a COPC on the basis of comparison of site concentrations to background concentrations.

For selenium, a comparison of background and site soil concentration summary statistics (Appendix D.12) indicates that site selenium concentrations (arithmetic mean = 0.39 mg/kg) are statistically indistinguishable from background selenium concentrations (arithmetic mean = 0.46 mg/kg). Therefore, although selenium concentrations exceed the ESL, it can be excluded as a COPC on the basis of comparison of site concentrations to background concentrations.

For thallium, a comparison of background and site soil concentration summary statistics (Appendix D.13) indicates that site vanadium concentrations (arithmetic mean = 0.13 mg/kg) are statistically less than background thallium concentrations (arithmetic mean = 0.19 mg/kg). Therefore, even though thallium concentrations exceed the ESL, it can be excluded as a COPC on the basis of comparison of site concentrations to background concentrations.

For vanadium, a comparison of background and site soil concentration summary statistics (Appendix D.14) indicates that site vanadium concentrations (arithmetic mean = 24.3 mg/kg) are nearly indistinguishable from background vanadium concentrations (arithmetic mean = 23.9 mg/kg). Therefore, although vanadium concentrations exceed the ESL, it can be excluded as a COPC on the basis of comparison of site concentrations to background concentrations.

For zinc, a comparison of background and site soil concentration summary statistics (Appendix D.15) indicates that site zinc concentrations (arithmetic mean = 523 mg/kg) exceed background zinc concentrations (arithmetic mean = 36 mg/kg). Except for the maximum concentration of 8,750 mg/kg

(X5-SB003), all other detected concentrations are less than the plant Eco-SSL (160 mg/kg) and only one other sample (140 mg/kg at X5-SB005) had a concentrations slightly greater than the soil invertebrate Eco-SSL (120 mg/kg). Therefore, although zinc concentrations exceed the ESL, risks to these receptors are not expected and zinc is excluded as a COPC for plants and invertebrates based on the limited number of exceedances. Risks to wildlife from zinc are discussed below.

Food-Chain Model Screening

A food-chain model screening for chemicals with detections exceeding their respective ESLs was completed using average exposure parameters and average chemical concentrations (see Appendix E for supporting documentation). EEQs exceeded 1.0 for cadmium, lead, thallium, and zinc for invertivorous receptors only (Table 6-2). Lead concentrations were not statistically different than background concentrations, and thallium concentrations were less than background concentrations, as described above. Therefore, although EEQs for lead and thallium are greater than 1.0, risks are not expected to be site related. The maximum cadmium and zinc detections (38.4 and 597 mg/kg, respectively) occur at X5-SB003, which is adjacent to the steel test pad near the drop tower. These maximum concentrations are causing the food-chain model EEQs for cadmium and zinc to exceed 1.0. This sample location consists of gravel interspersed with grass and is very poor ecological habitat. Invertivorous receptors are not likely to obtain a significant portion of their diet from this sample location. Therefore, although food-chain model EEQs exceeded 1.0 for cadmium and zinc, risks to invertivorous receptors are not likely because of the lack of suitable ecological habitat at the location of the maximum detection and the site in general.

6.4 UNCERTAINTY ANALYSIS

Measurement endpoints were used to evaluate the assessment endpoints selected for this ERSE. For this ERSE, the measures of effects were not the same as the assessment endpoints. The measures were used to predict effects to the assessment endpoints by selecting surrogate species that were evaluated. The contaminant dose to terrestrial wildlife was calculated using an equation that incorporates ingestion rates, body weights, Bioaccumulation Factors (BAFs), and other exposure factors. These exposure factors were obtained from literature studies or predicted using various equations. There is uncertainty in the chemical data collected at the site. Measured levels of chemicals are only estimates of the true site chemical concentrations. Risks are possible if an EEQ is greater than or equal to 1.0 regardless of the magnitude of the EEQ. However, the magnitude of effects to ecological receptors cannot be inferred based on the magnitude of the EEQ. Rather, an EEQ greater than 1.0 simply indicates that the dose used to derive the toxicity reference value was exceeded. Finally, there is

uncertainty in how the predicted risks to a species at a site translate into risk to the population in the area as a whole.

6.5 SUMMARY AND CONCLUSIONS

In summary, 2,4-dinitrotoluene and all of the 12 inorganics initially retained as COPCs were eliminated from quantitative consideration in this ERSE. Initial COPCs were eliminated on the basis of comparisons of site concentrations to background concentrations, frequencies of detection, numbers of ESL exceedances, and lack of suitable ecological habitat. Therefore, ecological risks at UXO 5 from explosives and inorganics are expected to be minimal, and NFA regarding ecological risk is warranted at this site.

TABLE 6-1

ECOLOGICAL RISK SCREENING EVALUATION COPC SELECTION
UXO 5 - BUILDING 2044 DROP TOWER AND TEST RAIL SITE
NSWC CRANE
CRANE, INDIANA

PARAMETER	FREQUENCY OF DETECTION	MINIMUM CONCENTRATION	MAXIMUM CONCENTRATION	LOCATION OF MAXIMUM CONCENTRATION	SAMPLE CONTAINING MAXIMUM CONCENTRATION	AVERAGE OF POSITIVE DETECTIONS	AVERAGE OF ALL RESULTS	ECOLOGICAL SCREENING LEVEL[1]	MAXIMUM EEQ	AVERAGE EEQ	SELECTED FOR FOOD-CHAIN MODELING?
Explosives (mg/kg)											
2,4-Dinitrotoluene	2/19	0.9	1.5	X5-SB014	X5SS-014C0002	1.2	0.13	1.28 [3]	1.171875	0.9375	Yes
Inorganics (mg/kg)											
Aluminum	19/19	2980	15500	X5-SB002	X5SS-002G0002	8321	8321	pH [2,4]	NA	NA	No
Antimony	6/19	0.96	2.1	X5-SB015	X5SS-015G0002	1	0.6	0.27 [2]	7.7777778	5.345679	Yes
Arsenic	19/19	1.01	13.6	X5-SB019	X5SS-019G0002	5	5.5	18 [2]	0.7555556	0.3039181	No
Barium	19/19	17.6	1170	X5-SB003	X5SS-003G0002	138	138	330 [2]	3.5454545	0.4177352	Yes
Beryllium	19/19	0.108	0.935	X5-SB019	X5SS-019G0002	0.4	0.4	21 [2]	0.0445238	0.0187419	No
Cadmium	19/19	1.61	38.4	X5-SB003	X5SS-003G0002	4	4.1	0.36 [2]	106.66667	11.454678	Yes
Calcium	19/19	550	241000	X5-SB014	X5SS-014G0002	106458	106458	NUT	NA	NA	No
Chromium	19/19	8.4	85.6	X5-SB003	X5SS-003G0002	21	21	26 [2]	3.2923077	0.8205466	Yes
Cobalt	19/19	1.75	16.6	X5-SB011	X5SS-011G0002	8	7.9	13 [2]	1.2769231	0.6077328	Yes
Copper	19/19	3.99	156	X5-SB005	X5SS-005G0002	21	21	28 [2]	5.5714286	0.7559962	Yes
Iron	19/19	4850	47200	X5-SB019	X5SS-019G0002	18896	18896	pH [2,5]	NA	NA	No
Lead	19/19	5.5	597	X5-SB003	X5SS-003G0002	46	46	11 [2]	54.272727	4.1964115	Yes
Magnesium	19/19	1510	102000	X5-SB013	X5SS-013G0002	18238	18238	NUT	NA	NA	No
Manganese	19/19	98.1	1120	X5-SB005	X5SS-005G0002	427	427	220 [2]	5.0909091	1.9404545	Yes
Nickel	19/19	9.75	34.1	X5-SB003	X5SS-003G0002	19	19	38 [2]	0.8973684	0.4974377	No
Potassium	19/19	365	1220	X5-SB013	X5SS-013G0002	705	705	NUT	NA	NA	No
Selenium	18/19	0.165	0.909	X5-SB003	X5SS-003G0002	0.4	0.4	0.52 [2]	1.7480769	0.7913462	Yes
Silver	19/19	0.0444	0.92	X5-SB014	X5SS-014G0002	0.2	0.2	4.2 [2]	0.2190476	0.050614	No
Sodium	12/19	57.8	636	X5-SB013	X5SS-013G0002	220	146	NUT	NA	NA	No
Thallium	19/19	0.0476	0.259	X5-SB009	X5SS-009G0002	0.1	0.1	0.0569 [3]	4.5518453	2.3436315	Yes
Vanadium	19/19	11.6	38.9	X5-SB019	X5SS-019G0002	24	24	7.8 [2]	4.9871795	3.1180837	Yes
Zinc	19/19	31	8750	X5-SB003	X5SS-003G0002	523	523	46 [2]	190.21739	11.376659	Yes

Notes:

Shading indicates an exceedance of the criteria.

1 - Sources of Ecological Screening Levels (in order of preference):
USEPA Ecological Soil Screening Levels (2003, 2005, 2006, 2007) individual documents available at http://www.epa.gov/ecotox/ecossl/
USEPA Region 5 Ecological Screening Levels, August 22, 2003 available at http://www.epa.gov/reg5rcra/ca/edql.htm.
2 - USEPA Eco-SSL
3 - USEPA Region 5
4 - Aluminum is considered a COPC only when the soil pH is less than 5.5.
5 - Iron is not expected to be toxic to plants with a soil pH between 5 and 8.

EEQ = Ecological Effects Quotient
NUT = Essential Nutrient
NA = Not applicable, not available

TABLE 6-2

FOOD CHAIN MODEL RESULTS -SOIL INVERTIVOROUS AND HERBIVOROUS RECEPTORS
UXO 5 - BUILDING 2044 DROP TOWER/TEST RAIL SITE
NSWC CRANE
CRANE, INDIANA

	Herbivorous Receptors EEQs				Soil Invertivorous Receptors EEQs			
	Meadow Vole		Bobwhite Quail		Short-Tailed Shrew		Woodcock	
Chemical	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Explosives								
2,4-DINITROTOLUENE	8.4E-02	1.1E-02	#VALUE!	#VALUE!	6.5E-02	8.7E-03	#VALUE!	#VALUE!
Inorganics								
ANTIMONY	1.1E-02	2.3E-04	#VALUE!	#VALUE!	9.8E-01	2.1E-02	#VALUE!	#VALUE!
BARIUM	2.2E-02	1.4E-02	#VALUE!	#VALUE!	2.6E-02	1.6E-02	#VALUE!	#VALUE!
CADMIUM	8.8E-02	9.9E-03	1.3E-02	3.1E-03	3.2E+00	3.6E-01	2.3E+00	5.4E-01
CHROMIUM	2.3E-02	9.5E-04	1.0E-02	1.7E-03	2.7E-01	1.1E-02	4.0E-01	6.7E-02
COBALT	1.0E-03	4.0E-04	8.7E-04	3.6E-04	1.4E-02	5.3E-03	2.6E-02	1.1E-02
COPPER	5.9E-02	4.0E-03	2.3E-02	2.7E-03	1.9E-01	1.3E-02	4.0E-01	4.7E-02
LEAD	2.9E-02	7.4E-04	3.8E-02	1.4E-03	3.8E-01	9.5E-03	1.7E-00	6.2E-02
MANGANESE	3.7E-02	1.3E-02	4.1E-03	1.9E-03	6.0E-02	2.1E-02	4.1E-02	1.9E-02
SELENIUM	2.0E-02	4.3E-03	3.3E-03	1.2E-03	2.9E-01	6.2E-02	2.0E-01	7.1E-02
THALLIUM	1.7E-01	1.7E-02	#VALUE!	#VALUE!	1.9E+00	1.9E-01	#VALUE!	#VALUE!
VANADIUM	4.8E-03	2.1E-03	5.7E-02	1.1E-02	2.9E-02	1.3E-02	1.0E+00	2.0E-01
ZINC	1.0E-01	2.6E-02	3.5E-02	1.3E-02	8.7E-01	2.2E-01	1.4E+00	5.5E-01

Cells are shaded if the EEQ is greater than 1.0

NOAEL - No Observed Adverse Effects Level
LOAEL - Lowest Observed Adverse Effects Level
EEQ - Ecological Effects Quotient
#VALUE! = Value not able to be calculated

7.0 CONCLUSIONS

Based on the analytical results from this SI and the human health and ecological risk screening evaluations, additional soil sampling at UXO 5 is not warranted, and a site status of NFA is recommended.

REFERENCES

Indiana Department of Environmental Management (IDEM), 2006. Risk Integrated System of Closure Users Guide and Technical Resource Guidance Document. Indiana Department of Environmental Management, February 2001, Updated January 2006, June 2006, August 2006.

Tetra Tech NUS, Inc. (TtNUS), 2001. Final Basewide Background Soil investigation Report, Naval Surface Warfare Center Crane, Crane, Indiana, Revision 1, January.

Tetra Tech (Tetra Tech NUS, Inc.), 2004. Quality Assurance Project Plan for RCRA Facility Investigation at Building 106 Pond (SWMU 8) Roads and Grounds Area (SWMU 15) AND Environmental Indicator Investigation for SWMU 18 (Load and Fill Area Buildings), SWMU 19 (Pyrotechnic Test Area), SWMU 20 (Crane Army Ammunition Activity Quality Assurance/Quality Control Test Area), and the Old Gun Tub Storage Lot, September.

Tetra Tech, 2007. Quality Assurance Project Plan for RCRA Facility Investigation at Building 106 Pond (SWMU 8) Roads and Grounds Area (SWMU 15) AND Environmental Indicator Investigation for SWMU 18 (Load and Fill Area Buildings), SWMU 19 (Pyrotechnic Test Area), SWMU 20 (Crane Army Ammunition Activity Quality Assurance/Quality Control Test Area), and the Old Gun Tub Storage Lot, Addendum No. 2. August.

USEPA (United States Environmental Protection Agency), 1989, Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A), Interim Final, EPA/540/1-89/002.

USEPA, 1994. Guidance on Residential Lead-Based Paint, Lead-Contaminated Dust, and Lead-Contaminated Soil. Office of Prevention, Pesticides, and Toxic Substances, Washington, D.C., July 14.

USEPA, 2002, Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C., OSWER 9285.6-10.

USEPA, 2003a. Ecological Screening Levels. USEPA Region 5 (http://www.epa.gov/reg5rcra/ca/edql.htm). August.

USEPA, 2003b. Ecological Soil Screening Level for Aluminum, Interim Final. Office of Emergency and Remedial Response. OSWER Directive 9285.7-60. November.

USEPA, 2003c. Ecological Soil Screening Level for Iron, Interim Final. Office of Emergency and Remedial Response. OSWER Directive 9285.7-69. November.

USEPA, 2005a. Guidance for Developing Ecological Soil Screening Level. Office of Solid Waste and Emergency and Response. OSWER Directive 92857-55. February.

USEPA, 2005b. Ecological Soil Screening Level for Antimony, Interim Final. Office of Emergency and Remedial Response. OSWER Directive 9285.7-61. February.

USEPA, 2005c. Ecological Soil Screening Level for Arsenic, Interim Final. Office of Emergency and Remedial Response. OSWER Directive 9285.7-62. March.

USEPA, 2005d. Ecological Soil Screening Level for Barium, Interim Final. Office of Emergency and Remedial Response. OSWER Directive 9285.7-63. February.

USEPA, 2005e. Ecological Soil Screening Level for Beryllium, Interim Final. Office of Emergency and Remedial Response. OSWER Directive 9285.7-64. February.

USEPA, 2005f. Ecological Soil Screening Level for Cadmium, Interim Final. Office of Emergency and Remedial Response. OSWER Directive 9285.7-65. March.

USEPA, 2005g. Ecological Soil Screening Level for Chromium, Interim Final. Office of Emergency and Remedial Response. OSWER Directive 9285.7-66. March.

USEPA, 2005h. Ecological Soil Screening Level for Cobalt, Interim Final. Office of Emergency and Remedial Response. OSWER Directive 9285.7-67. March.

USEPA, 2005i. Ecological Soil Screening Level for Lead, Interim Final. Office of Emergency and Remedial Response. OSWER Directive 9285.7-70. March.

USEPA, 2005j. Ecological Soil Screening Level for Vanadium, Interim Final. Office of Emergency and Remedial Response. OSWER Directive 9285.7-75. April.

USEPA, 2006. Ecological Soil Screening Level for Silver, Interim Final. Office of Emergency and Remedial Response. OSWER Directive 9285.7-77. October.

USEPA, 2007a. Ecological Soil Screening Level for Copper, Interim Final. Office of Emergency and Remedial Response. OSWER Directive 9285.7-68. February.

USEPA, 2007b. Ecological Soil Screening Level for Nickel, Interim Final. Office of Emergency and Remedial Response. OSWER Directive 9285.7-76. March.

USEPA, 2007c. Guidance for Developing Ecological Soil Screening Level, Attachment 4-1, Exposure Factors and Bioaccumulation Models for Derivation of Wildlife Eco-SSLs. Office of Solid Waste and Emergency and Response. OSWER Directive 9285.7-55. April.

USEPA, 2007d. Ecological Soil Screening Level for Manganese, Interim Final. Office of Emergency and Remedial Response. OSWER Directive 9285.7-71. April.

USEPA, 2007e. U.S. EPA Technical Review Workgroup for Lead. Guidance Document. Frequently Asked Question (FAQs) on the Adult Lead Model. August 2007 (Online - http://www.epa.gov/superfund/health/contaminants/lead/almfaq.htm)

USEPA, 2007f. Ecological Soil Screening Level for Selenium, Interim Final. Office of Emergency and Remedial Response. OSWER Directive 9285.7-72. November.

USEPA, 2007g. Ecological Soil Screening Level for Zinc, Interim Final. Office of Emergency and Remedial Response. OSWER Directive 9285.7-73. November.

APPENDIX A

FIELD SAMPLE LOGS

MULTIPLE SAMPLE LOG SHEET

Tetra Tech NUS, Inc.

[X] SURFACE SOIL [] SEDIMENT
[] SUBSURFACE SOIL [] LAGOON / POND
[] OTHER _____

SIGNATURE(S): _____

SAMPLER (S): _ James Goerdt / Frank Montes

PROJECT NAME: **NSWC Crane - UXO 5**
PROTECT NUMBER: **112G00447**
YEAR **2007**

LOCATION: **Building 2044 DropTower/Test Rail**

SAMPLE No.	SAMPLE METHOD	DEPTH (Ft.)	DATE	TIME	CONCENTRATION (L)LOW (H)HIGH	(G) GRAB (C) COMPOSITE	TOTAL NUMBER OF CONTAINERS	ANALYSES: Nitroaromatics and Nitramines SW-846-8330	ANALYSES: TAL Metals SW-846-3050B/6020					USCS	PID READING	SOIL DESCRIPTION
X5SS0010002	HA	0-2	10/8	8:15		G	1		X					- - -	NA	Area was very rocky in top 6", then mixed rock/soil down to 2 feet. Soil was sandy. Metals collected from SE Quad.
X5SS0010002	HA	0-2	10/8	8:15		C	1	X						- - -	NA	
X5SS0020002	HA	0-2	10/8	8:30		G	1		X					- - -	NA	Area was very rocky in top 6", then mixed rock/soil down to 2 feet. Soil was sandy. Metals collected from SE Quad.
X5SS0020002	HA	0-2	10/8	8:30		C	1	X						- - -	NA	
X5SS0030002	HA	0-2	10/8	8:50		G	1		X					- - -	NA	Location was underneath the drop tower. Area was fairly rocky in first 6", then mixed rock/soil down to ~ 18". Metals collected from NE Quad.
X5SS0030002	HA	0-2	10/8	8:50		C	1	X						- - -	NA	
X5SS0040002	HA	0-2	10/8	9:10		G	1		X					- - -	NA	Sample location just inside chain-link fence. Mixture of rock/soil. Metals collected from SW Quad.
X5SS0040002	HA	0-2	10/8	9:10		C	1	X						- - -	NA	
X5SS0050002	HA	0-2	10/8	9:25		G	1		X					- - -	NA	Mixture of rock/soil. Metals collected from NW Quad.
X5SS0050002	HA	0-2	10/8	9:25		C	1	X						- - -	NA	
X5SS0060002	HA	0-2	10/8	9:45		G	1		X					- - -	NA	Mixture of rock/soil. Metals collected from SW Quad.
X5SS0060002	HA	0-2	10/8	9:45		C	1	X						- - -	NA	
X5SS0070002	HA	0-2	10/8	10:20		G	1		X					- - -	NA	Sample location just inside chain-link fence. Mixture of rock/soil. Metals collected from SE Quad.
X5SS0070002	HA	0-2	10/8	10:20		C	1	X						- - -	NA	

REMARKS:

LABORATORY:

Laucks Testing Laboratories, Inc.

COC No(s).:

3269 and 3270

MULTIPLE SAMPLE LOG SHEET

Tetra Tech NUS, Inc.

[X] SURFACE SOIL [] SEDIMENT
[] SUBSURFACE SOIL [] LAGOON / POND
[] OTHER _____

SIGNATURE(S): _____

SAMPLER (S): _ James Goerdt / Frank Montes

PROJECT NAME: **NSWC Crane - UXO 5**
PROTECT NUMBER: **112G00447**
YEAR **2007**

LOCATION: **Building 2044 DropTower/Test Rail**

SAMPLE No.	SAMPLE METHOD	DEPTH (Ft.)	DATE	TIME	CONCENTRATION (L)LOW (H)HIGH	(G) GRAB (C) COMPOSITE	TOTAL NUMBER OF CONTAINERS	ANALYSES: Nitroaromatics and Nitramines SW-846-8330	ANALYSES: TAL Metals SW-846-3050B/6020					USCS	PID READING	SOIL DESCRIPTION
X5SS0080002	HA	0-2	10/8	14:38		G	1		X					- - -	NA	Sandy soil. Metals collected from NE Quad.
X5SS0080002	HA	0-2	10/8	14:38		C	1	X						- - -	NA	
X5SS0090002	HA	0-2	10/8	12:30		G	1		X					- - -	NA	Sandy soil. Metals collected from NE Quad.
X5SS0090002	HA	0-2	10/8	12:30		C	1	X						- - -	NA	
X5SS0100002	HA	0-2	10/8	12:50		G	1		X					- - -	NA	Sandy soil. Metals collected from NW Quad. Field duplicate collected on metals (X5FD10080701).
X5SS0100002	HA	0-2	10/8	12:50		C	1	X						- - -	NA	
X5SS0110002	HA	0-2	10/8	13:00		G	1		X					- - -	NA	Sandy soil. Metals collected from SW Quad.
X5SS0110002	HA	0-2	10/8	13:00		C	1	X						- - -	NA	
X5SS0120002	HA	0-2	10/8	10:45		G	1		X					- - -	NA	Had to remove top 12" of gravel to get to sil below. Metals collected from NE Quad.
X5SS0120002	HA	0-2	10/8	10:45		C	1	X						- - -	NA	
X5SS0130002	HA	0-2	10/8	11:05		G	1		X					- - -	NA	Had to remove top 12" of gravel to get to sil below. Metals collected from NW Quad.
X5SS0130002	HA	0-2	10/8	11:05		C	1	X						- - -	NA	
X5SS0140002	HA	0-2	10/8	11:25		G	1		X					- - -	NA	Mixture of rock/soil. Metals collected from SE Quad.
X5SS0140002	HA	0-2	10/8	11:25		C	1	X						- - -	NA	

REMARKS:

LABORATORY:

Laucks Testing Laboratories, Inc.

COC No(s).:

3270 and 0180

MULTIPLE SAMPLE LOG SHEET

Tetra Tech NUS, Inc.

[X] SURFACE SOIL [] SEDIMENT
[] SUBSURFACE SOIL [] LAGOON / POND
[] OTHER _____

SIGNATURE(S): _____

SAMPLER (S): James Goerdt / Frank Montes

PROJECT NAME: **NSWC Crane - UXO 5**
PROTECT NUMBER: **112G00447**
YEAR **2007**

LOCATION: **Building 2044 DropTower/Test Rail**

SAMPLE No.	SAMPLE METHOD	DEPTH (Ft.)	DATE	TIME	CONCENTRATION (L)LOW (H)HIGH	(G) GRAB (C) COMPOSITE	TOTAL NUMBER OF CONTAINERS	ANALYSES: Nitroaromatics and Nitramines SW-846-8330	ANALYSES: TAL Metals SW-846-3050B/6020					USCS	PID READING	SOIL DESCRIPTION
X5SS0150002	HA	0-2	10/8	14:25		G	1		X					---	NA	Mixture of rock/soil. Metals collected from SE Quad.
X5SS0150002	HA	0-2	10/8	14:25		C	1	X						---	NA	
X5SS0160002	HA	0-2	10/8	14:08		G	1		X					---	NA	Mixture of rock/soil. Metals collected from NW Quad.
X5SS0160002	HA	0-2	10/8	14:08		C	1	X						---	NA	
X5SS0170002	HA	0-2	10/8	13:55		G	1		X					---	NA	Mixture of rock/soil. Metals collected from SW Quad.
X5SS0170002	HA	0-2	10/8	13:55		C	1	X						---	NA	
X5SS0180002	HA	0-2	10/8	13:45		G	1		X					---	NA	Mixture of rock/soil. Metals collected from SE Quad.
X5SS0180002	HA	0-2	10/8	13:45		C	1	X						---	NA	
X5SS0190002	HA	0-2	10/8	13:12		G	1		X					---	NA	Mixture of rock/soil. Metals collected from NE Quad.
X5SS0190002	HA	0-2	10/8	13:12		C	1	X						---	NA	

REMARKS:

LABORATORY:

Laucks Testing Laboratories, Inc.

COC No(s).:

0180

APPENDIX B

MISCELLANEOUS FIELD DOCUMENTATION

TETRA TECH NUS, INC. CHAIN OF CUSTODY NUMBER 3269 PAGE 1 OF 7

PROJECT NO:	FACILITY:	PROJECT MANAGER	PHONE NUMBER	LABORATORY NAME AND CONTACT:
112G00447	NSWC Crane	R. Basinski	412-921-8308	Laucks Testing Labs
SAMPLERS (SIGNATURE)		FIELD OPERATIONS LEADER	PHONE NUMBER	ADDRESS
Jim [illegible] / Frank Montes		J. Goerdt	412-443-0244	940 South Harney St
		CARRIER/WAYBILL NUMBER		CITY, STATE
		FedEx/8616 5831 5956		Seattle, WA 98108

STANDARD TAT ☒
RUSH TAT ☐
☐ 24 hr. ☐ 48 hr. ☐ 72 hr. ☐ 7 day ☐ 14 day

CONTAINER TYPE PLASTIC (P) or GLASS (G): G G

PRESERVATIVE USED: 4°C 4°C

TYPE OF ANALYSIS: EXP. 846-8330 / TAL Metals 6010B/6020

	DATE YEAR 2007	TIME	SAMPLE ID	LOCATION ID	TOP DEPTH (FT)	BOTTOM DEPTH (FT)	MATRIX (GW, SO, SW, SD, QC, ETC.)	COLLECTION METHOD GRAP (G) COMP (C)	No. OF CONTAINERS			COMMENTS
1	10/8	0815	X5550016 0002	X501	0	2	SO	G	2		1	
1	10/8	"	-0016 0002	X501				C	1	1		
2	10/8	0830	-0026 0002	X502				G			1	
2	10/8	"	-0026 0002	"				C		1		
3	10/8	0850	-0036 0002	X503				G			1	
3	10/8	"	-0036 0002	"				C		1		
4	10/8	0910	-0046 0002	X504				G			1	
4	10/8	"	-0046 0002	"				C		1		
5	10/8	0925	-0056 0002	X505				G			1	
5	10/8	"	-0056 0002	"				C		1		
6	10/8	0945	-0066 0002	X506				G			1	
6	10/8	"	-0066 0002	"				C		1		
7	10/8	1020	-0076 0002	X507				G			1	

1. RELINQUISHED BY: J. Goerdt	DATE 10/9/07	TIME 1530	1. RECEIVED BY	DATE	TIME
2. RELINQUISHED BY: James Goerdt	DATE 10/10/07	TIME 0900	2. RECEIVED BY	DATE 10/11/07	TIME 0825
3. RELINQUISHED BY	DATE	TIME	3. RECEIVED BY	DATE	TIME

COMMENTS

DISTRIBUTION: WHITE (ACCOMPANIES SAMPLE) YELLOW (FIELD COPY) PINK (FILE COPY)

4/02R
FORM NO. TINUS-001

TETRA TECH NUS, INC. CHAIN OF CUSTODY | NUMBER 3270 | PAGE 2 OF 7

PROJECT NO:	FACILITY:	PROJECT MANAGER	PHONE NUMBER	LABORATORY NAME AND CONTACT:
112G00447	NSWC Crane	R. Bosinski	4129218308	Laucks Testing Labs
SAMPLERS (SIGNATURE)		FIELD OPERATIONS LEADER	PHONE NUMBER	ADDRESS
[signature]		J. Goerdt	4124430244	940 South Harney St
		CARRIER/WAYBILL NUMBER		CITY, STATE
		FedEx/8616 5831 5956		Seattle, WA 98108

STANDARD TAT ☒
RUSH TAT ☐
☐ 24 hr. ☐ 48 hr. ☐ 72 hr. ☐ 7 day ☐ 14 day

CONTAINER TYPE PLASTIC (P) or GLASS (G): G G G
PRESERVATIVE USED: 4°C 4°C

	DATE YEAR 2007	TIME	SAMPLE ID	LOCATION ID	TOP DEPTH (FT)	BOTTOM DEPTH (FT)	MATRIX (GW, SO, SW, SD, QC, ETC.)	COLLECTION METHOD GRAP (G) COMP (C)	No. OF CONTAINERS	TYPE OF ANALYSIS: EPA 8330	EPA 8330	EPA 6020	COMMENTS
7	10/8	1020	X555-007C0002	X507	0	2	SO	C	1	1			
8		1428	" -008G0002	X508				G	1		1		
8		"	" -008C0002	"				C	1	1			
9		1230	" -009G0002	X509				G	1		1		
9		"	" -009C0002	"				C	1	1			
10		1250	" -010G0002	X510				G	1		1		
10		"	" -010C0002	"				C	1	1			
11		1300	" -011G0002	X511				G	3		3		MS/MSD
11		"	" -011C0002	"				C	3	3			MS/MSD
12		1045	" -012G0002	X512				G	1		1		
12		"	" -012C0002	"				C	1	1			
13		1105	" -013G0002	X513				G	1		1		
13	✓	"	" -013C0002	"	✓	✓	✓	C	1	1			

1. RELINQUISHED BY [signature]	DATE 10/9/07	TIME 1530	1. RECEIVED BY	DATE	TIME
2. RELINQUISHED BY James Goerdt	DATE 10/10/07	TIME 0900	2. RECEIVED BY [signature]	DATE 10/11/07	TIME 08:35
3. RELINQUISHED BY	DATE	TIME	3. RECEIVED BY	DATE	TIME

COMMENTS

DISTRIBUTION: WHITE (ACCOMPANIES SAMPLE) YELLOW (LAB COPY) PINK (FILE COPY)

FORM TTNUS-001 4/02R

4574 TT030

TETRA TECH NUS, INC. CHAIN OF CUSTODY | NUMBER 0183 | PAGE 4 OF 7

PROJECT NO:	FACILITY:	PROJECT MANAGER	PHONE NUMBER	LABORATORY NAME AND CONTACT:
112G-00447	Wasac Cram	R. Bubinski	412-921-8308	Laucks Testing Labs
SAMPLERS (SIGNATURE)		FIELD OPERATIONS LEADER	PHONE NUMBER	ADDRESS
[signature]		J. Gerald	412 443 0244	940 South Harney St
		CARRIER/WAYBILL NUMBER		CITY, STATE
		Fed Ex/8616 5831 5956		Seattle, WA 98108

STANDARD TAT ☒
RUSH TAT ☐
☐ 24 hr. ☐ 48 hr. ☐ 72 hr. ☐ 7 day ☐ 14 day

CONTAINER TYPE PLASTIC (P) or GLASS (G): G G G G
PRESERVATIVE USED: 4°C 4°C 4°C

	DATE YEAR 2007	TIME	SAMPLE ID	LOCATION ID	TOP DEPTH (FT)	BOTTOM DEPTH (FT)	MATRIX (GW, SO, SW, SD, QC, ETC.)	COLLECTION METHOD GRAB (G) COMP (C)	No. OF CONTAINERS	TYPE OF ANALYSIS: EXP 846-5330	TAL 846-3030B/6020	PAH 846-8270C						COMMENTS
1	10/8	0000	X5FD100807 01	QC	0	2	SO	C	1	1								
2	10/2	1045	X755002 0002	X702				G	1		1							
3	10/2	1025	X755003 0002	X703					1		1							
4	10/2	1100	X755004 0002	X704					1		1							
5	10/2	1504	X755012 0002	X712					1		1							
6	10/2	0000	X7FD100207 01	QC					1		1							
	—	—	~~X7FD10010~~ PS						—		—							
7	10/2	1510	X755019 0002	X719					1		1							
8	10/3	0850	X755026 0002	X726					1		1							
9	10/3	1150	X755039 0002	X739					1		1							
10	10/3	1320	X755044 0002	X744					1		1							
11	10/3	1255	X755045 0002	X745					1		1							
12	10/3	1244	X755046 0002	X746					1		1							

	DATE	TIME		DATE	TIME
1. RELINQUISHED BY: J. Gerald	10/9/07	1830	1. RECEIVED BY		
2. RELINQUISHED BY: James Gerald	10/10/07	0900	2. RECEIVED BY	10/11/07	08:35
3. RELINQUISHED BY			3. RECEIVED BY		

COMMENTS

DISTRIBUTION: WHITE (ACCOMPANIES SAMPLE) YELLOW (FIELD COPY) PINK (FILE COPY)

4/02R
FORM NO. TINUS-001

TETRA TECH NUS, INC. CHAIN OF CUSTODY | NUMBER 0184 | PAGE 5 OF 7

PROJECT NO:	FACILITY:	PROJECT MANAGER	PHONE NUMBER	LABORATORY NAME AND CONTACT:
112G00447	NSWC Crane	R. Bosinski	412921 8308	Lab Ks Testing Labs
SAMPLERS (SIGNATURE)		FIELD OPERATIONS LEADER	PHONE NUMBER	ADDRESS
[signature]		J. Gorski	412 443 0244	940 South Harrison St.
		CARRIER/WAYBILL NUMBER		CITY, STATE
		Fed Ex 8616 5831 5956		Sea A, WA 98108

STANDARD TAT ☒
RUSH TAT ☐
☐ 24 hr. ☐ 48 hr. ☐ 72 hr. ☐ 7 day ☐ 14 day

CONTAINER TYPE PLASTIC (P) or GLASS (G): G G G
PRESERVATIVE USED: 4°C 4°C 4°C

	DATE YEAR 2007	TIME	SAMPLE ID	LOCATION ID	TOP DEPTH (FT)	BOTTOM DEPTH (FT)	MATRIX (GW, SO, SW, SD, QC, ETC.)	COLLECTION METHOD GRAB (G) COMP (C)	No. OF CONTAINERS	TYPE OF ANALYSIS: EXP 8260	TAL 6010	TAL 7470						COMMENTS
14	10/3	0000	X7FD100030701	QC	0	2	SO	G	1		1							
15	10/3	1231	X7SS048 0002	X748					1		1							
16	10/6	0737	X7SS055 0002	X755					1		1							
17	10/4	1603	X7SS066 0002	X766					1		1							
18	10/5	0854	X7SS071 0002	X771					1			1						
19	10/5	0998	X7SS075 0002	X775					2		1	1						
20	10/5	0912	X7SS079 0002	X779					1			1						
21	10/5	0000	X7FD100050701	QC					1			1						
22	10/5	1423	X7SS081 0002	X781					1			1						
23	10/5	1413	X7SS086 0002	X786					1			1						
24	10/6	1019	X7SS116 0002	X7116					1			1						
25	10/6	0857	X7SS121 0002	X7121					3			3						MS/MSD
26	10/6	0903	X7SS122 0002	X7122					1			1						

1. RELINQUISHED BY: James Gorski	DATE: 10/10/07	TIME: 0900	1. RECEIVED BY: [signature]	DATE: 10/11/07	TIME: 08:35
2. RELINQUISHED BY	DATE	TIME	2. RECEIVED BY	DATE	TIME
3. RELINQUISHED BY	DATE	TIME	3. RECEIVED BY	DATE	TIME

COMMENTS

DISTRIBUTION: WHITE (ACCOMPANIES SAMPLE) YELLOW (FIELD COPY) PINK (FILE COPY)

FORM 4/02R NUS-001

9975 TT03403

TETRA TECH NUS, INC. CHAIN OF CUSTODY | NUMBER 0185 | PAGE 6 OF 7

PROJECT NO:	FACILITY:	PROJECT MANAGER	PHONE NUMBER	LABORATORY NAME AND CONTACT:
112G00447	NSWC Crane	R. Bosinski	412 921 8308	Lucius Testing Labs
SAMPLERS (SIGNATURE)		FIELD OPERATIONS LEADER	PHONE NUMBER	ADDRESS
[signature]		J. Gerald	412 443 0244	990 South Barney St
		CARRIER/WAYBILL NUMBER		CITY, STATE
		Fed Ex/8616 5831 5956		Seattle WA 98108

STANDARD TAT ☒
RUSH TAT ☐
☐ 24 hr. ☐ 48 hr. ☐ 72 hr. ☐ 7 day ☐ 14 day

CONTAINER TYPE PLASTIC (P) or GLASS (G): G G G

PRESERVATIVE USED: 4°C 4°C 4°C

TYPE OF ANALYSIS: EXT-8330 SS 8346-8330 SS/6020 TAL 8346-8330 SS 8346-8270C

	DATE YEAR 2007	TIME	SAMPLE ID	LOCATION ID	TOP DEPTH (FT)	BOTTOM DEPTH (FT)	MATRIX (GW, SO, SW, SD, QC, ETC.)	COLLECTION METHOD GRAB (G) COMP (C)	No. OF CONTAINERS								COMMENTS
1	10/6	0915	X7551230002	X7123	0	2	SO	G	1			1					
2	10/7	0823	X7551270002	X7127					1		1	1					
3	10/6	0820	X7551290002	X7129					1			1					
4	10/6	1023	X7551360002	X7136					1			1					
5	10/7	1016	X7551480002	X7148					3		3						MS/MSD
6	10/7	1002	X7551530002	X7153					1		1						
7	10/7	1450	X7551670002	X7167					1		1						
8	10/7	1000	X7551730002	X7173					1		1						
9	10/7	0950	X7551740002	X7174					1		1						
10	10/7	1008	X7551750002	X7175					1		1						
11	10/7	1018	X7551760002	X7176					1		1						
12	10/7	1036	X7551770002	X7177					1		1						
13	10/7	1047	X7551780002	X7178					1		1						

	DATE	TIME		DATE	TIME
1. RELINQUISHED BY James Gerald	10/10/07	0900	1. RECEIVED BY	10/11/07	0825
2. RELINQUISHED BY			2. RECEIVED BY		
3. RELINQUISHED BY			3. RECEIVED BY		

COMMENTS

DISTRIBUTION: WHITE (ACCOMPANIES SAMPLE) YELLOW (FIELD COPY) PINK (FILE COPY)

4/02R
FORM NO. TINUS-001

TETRA TECH NUS, INC. CHAIN OF CUSTODY | NUMBER 0187 | PAGE 2 OF 2

PROJECT NO:	FACILITY:	PROJECT MANAGER	PHONE NUMBER	LABORATORY NAME AND CONTACT:
112G00447	NSWC Crane	R. Bosinski	4139218308	Lauck Testing Labs
SAMPLERS (SIGNATURE)		FIELD OPERATIONS LEADER	PHONE NUMBER	ADDRESS
[signature]		J. Goerdt	4124430247	940 South Harney St
		CARRIER/WAYBILL NUMBER		CITY, STATE
		FedEx/8616 5831 5956		Seattle, WA 98108

STANDARD TAT ☒
RUSH TAT ☐
☐ 24 hr. ☐ 48 hr. ☐ 72 hr. ☐ 7 day ☐ 14 day

CONTAINER TYPE PLASTIC (P) or GLASS (G): G G
PRESERVATIVE USED: 4°C 4°C 4°C

TYPE OF ANALYSIS: EAP 8260-8330 | TAL Metals 6020 | 8260 BTEX 8270C

	DATE YEAR 2007	TIME	SAMPLE ID	LOCATION ID	TOP DEPTH (FT)	BOTTOM DEPTH (FT)	MATRIX (GW, SO, SW, SD, QC, ETC.)	COLLECTION METHOD GRAB (G) COMP (C)	No. OF CONTAINERS	EAP 8260-8330	TAL Metals 6020	8260 BTEX 8270C						COMMENTS
13	10/7	1030	X755 179 0002	X7179	0	2	SO	G	1		1							
14	10/7	1055	X755 180 0002	X7180	↓	↓	↓	↓	1		1							
15	10/7	1103	X755 181 0002	X7181	↓	↓	↓	↓	1		1							
16	10/7	1112	X755 182 0002	X7182	↓	↓	↓	↓	1		1							
17	10/7	1130	X755 183 0002	X7183	↓	↓	↓	↓	1		1							
18	10/7	1145	X755 184 0002	X7184	↓	↓	↓	↓	1		1							
19	10/8	1527	X755 189 0002	X7189	↓	↓	↓	↓	3		3							Do MS/MSD
20	10/9	1630	RB10090701	QC	–	–	–	–	5	2	1	2						

	DATE	TIME		DATE	TIME
1. RELINQUISHED BY: James Goerdt	10/10/07	0900	1. RECEIVED BY: [signature]	10/11/07	08:35
2. RELINQUISHED BY			2. RECEIVED BY		
3. RELINQUISHED BY			3. RECEIVED BY		

COMMENTS

DISTRIBUTION: WHITE (ACCOMPANIES SAMPLE) YELLOW (FIELD COPY) PINK (FILE COPY)

FORM 4/02R NUS-001

FIGURE 8-2

SITE-SPECIFIC TRAINING DOCUMENTATION

My signature below indicates that I am aware of the potential hazardous nature of performing investigation activities at NSWC Crane, and that I have received site-specific training that included the elements presented below:

- Names of personnel and alternates responsible for site safety and health
- Safety, health and other hazards present on site
- Use of personal protective equipment
- Work practices to minimize risks from hazards
- Safe use of engineering controls and equipment
- Medical surveillance requirements
- Signs and symptoms of overexposure
- The contents of the health and safety plan including Table 5-1 and 6-1
- Emergency response procedures (evacuation and assembly points)
- Review contents of relevant Material Safety Data Sheets
- Review of Safe Work Permits

I have been given the opportunity to ask questions and that my questions have been answered to my satisfaction. The dates of my training and my medical surveillance requirements are accurate and correct to the best of my knowledge.

Name (Printed and Signature)	Site-Specific Training Date	40-Hour Training (Date)	8-Hour Refresher Training (Date)	8-Hour Supervisory Training (Date)	Medical Exam
James Goerdt	10/2/07	12/91		8/07	11/05
Frank Montes	10/2/07	1/91	7/07		8/07
Fred W Ramsey	10/2/07	7/91	9/07	6/06	12/06

MEDICAL DATA SHEET

This Medical Data Sheet must be completed by all on-site personnel and kept in the command post during the conduct of site operations. This data sheet will accompany any personnel when medical assistance is needed or if transport to hospital facilities is required.

Project NSWC Crane UXO 5/7

Name Jim Goerdt Home Telephone 412-319-7303

Address 5418 Forest Edge Dr McDonald, PA

Age 43 Height 5' 11" Weight 175

Name of Next Kin Shannon Goerdt - 412-445-4496

Drug or Other Allergies None

Particular Sensitivities Poison Ivy

Do you wear contacts? No

Provide a checklist of Previous Illnesses or Exposure to Hazardous Chemicals None

What medications are you currently using? None

Do you have any medical restrictions? None

Name, address, and phone number of your personal physician

Dr. Fatigati

I am the individual described above. I have read and understood this HASP.

Signature

10/2/07

Date

TETRA TECH NUS

CERTIFICATE OF TRAINING

THIS CERTIFIES THAT

Jim Goerdt

has successfully completed an 8-hour course of instruction in

OSHA 29 CFR 1910.120

GENERAL SITE WORKER
REFRESHER TRAINING

prepared and instructed by
Tetra Tech NUS, Inc.
Pittsburgh, Pennsylvania

February 2, 2007

Date of Award

Matthew M. Soltis, CIH, CSP
Manager
Health and Safety

CLICKSAFETY®

CERTIFICATE OF WEB BASED TRAINING

This is to certify that

JAMES GOERDT

Has successfully completed

C4 Hazwoper Supervisor

The course was developed and presented by ClickSafety

Serial Number: 1657569

Completed: 8/6/2007

MEDICAL DATA SHEET

This Medical Data Sheet must be completed by all on-site personnel and kept in the command post during the conduct of site operations. This data sheet will accompany any personnel when medical assistance is needed or if transport to hospital facilities is required.

Project NSWC CRANE UXO 5 + 7

Name FRED W RAMSER Home Telephone 412 937 0654

Address 205 W. PROSPECT AVE

Age 47 Height 5' 8" Weight 155

Name of Next Kin BRENDA LESPERANCE - RAMSER

Drug or Other Allergies HAY FEVER

Particular Sensitivities

Do you wear contacts?

Provide a checklist of Previous Illnesses or Exposure to Hazardous Chemicals

What medications are you currently using? ALLERGIE ANTIHISTAMINES

Do you have any medical restrictions? Z-PAK ANTIBIOTICS

Name, address, and phone number of your personal physician GREENTREE MEDICAL CENTER DR DOMBROSKI 412-922-8490

I am the individual described above. I have read and understood this HASP.

Fred W Ramser 10-2-07

Signature Date

CERTIFICATE OF TRAINING

This Certifies

FRED RAMSER

has successfully completed an 8 hour refresher in

HAZARDOUS WASTE OPERATIONS AND EMERGENCY RESPONSE

Prepared and conducted by the Center for Safety and Environmental Management

in compliance with OSHA standard 29 CFR 1910.120

Frank V. Quarato

Frank V. Quarato, Instructor

August 22, 2007

Completion Date

HALLIBURTON NUS
Environmental Corporation

CERTIFICATE OF TRAINING

THIS CERTIFIES THAT

FRED W. RAMSER

has successfully completed a 40 hour course of instruction in
OSHA 29 CFR 1910.120

HAZARDOUS WASTE HEALTH AND SAFETY TRAINING

prepared and conducted by the
HALLIBURTON NUS Environmental Corporation,
Pittsburgh, Pennsylvania

JULY 15 - 19, 1991
Date of Award

Dana R. Irvin
Principal Instructor, Project Manager
Environmental Management Group

James K. Laffey
Director, Hazardous Materials Training
Environmental Management Group

MEDICAL DATA SHEET

This Medical Data Sheet must be completed by all on-site personnel and kept in the command post during the conduct of site operations. This data sheet will accompany any personnel when medical assistance is needed or if transport to hospital facilities is required.

Project NSW C CRANE UXO 5/7

Name FRANK MONTES Home Telephone (402) 493-6887

Address 2117 CENTRAL AVE

Age 48 Height 5'5 Weight 175 lb.

Name of Next Kin PAULA BURRIGHT (SISTER)

Drug or Other Allergies NONE

Particular Sensitivities NONE

Do you wear contacts? NO

Provide a checklist of Previous Illnesses or Exposure to Hazardous Chemicals

What medications are you currently using? NONE

Do you have any medical restrictions? NONE

Name, address, and phone number of your personal physician

I am the individual described above. I have read and understood this HASP.

Frank Montes

Signature

10/2/07

Date

Certificate of Completion

Awarded to

Frank Montes

ATI

For completion of an exam and 8 hour training course entitled

"HAZARDOUS WASTE OPERATIONS and EMERGENCY RESPONSE"

Test Scores: 87 and 94

THE AMERICAN BOARD OF INDUSTRIAL HYGIENISTS INCORPORATED
CERTIFICATION NUMBER 2064 CP
EXPIRES 6-1-2008
PENNSYLVANIA
CHARLES C. PHILLIPS

BCSP
CHARLES C. PHILLIPS
19561
CERTIFIED SAFETY PROFESSIONAL

Dr. Charles Phillips, CSP, CIH

July 26, 2007

Tetra Tech NUS, Inc.

DAILY ACTIVITY LOG

UXO 5 Lead Investigation September 2007 - CRANE NSWC

Project Information

Activity Date	8/30/07	**Weather/Temp**		**Created By**	James Goerdt
Facility Name	CRANE NSWC	**TtNUS Personnel**	JG = James Goerdt	**Created Date**	8/31/07
TtNUS Project #	112G00447			**Modified By**	James Goerdt
Task/Contract #	0034	**Subcontractor Personnel**	NA	**Modified Date**	8/31/07
WBS Code #	xx	**Visitors**	NA	**Printed By**	John Wright
Client		**Status**	Archive	**Printed Date**	4/25/08

Daily Activity

Date	Time	Author	Notes
8/30/07	13:45	James Goerdt	JG met with Tom Brent to locate Township and Section for UXO 5. Information needed for utility clearance with IUPPS.
8/30/07	14:15	James Goerdt	JG marked boundaries of field investigation area with white pin flags to assist utility clearance personnel. Location figure was hand marked to reflect current status/location of buildings and site features.

- End of Report -

Tetra Tech NUS, Inc.

DAILY ACTIVITY LOG

UXO 5 Lead Investigation September 2007 - CRANE NSWC

Project Information

Activity Date	8/31/07	**Weather/Temp**		**Created By**	James Goerdt
Facility Name	CRANE NSWC	**TtNUS Personnel**	JG = James Goerdt	**Created Date**	8/31/07
TtNUS Project #	112G00447			**Modified By**	James Goerdt
Task/Contract #	0034	**Subcontractor Personnel**	NA	**Modified Date**	8/31/07
WBS Code #	xx	**Visitors**	NA	**Printed By**	John Wright
Client		**Status**	Archive	**Printed Date**	4/25/08

Daily Activity

Date	Time	Author	Notes
8/31/07	09:15	James Goerdt	JG contacted IUPPS for utility clearance at UXO 5 (spoke with Carol). Martin County, Perry Township, Section 13. Ticket #0708310530. Utilities contacted will be Crane, Vector, and Verizon. Clearance period is 9/4/07 through 9/20/07.

- End of Report -

Tetra Tech NUS, Inc.

DAILY ACTIVITY LOG

UXO 5 Lead Investigation September 2007 - CRANE NSWC

Project Information

Activity Date	9/17/07	**Weather/Temp**		**Created By**	James Goerdt
Facility Name	CRANE NSWC	**TtNUS Personnel**	JG = James Goerdt	**Created Date**	9/17/07
TtNUS Project #	112G00447			**Modified By**	James Goerdt
Task/Contract #	0034	**Subcontractor Personnel**		**Modified Date**	9/17/07
WBS Code #	xx	**Visitors**		**Printed By**	John Wright
Client		**Status**	Archive	**Printed Date**	4/25/08

Daily Activity

Date	Time	Author	Notes
9/17/07	10:45	James Goerdt	Due to change in field invetigation dates, JG phoned IUPPS to extend utility clearance #0708310530. Ticket has been extended to 10/7/07. Changes and/or extensions need to be called in by 10/3/07. New ticket #0709171346.

- End of Report -

Tetra Tech NUS, Inc.

DAILY ACTIVITY LOG

UXO 5 Lead Investigation September 2007 - CRANE NSWC

Project Information

Activity Date	10/10/07	**Weather/Temp**	NA	**Created By**	James Goerdt
Facility Name	CRANE NSWC	**TtNUS Personnel**	JG = James Goerdt	**Created Date**	10/24/07
TtNUS Project #	112G00447			**Modified By**	James Goerdt
Task/Contract #	0034	**Subcontractor Personnel**		**Modified Date**	10/24/07
WBS Code #	xx	**Visitors**		**Printed By**	John Wright
Client		**Status**	Archive	**Printed Date**	4/25/08

Daily Activity

Date	Time	Author	Notes
10/10/07	06:30	James Goerdt	JG arrives at Crane to finish packing equipment for shipment back to rental companies.
10/10/07	09:50	James Goerdt	JG dropping off equipment at Fed Ex. Remainder of day spent traveling back to Pittsburgh.

- End of Report -

Tetra Tech NUS, Inc.

DAILY ACTIVITY LOG

UXO 5 Lead Investigation September 2007 - CRANE NSWC

Project Information

Activity Date	10/1/07	**Weather/Temp**	NA	**Created By**	James Goerdt
Facility Name	CRANE NSWC	**TtNUS Personnel**	JG = James Goerdt;FR = Fred Ramser	**Created Date**	10/24/07
TtNUS Project #	112G00447			**Modified By**	James Goerdt
Task/Contract #	0034	**Subcontractor Personnel**		**Modified Date**	10/24/07
WBS Code #	xx			**Printed By**	John Wright
Client		**Visitors**		**Printed Date**	4/25/08
		Status	Archive		

Daily Activity

Date	Time	Author	Notes
10/1/07	09:00	James Goerdt	JG and FR travel from Pittsburgh to NSWC Crane.
10/1/07	14:30	James Goerdt	JG and FR stop at WalMart in Martinsville, IN on way to Crane to purchase needed feild supplies.
10/1/07	16:30	James Goerdt	JG and FR stop at hotel to drop off luggage and to check in. Leave FR vehicle at hotel and enroute to Crane.
10/1/07	16:45	James Goerdt	JG and FR arrive at Crane visitors center to obtain passes. FR has left his ID in rental vehicle back at hotel and unable to obtain pass. Jg obtains his pass, leaves FR at gate and drives to Bldg 3245 to check and make sure all equipment

			has arrived. JG returns to visitors center to pick up FR. Enroute back to Bloomington, stopping off at WalMart for additional field supplies.

- End of Report -

Tetra Tech NUS, Inc.

DAILY ACTIVITY LOG

UXO 5 Lead Investigation September 2007 - CRANE NSWC

Project Information

Activity Date	10/24/07	**Weather/Temp**		**Created By**	James Goerdt
Facility Name	CRANE NSWC	**TtNUS Personnel**		**Created Date**	10/24/07
TtNUS Project #	112G00447	**Subcontractor Personnel**		**Modified By**	
Task/Contract #	0034	**Visitors**		**Modified Date**	
WBS Code #	xx	**Status**	Archive	**Printed By**	John Wright
Client				**Printed Date**	4/25/08

Daily Activity

Date	Time	Author	Notes

- End of Report -

APPENDIX C

SITE PHOTOS

Base of Drop Tower Looking North

Base of Drop Tower Looking Northeast

Test Rail Looking West

APPENDIX D

STATISTICAL EVALUATIONS

USERS' GUIDE AND BACKGROUND TECHNICAL DOCUMENT FOR USEPA REGION 9'S PRELIMINARY REMEDIATION GOALS (PRG) TABLE

TABLE OF CONTENTS

1.0 INTRODUCTION 3

2.0 READING THE PRG TABLE 5

General Considerations 5
Toxicity Values 6
PRGs Derived with Special Considerations 8
Cal-Modified PRGs 10
Soil Screening Levels 10
Miscellaneous 11

3.0 USE OF PRGS AT SITES 11

Conceptual Site Model 12
Background Levels Evaluation 13
Screening Sites with Multiple Pollutants 14
Potential Problems 15

4.0 TECHNICAL SUPPORT DOCUMENTATION 16

Ambient Air and Vapor Intrusion Pathway 16
Soils - Direct Ingestion 17
Soils - Dermal Contact 18
Soils - Vapor and Particulate Inhalation 18
Soils - Migration to Groundwater 20
Soil Saturation Limits 21
Tap Water - Ingestion and Inhalation 21
Default Exposure Factors 22
Standardized Equations 24

REFERENCES 29

DISCLAIMER

Preliminary remediation goals (PRGs) focus on common exposure pathways and may not consider all exposure pathways encountered at CERCLA / RCRA sites (Exhibit 1-1). PRGs do not consider impact to groundwater or address ecological concerns. The PRG Table is specifically not intended as a (1) stand-alone decision-making tool, (2) as a substitute for EPA guidance for preparing baseline risk assessments, (3) a rule to determine if a waste is hazardous under RCRA, or (4) set of final cleanup or action levels to be applied at contaminated sites.

The guidance set out in this document is not final Agency action. It is not intended, nor can it be relied upon to create any rights enforceable by any party in litigation with the United States. EPA officials may decide to follow the guidance provided herein, or act at variance with the guidance, based on an analysis of specific circumstances. The Agency also reserves the right to change this guidance at any time without public notice.

1.0 INTRODUCTION

Region 9 Preliminary Remediation Goals (PRGs) are risk-based tools for evaluating and cleaning up contaminated sites. They are being used to streamline and standardize all stages of the risk decision-making process.

The Region 9 PRG Table combines current human health toxicity values with standard exposure factors to estimate contaminant concentrations in environmental media (soil, air, and water) that are considered by the Agency to be health protective of human exposures (including sensitive groups), over a lifetime. Chemical concentrations above these levels would not automatically designate a site as "dirty" or trigger a response action. However, exceeding a PRG suggests that further evaluation of the potential risks that may be posed by site contaminants is appropriate. Further evaluation may include additional sampling, consideration of ambient levels in the environment, or a reassessment of the assumptions contained in these screening-level estimates (e.g. appropriateness of route-to-route extrapolations, appropriateness of using chronic toxicity values to evaluate childhood exposures, appropriateness of generic exposure factors for a specific site etc.).

The risk-based concentrations presented in the Table may be used as screening goals or initial cleanup goals if applicable. Generally a screening goal is intended to provide health protection without knowledge of the specific exposure conditions at a site. PRGs may also be used as initial cleanup goals when the exposure assumptions based on site-specific data match up with the default exposure assumptions in the PRG Table. When considering PRGs as cleanup goals, it is EPA's preference to assume maximum beneficial use of a property (that is, residential use) unless a non-residential number (for example, industrial soil PRG) can be justified.

Before applying PRGs at a particular site, the Table user should consider whether the exposure pathways and exposure scenarios at the site are fully accounted for in the PRG calculations. Region 9 PRG concentrations are based on direct contact pathways for which generally accepted methods, models, and assumptions have been developed (i.e. ingestion, dermal contact, and inhalation) for specific land-use conditions and do not consider impact to groundwater or ecological receptors (see Developing a Conceptual Site Model below).

EXHIBIT 1-1
TYPICAL EXPOSURE PATHWAYS BY MEDIUM
FOR RESIDENTIAL AND INDUSTRIAL LAND USES[a]

EXPOSURE PATHWAYS, ASSUMING:		
MEDIUM	RESIDENTIAL LAND USE	INDUSTRIAL LAND USE
Ground Water	***Ingestion from drinking***	Ingestion from drinking
	Inhalation of volatiles	Inhalation of volatiles
	Dermal absorption from bathing	Dermal absorption
Surface Water	***Ingestion from drinking***	Ingestion from drinking
	Inhalation of volatiles	Inhalation of volatiles
	Dermal absorption from bathing	Dermal absorption
	Ingestion during swimming	
	Ingestion of contaminated fish	
Soil	***Ingestion***	***Ingestion***
	Inhalation of particulates	***Inhalation of particulates***
	Inhalation of volatiles	***Inhalation of volatiles***
	Exposure to indoor air from soil gas	Exposure to indoor air from soil gas
	Exposure to ground water contaminated by soil leachate	Exposure to ground water contaminated by soil leachate
	Ingestion via plant, meat, or dairy products	Inhalation of particulates from trucks and heavy equipment
	Dermal absorption	***Dermal absorption***

Footnote:
[a]Exposure pathways considered in the PRG calculations are indicated in boldface italics.

2.0 READING THE PRG TABLE

2.1 General Considerations

With the exceptions described below, PRGs are chemical concentrations that correspond to fixed levels of risk (i.e. either a one-in-one million [10^{-6}] cancer risk or a noncarcinogenic hazard quotient of 1) in soil, air, and water. In most cases, where a substance causes both cancer and noncancer (systemic) effects, the 10^{-6} cancer risk will result in a more stringent criteria and consequently this value is presented in the printed copy of the Table. PRG concentrations that equate to a 10^{-6} cancer risk are indicated by "ca". PRG concentrations that equate to a hazard quotient of 1 for noncarcinogenic concerns are indicated by "nc".

If the risk-based concentrations are to be used for site screening, it is recommended that both cancer and noncancer-based PRGs be used. Both carcinogenic and noncarcinogenic values may be obtained at the Region 9 PRG homepage at:

http://www.epa.gov/region09/waste/sfund/prg/

It has come to my attention that some users have been multiplying the cancer PRG concentrations by 10 or 100 to set "action levels" for triggering remediation or to set less stringent cleanup levels for a specific site after considering non-risk-based factors such as ambient levels, detection limits, or technological feasibility. This risk management practice recognizes that there may be a range of values that may be "acceptable" for carcinogenic risk (EPA's risk management range is one-in-a-million [10^{-6}] to one-in-ten thousand [10^{-4}]). However, this practice could lead one to overlook serious noncancer health threats and it is strongly recommended that the user consult with a toxicologist or regional risk assessor before doing this. For carcinogens, I have indicated by asterisk ("ca*") in the PRG Table where the noncancer PRGs would be exceeded if the cancer value that is displayed is multiplied by 100. Two stars ("ca**") indicate that the noncancer values would be exceeded if the cancer PRG were multiplied by 10. There is no range of "acceptable" noncarcinogenic "risk" so that under no circumstances should noncancer PRGs be multiplied by 10 or 100, when setting final cleanup criteria. In the rare case where noncancer PRGs are more stringent than cancer PRGs set at one-in-one-million risk, a similar approach has been applied (e.g. "nc**").

In general, PRG concentrations in the printed Table are risk-based but for soil there are two important exceptions: (1) for several volatile chemicals, PRGs are based on the soil saturation equation ("sat") and (2) for relatively less toxic inorganic and semivolatile contaminants, a non-risk based "ceiling limit" concentration is given as 10^{+5} mg/kg ("max"). At the Region 9 PRG website, the risk-based calculations for these same chemicals are also available in the "InterCalc Tables" if the user wants to view the risk-based concentrations prior to the application of "sat" or "max". For more information on why the "sat" value and not a risk-based value is presented for several volatile chemicals in the PRG Table, please see the discussion in Section 4.6.

With respect to applying a "ceiling limit" for chemicals other than volatiles, it is recognized that

this is not a universally accepted approach. Some within the agency argue that all values should be risk-based to allow for scaling (for example, if the risk-based PRG is set at a hazard quotient = 1.0, and the user would like to set the hazard quotient to 0.1 to take into account multiple chemicals, then this is as simple as multiplying the risk-based PRG by 1/10th). If scaling is necessary, PRG users can do this simply by referring to the "InterCalc Tables" at our website where risk-based soil concentrations are presented for all chemicals (see soil calculations, "combined" pathways column).

In spite of the fact that applying a ceiling limit is not a universally accepted approach, we have opted to continue applying a "max"soil concentration to the PRG Table for the following reasons:

- Risk-based PRGs for some chemicals in soil exceed unity (>1,000,000 mg/kg) which is not possible.
- The ceiling limit of 10^{+5} mg/kg is equivalent to a chemical representing 10% by weight of the soil sample. At this contaminant concentration (and higher), the assumptions for soil contact may be violated (for example, soil adherence and windborne dispersion assumptions) due to the presence of the foreign substance itself.
- PRGs currently do not address short-term exposures (e.g. pica children and construction workers). Although extremely high soil PRGs are likely to represent relatively non-toxic chemicals, such high values may not be justified if in fact more toxicological data were available for evaluating short-term and/or acute exposures.

In addition to Region 9 PRG values, the PRG Table also includes California EPA PRGs ("CAL-Modified PRGs") for specific chemicals where CAL-EPA screening values may deviate significantly from the federal values (see Section 2.4) and EPA OSWER soil screening levels (SSLs) for protection of groundwater (see Section 2.5).

2.2 Toxicity Values

Hierarchy of Toxicity Values

There is a new hierarchy of human health toxicity values that replaces earlier guidance. This is important because human toxicity values known as cancer slope factors (SF) or non-cancer reference doses (RfDs) form the basis of the PRG values listed in the table. As noted in OSWER Directive 9285.7-53 (dated December 5, 2003), the updated EPA hierarchy is as follows: Tier 1 - EPA's Integrated IRIS, Tier 2 - EPA's Provisional Peer Reviewed Toxicity Values (PPRTVs), and Tier 3 - Other Toxicity Values. Tier 3 includes additional EPA sources (e.g. historic HEAST and NCEA provisional values) and non-EPA sources of toxicity information (e.g. California EPA toxicity values).

The PRG Table lists Tier 1 toxicity values from IRIS as "i" and Tier 2 toxicity values known as PPRTVs as "p". Tier 3 toxicity values were obtained from various sources including California EPA databases "c", historic HEAST tables "h" and NCEA provisional values "n".

Inhalation Conversion Factors

As of January 1991, IRIS and NCEA databases no longer present RfDs or SFs for the inhalation route. These criteria have been replaced with reference concentrations (RfC) for noncarcinogenic effects and unit risk factors (URF) for carcinogenic effects. However, for purposes of estimating risk and calculating risk-based concentrations, inhalation reference doses (RfDi) and inhalation slope factors (SFi) are preferred. This is not a problem for most chemicals because the inhalation toxicity criteria are easily converted. To calculate an RfDi from an RfC, the following equation and assumptions may be used for most chemicals:

$$\text{RfDi}\ \frac{\text{mg}}{(\text{kg-day})} = \text{RfC}(\text{mg}/\text{m}^3) \times \frac{20\text{m}^3}{\text{day}} \times \frac{1}{70\text{kg}}$$

Likewise, to calculate an SFi from an inhalation URF, the following equation and assumptions may be used:

$$\text{SFi}\ \frac{(\text{kg-day})}{(\text{mg})} = \text{URF}(\text{m}^3/\text{ug}) \times \frac{\text{day}}{20\text{m}^3} \times 70\text{kg} \times \frac{10^3\ \text{ug}}{\text{mg}}$$

Route-to-Route Methods

Route-to-route extrapolations ("r") were frequently used when there were no toxicity values available for a given route of exposure. Oral cancer slope factors ("SFo") and reference doses ("RfDo") were used for both oral and inhaled exposures for organic compounds lacking inhalation values. Inhalation slope factors ("SFi") and inhalation reference doses ("RfDi") were used for both inhaled and oral exposures for organic compounds lacking oral values. Route extrapolations were not performed for inorganics due to portal of entry effects and known differences in absorption efficiency for the two routes of exposure.

An additional route extrapolation is the use of oral toxicity values for evaluating dermal exposures. In general, dermal toxicity values are not listed in EPA databases and consequently must be estimated from oral toxicity information. However, a scientifically defensible data base often does not exist for making an adjustment to the oral slope factor/RfD so that the oral toxicity value is often applied without adjustment to estimate a dermal toxicity value. For more information please refer to recent Agency guidance (USEPA 2004) entitled *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)* available on the web at: http://www.epa.gov/superfund/programs/risk/ragse/index.htm

Please note that whenever route-extrapolated values are used to calculate risk-based PRGs, additional uncertainties are introduced in the calculation.

2.3 PRGs Derived with Special Considerations

Most of the Region 9 PRGs are readily derived by referring to Equations 4-1 thru 4-8 contained in this "User's Guide/Technical Background Document" to the Region 9 PRGs. However, there are some chemicals for which the standard equations do no apply and/or adjustments to the toxicity values are recommended. These special case chemicals are discussed below.

Cadmium The PRGs for Cadmium are based on the oral RfD for water which is slightly more conservative (by a factor of 2) than the RfD for food. Because the PRGs are considered screening values, we elected to use the more conservative RfD for cadmium. However, reasonable arguments could be made for applying an RfD for food (instead of the oral RfD for water) for some media such as soils.

The water RfD for cadmium assumes a 5% oral absorption factor. The assumption of an oral absorption efficiency of 5% for Cadmium leads to an estimated dermal RfD of 2.5E-05. The PRG calculations incorporate these adjustments per recent guidance (USEPA 2004).

Chromium 6 For Chromium 6 (Cr6), IRIS shows an air unit risk of 1.2E-2 per (ug/cu.m) or expressed as an inhalation cancer slope factor (adjusting for inhalation/body weight) of 42 $(mg/kg\text{-}day)^{-1}$. However, the supporting documentation in the IRIS file states that these toxicity values are based on an assumed 1:6 ratio of Cr6:Cr3. Because of this assumption, we in Region 9 prefer to present PRGs based on these cancer toxicity values as "total chromium" numbers.

In the PRG Table, we also include a Cr6 specific value (assuming 100% Cr6) that is derived by multiplying the "total chromium" value by 7, yielding a cancer potency factor of 290 $(mg/kg\text{-}day)^{-1}$. This is considered to be an overly conservative assumption by some within the Agency. However, this calculation is also consistent with the State of California's interpretation of the Mancuso study that forms the basis of Cr6's toxicity values.

If you are working on a project outside of California (and outside of Region 9), you may want to contact the appropriate regulatory officials to determine what their position is on this issue. As mentioned, Region 9 also includes PRGs for "total chromium" which is based on the same ratio (1:6 ratio Cr6:Cr3) that forms the basis of the cancer slope factor of 42 $(mg/kg\text{-}day)^{-1}$ presented in IRIS.

Dioxin Dioxins, furans, and some polychlorinated biphenyls are members of the same family and exhibit similar toxicological properties. Before using the dioxin PRG at an individual site, these dioxin-related compounds must be summed together. However, they differ in the degree of toxicity so that a toxicity equivalence factor (TEF) must first be applied to adjust the measured concentrations to a toxicity equivalent concentration. EPA Region 9 has adopted the 1997 World Health Organization (WHO) TEFs. For more on this, please refer to the following article (in Environmental Health Perspectives, Vol. 6, No. 12, Dec. 1998) online at: http://ehp.niehs.nih.gov/members/1998/106p775-792vandenberg/vandenberg-full.html

Lead Residential PRGs for Lead (Region 9 EPA and California EPA) are derived based on pharmacokinetic models. Both EPA's Integrated Exposure Uptake Biokinetic (IEUBK) Model and California's LeadSpread model are designed to predict the probable blood lead concentrations for children between six months and seven years of age who have been exposed to lead through various sources (air, water, soil, dust, diet and *in utero* contributions from the mother). Run in the reverse, these models also allow the user to calculate lead PRGs that are considered "acceptable" by EPA or the State of California.

EPA uses a second Adult Lead Model to estimate PRGs for an industrial setting. This PRG is intended to protect a fetus that may be carried by a pregnant female worker. It is assumed that a cleanup goal that is protective of a fetus will also afford protection for male or female adult workers. The model equations were developed to calculate cleanup goals such that there would be no more than a 5% probability that fetuses exposed to lead would exceed a blood lead (PbB) of 10 • g/dl. An updated screening level for soil lead at commercial/industrial (i.e., non-residential) sites of 800 ppm is based on a recent analysis of the combined phases of NHANES III that chooses a cleanup goal protective of all subpopulations.

For more information on EPA's lead models and other lead-related topics, please go to:
http://www.epa.gov/oerrpage/superfund/programs/lead/

For more information on California's LeadSpread Model and Cal-Modified PRGs for lead, please go to:
http://www.dtsc.ca.gov/ScienceTechnology/ledspred.html

Manganese The IRIS RfD (0.14 mg/kg-day) includes manganese from all sources, including diet. The author of the IRIS assessment for manganese recommends that the dietary contribution from the normal U.S. diet (an upper limit of 5 mg/day) be subtracted when evaluating non-food (e.g. drinking water or soil) exposures to manganese, leading to a RfD of 0.071 mg/kg-day for non-food items. The explanatory text in IRIS further recommends using a modifying factor of 3 when calculating risks associated with non-food sources due to a number of uncertainties that are discussed in the IRIS file for manganese, leading to a RfD of 0.024 mg/kg-day. This modified RfD is applied in the derivation of the Region 9 PRGs for soil and water. For more information regarding the Manganese RfD, you may want to contact Dr. Bob Benson at (303) 312-7070.

Nitrates/Nitrates Tap water PRGs for Nitrates/Nitrites are based on the MCL as there is no available RfD for these compounds. For more information, please see IRIS at:
http://www.epa.gov/iriswebp/iris/index.html

Thallium IRIS has many values for the different salts of thallium. However, our analytical data packages typically report "thallium". Therefore, as a practical matter it makes more sense to report a PRG for plain thallium. We have done this by making the adjustment contained in the IRIS file for thallium sulfate based on the molecular weight of the thallium in the thallium salt. The adjusted oral RfD for plain thallium is 6.6 E-05 mg/kg-day which we use to calculate a thallium PRG.

Vinyl Chloride In EPA's recent reassessment of vinyl chloride toxicity, IRIS presents two cancer slope factors for vinyl chloride (VC): one that is intended to be applied towards evaluating adult risks and a second more protective slope factor that takes into account the unique susceptibility of developing infants and young children. For residential PRGs, the Region 9 PRG Table applies the more conservative cancer potency factor that addresses exposures to both children and adults whereas for the industrial soils PRG, the adult only cancer slope factor is applied.

Because of the age-dependent vulnerability associated with vinyl chloride exposures, and due to the method that is applied in deriving the cancer slope factor for VC, an assumption of a 70 year exposure over the lifetime is assumed, consistent with the way that the toxicity value for VC was derived. Therefore, instead of the usual exposure assumption of 6 years as a child and 24 years as an adult that is assumed for carcinogenic substances, we have revised the exposure assumption for VC to 6 years as a child and 64 years as adult. Since most of the cancer risk is associated with the first 30 years of exposure to VC, there is actually little difference between a 30 year exposure assumption (typically assumed for Superfund risk assessments) and the 70 year exposure assumption that is assumed in calculating the PRG for VC.

2.4 Cal-Modified PRGs

When EPA Region 9 first came out with a Draft of the PRG Table in 1992, there was concern expressed by California EPA's Department of Toxic Substances and Control (DTSC) that for some chemicals, the risk-based concentrations that are calculated using Cal-EPA toxicity values are "significantly" more protective than the risk-based concentrations that are calculated using EPA toxicity values. Because the risk-based PRGs are order-of-magnitude estimates at best, it was agreed by both Agencies that a difference of approximately 4 or greater would be regarded as a significant difference. For chemicals with California and EPA values that differ by a factor of 4 or more, both the EPA PRGs and the "Cal-Modified PRGs" are listed in the Table.

Please note that in the State of California, Cal-Modified PRGs should be used as screening levels for contaminated sites if they are more stringent than the Federal numbers.

2.5 Soil Screening Levels

Generic, soil screening levels (SSLs) for the protection of groundwater have been included in the PRG Table for 100 of the most common contaminants at Superfund sites. Generic SSLs are derived using default values in standardized equations presented in EPA OSWER's *Soil Screening Guidance* series, available on the web at http://www.epa.gov/superfund/resources/soil/index.htm .

The SSLs were developed using a default dilution-attenuation factor (DAF) of 20 to account for natural processes that reduce contaminant concentrations in the subsurface. Also included are generic SSLs that assume no dilution or attenuation between the source and the receptor well (i.e., a DAF of 1). These values can be used at sites where little or no dilution or attenuation of soil leachate concentrations is expected at a site (e.g., sites with shallow water tables, fractured media, karst topography, or source size greater than 30 acres).

In general, if an SSL is not exceeded for the migration to groundwater pathway, the user may eliminate this pathway from further investigation.

It should be noted that in the State of California, the California Regional Water Quality Control Board has derived "California SSLs" for a number of pathways including migration to groundwater. These are not included in the Region 9 PRG Table, but may be accessed at the following website:

http://www.swrcb.ca.gov/rwqcb2/rbsl.htm

Or, for more information on the "California SSLs", please contact Dr Roger Brewer at: (510) 622-2374.

2.6 Miscellaneous

Volatile organic compounds (VOCs) are indicated by "y" in the VOC column of the Table and in general, are defined as those chemicals having a Henry's Law constant greater than 10^{-5} (atm-m^3/mol) and a molecular weight less than 200 g/mole). Three borderline chemicals (dibromochloromethane, 1,2-dibromochloropropane, and pyrene) which do not strictly meet these criteria of volatility have also been included based upon discussions with other state and federal agencies and after a consideration of vapor pressure characteristics etc. Volatile organic chemicals are evaluated for potential volatilization from soil/water to air using volatilization factors (see Section 4.4).

Chemical-specific dermal absorption values for contaminants in soil and dust are presented for arsenic, cadmium, chlordane, 2,4-D, DDT, lindane, TCDD, PAHs, PCBs, and pentachlorophenols as recommended in the *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Interim Guidance* (USEPA 2004). Otherwise, default skin absorption fractions are assumed to be 0.10 for nonvolatile organics. Please note that previous defaults of 0.01 and 0.10 for inorganics and VOCs respectively, have been withdrawn per new guidance.

3.0 USE OF PRGS AT SITES

The decision to use PRGs at a site will be driven by the potential benefits of having generic risk-based concentrations in the absence of site-specific risk assessments. The original intended use of PRGs was to provide initial cleanup goals for individual chemicals given specific medium and land-use combinations (see RAGS Part B, 1991), however risk-based concentrations have several applications. They can also be used for:

- Setting health-based detection limits for chemicals of potential concern
- Screening sites to determine whether further evaluation is appropriate
- Calculating cumulative risks associated with multiple contaminants

A few basic procedures are recommended for using PRGs properly. These are briefly described below. Potential problems with the use of PRGs are also identified.

3.1 Conceptual Site Model

The primary condition for use of PRGs is that exposure pathways of concern and conditions at the site match those taken into account by the PRG framework. Thus, it is always necessary to develop a conceptual site model (CSM) to identify likely contaminant source areas, exposure pathways, and potential receptors. This information can be used to determine the applicability of PRGs at the site and the need for additional information. For those pathways not covered by PRGs, a risk assessment specific to these additional pathways may be necessary. Nonetheless, the PRG lookup values will still be useful in such situations for focusing further investigative efforts on the exposure pathways not addressed.

To develop a site-specific CSM, perform an extensive records search and compile existing data (e.g. available site sampling data, historical records, aerial photographs, and hydrogeologic information). Once this information is obtained, CSM worksheets such as those provided in ASTM's *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites* (1995) can be used to tailor the generic worksheet model to a site-specific CSM. The final CSM diagram represents linkages among contaminant sources, release mechanisms, exposure pathways and routes and receptors. It summarizes our understanding of the contamination problem.

As a final check, the CSM should answer the following questions:

- Are there potential ecological concerns?
- Is there potential for land use other than those covered by the PRGs (that is, residential and industrial)?
- Are there other likely human exposure pathways that were not considered in development of the PRGs (e.g. impact to groundwater, local fish consumption, raising beef, dairy, or other livestock)?
- Are there unusual site conditions (e.g. large areas of contamination, high fugitive dust levels, potential for indoor air contamination)?

If any of these four conditions exist, the PRG may need to be adjusted to reflect this new information. Suggested websites for the evaluation of pathways not currently addressed by Region 9 PRG's are presented in Exhibit 3-1.

EXHIBIT 3-1
SUGGESTED WEBSITES FOR EVALUATING EXPOSURE PATHWAYS NOT CURRENTLY ADDRESSED BY REGION 9 PRGs

EXPOSURE PATHWAY	WEBSITE
Migration of contaminants to an underlying potable aquifer	EPA Soil Screening Guidance: http://www.epa.gov/superfund/resources/soil/index.htm California Water Board Guidance: http://www.swrcb.ca.gov/rwqcb2/rbsl.htm
Ingestion via plant uptake	EPA Soil Screening Guidance: http://www.epa.gov/superfund/resources/soil/index.htm EPA Fertilizer Risk Assessment: http://www.epa.gov/epaoswer/hazwaste/recycle/fertiliz/risk/
Ingestion via meat, dairy products, human milk	EPA Protocol for Combustion Facilities: http://www.epa.gov/epaoswer/hazwaste/combust/riskvol.htm#volume1 California "Hot Spots" Risk Guidelines: http://www.oehha.ca.gov/air/hot_spots/HRSguide.html
Inhalation of volatiles that have migrated into basements or other enclosed spaces.	EPA's draft Subsurface Vapor Intrusion Guidance: http://www.epa.gov/correctiveaction/eis/vapor.htm EPA's Version of Johnson & Ettinger Model: http://www.epa.gov/oerrpage/superfund/programs/risk/airmodel/johnson_ettinger.htm
Ecological pathways	EPA Ecological Soil Screening Guidance: http://www.epa.gov/superfund/programs/risk/ecorisk/ecossl.htm NOAA Sediment Screening Table: http://response.restoration.noaa.gov/cpr/sediment/squirt/squirt.html

3.2 Background Levels Evaluation

A necessary step in determining the applicability of Region 9 risk-based PRGs is the consideration of background contaminant concentrations. There is new EPA guidance on determining background at sites. *Guidance for Characterizing Background Chemicals in Soil at Superfund Sites* (USEPA 2001b) is available on the web at: http://www.epa.gov/superfund/programs/risk/background.pdf .

EPA may be concerned with two types of background at sites: naturally occurring and

anthropogenic. Natural background is usually limited to metals whereas anthropogenic (i.e. human-made) "background" includes both organic and inorganic contaminants. Before embarking on an extensive sampling and analysis program to determine local background concentrations in the area, one should first compile existing data on the subject. Far too often there is pertinent information in the literature that gets ignored, resulting in needless expenditures of time and money.

Generally EPA does not clean up below natural background. In some cases, the predictive risk-based models generate PRG concentrations that lie within or even below typical background concentrations for the same element or compound. If natural background concentrations are higher than the risk-based PRG concentrations, then background concentrations should also be considered in determining whether further evaluation and/or remediation is necessary at a particular site. Exhibit 3-2 presents summary statistics for selected elements in soils that have background levels that may exceed risk-based PRGs.

Where anthropogenic "background" levels exceed PRGs and EPA has determined that a response action is necessary and feasible, EPA's goal will be to develop a comprehensive response to the widespread contamination. This will often require coordination with different authorities that have jurisdiction over the sources of contamination in the area.

EXHIBIT 3-2
BACKGROUND CONCENTRATIONS OF SELECTED ELEMENTS IN SOILS

TRACE	U.S. STUDY DATA[1]			CALIFORNIA DATA[2]		
ELEMENT	Range	GeoMean	ArMean	Range	GeoMean	ArMean
Arsenic	<.1-97	5.2 mg/kg	7.2 mg/kg	0.59-11	2.75 mg/kg	3.54 mg/kg
Beryllium	<1-15	0.63 "	0.92 "	0.10-2.7	1.14 "	1.28 "
Cadmium	<1-10	--	<1	0.05-1.7	0.26	0.36
Chromium	1-2000	37	54	23-1579	76.25	122.08
Nickel	<5-700	13	19	9.0-509	35.75	56.60

[1]Shacklette and Hansford, "Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States",USGS Professional Paper 1270, 1984.

[2]Bradford et. al, "Background Concentrations of Trace and Major Elements in California Soils", Kearney Foundation Special Report, UC-Riverside and CAL-EPA DTSC, March 1996.

3.3 Screening Sites with Multiple Pollutants

A suggested stepwise approach for PRG-screening of sites with multiple pollutants is as follows:

- Perform an extensive records search and compile existing data.

- Identify site contaminants in the PRG Table. Record the PRG concentrations for various media and note whether PRG is based on cancer risk (indicated by "ca"). or noncancer hazard (indicated by "nc"). Segregate cancer PRGs from non-cancer PRGs and exclude (but don't eliminate) non-risk based PRGs ("sat" or "max").

- For cancer risk estimates, take the site-specific concentration (maximum or 95 UCL) and divide by the PRG concentrations that are designated for cancer evaluation ("ca"). Multiply this ratio by 10^{-6} to estimate chemical-specific risk for a reasonable maximum exposure (RME). For multiple pollutants, simply add the risk for each chemical:

$$Risk = [(\frac{conc_x}{PRG_x}) + (\frac{conc_y}{PRG_y}) + (\frac{conc_z}{PRG_z})] \times 10^{-6}$$

- For non-cancer hazard estimates. Divide the concentration term by its respective non-cancer PRG designated as "nc" and sum the ratios for multiple contaminants. The cumulative ratio represents a non-carcinogenic hazard index (HI). A hazard index of 1 or less is generally considered "safe". A ratio greater than 1 suggests further evaluation. **[Note that carcinogens may also have an associated non-cancer PRG that is not listed in the PRG Table. To obtain these values, the user should view or download the InterCalc Tables at the PRG website and display the appropriate sections.]**

$$Hazard\ Index = [(\frac{conc_x}{PRG_x}) + (\frac{conc_y}{PRG_y}) + (\frac{conc_z}{PRG_z})]$$

For more information on screening site risks, the reader should contact EPA Region 9's Technical Support Section.

3.4 Potential Problems

As with any risk-based tool, the potential exists for misapplication. In most cases the root cause will be a lack of understanding of the intended use of Region 9 PRGs. In order to prevent misuse of PRGs, the following should be avoided:

- Applying PRGs to a site without adequately developing a conceptual site model that identifies relevant exposure pathways and exposure scenarios,

- Not considering background concentrations when choosing PRGs as cleanup goals,

- Use of PRGs as cleanup levels without the nine-criteria analysis specified in the National Contingency Plan (or, comparable analysis for programs outside of Superfund),

- Use of PRGs as cleanup levels without verifying numbers with a toxicologist or regional risk assessor,

- Use of antiquated PRG Tables that have been superseded by more recent publications,

- Not considering the effects of additivity when screening multiple chemicals, and

- Adjusting PRGs upward by factors of 10 or 100 without consulting a toxicologist or regional risk assessor.

4.0 TECHNICAL SUPPORT DOCUMENTATION

Region 9 PRGs consider human exposure hazards to chemicals from contact with contaminated soils, air, and water. The emphasis of the PRG equations and technical discussion are aimed at developing screening criteria for soils, since this is an area where few standards exist. For air and water, additional reference concentrations or standards are available for many chemicals (e.g. MCLs, non-zero MCLGs, AWQC, and NAAQS) and consequently the discussion of these media are brief.

4.1 Ambient Air and the Vapor Intrusion Pathway

The ambient air PRG is applicable to both indoor and outdoors and is based on a residential exposure scenario using standard Superfund exposure factors (see Exhibit 4-1 below).

The air PRG may also be used as a health-protective indoor air target for determining soil gas and groundwater screening levels for the evaluation of the subsurface vapor intrusion pathway. The "vapor intrusion pathway" refers to the migration of volatile chemicals from the subsurface into overlying buildings. Volatile chemicals in buried wastes and/or contaminated groundwater can emit vapors that may migrate through subsurface soils and into indoor air spaces of overlying buildings in ways similar to that of radon gas seeping into homes.

To derive a soil gas and/or groundwater screening level that targets the air PRG, it is necessary to divide the air PRG by an appropriate attenuation factor. The attenuation factor represents the factor by which subsurface vapor concentrations migrating into indoor air spaces are reduced due to diffusive, advective, and/or other attenuating mechanisms. The attenuation factor can be empirically determined and/or calculated using an appropriate vapor intrusion model such as the Johnson and Ettinger model available at: http://www.epa.gov/oerrpage/superfund/programs/risk/airmodel/johnson_ettinger.htm . Once the appropriate attenuation factor is determined, the following equation can be used to derive a screening level that would be protective of indoor air assuming residential land use.

For Soil Gas, the relationship is as follows:

$C_{soil\text{-}gas}[ug/m^3]$ = Air PRG $[ug/m^3]/AF$

where

$C_{soil\text{-}gas}$ = soil gas screening level
AF = attenuation factor (ratio of indoor air concentration to soil gas concentration)

For Groundwater, the relationship is as follows:

C_{gw}[ug/L] = Air PRG [ug/m^3] x 10^{-3} m^3/L x 1/H x 1/AF

where

C_{gw} = groundwater screening level
H = dimensionless Henry's Law Constant at 25C [(mg/L - vapor)/(mg/L - water)]
AF = attenuation factor (ratio of indoor air concentration to soil gas concentration)

For more information on EPA's current understanding of this emerging exposure pathway, please refer to EPA's recent draft guidance *Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)* (USEPA 2002) available on the web at:
http://www.epa.gov/correctiveaction/eis/vapor.htm

4.2 Soils - Direct Ingestion

Calculation of risk-based PRGs for direct ingestion of soil is based on methods presented in RAGS HHEM, Part B (USEPA 1991a) and *Soil Screening Guidance* (USEPA 1996a,b, USEPA 2001a). Briefly, these methods backcalculate a soil concentration level from a target risk (for carcinogens) or hazard quotient (for noncarcinogens).

Residential Soil PRGs

A number of studies have shown that inadvertent ingestion of soil is common among children 6 years old and younger (Calabrese et al. 1989, Davis et al. 1990, Van Wijnen et al. 1990). To take into account the higher soil intake rate for children, two different approaches are used to estimate PRGs, depending on whether the adverse health effect is cancer or some effect other than cancer.

For carcinogens, the method for calculating PRGs uses an age-adjusted soil ingestion factor that takes into account the difference in daily soil ingestion rates, body weights, and exposure duration for children from 1 to 6 years old and others from 7 to 31 years old. This health-protective approach is chosen to take into account the higher daily rates of soil ingestion in children as well as the longer duration of exposure that is anticipated for a long-term resident. For more on this method, see USEPA RAGs Part B (1991a).

For noncarcinogenic concerns, the more protective method of calculating a soil PRG is to evaluate childhood exposures separately from adult exposures. In other words, an age-adjustment factor is not applied as was done for carcinogens. This approach is considered conservative because it combines the higher 6-year exposure for children with chronic toxicity criteria. In their analysis of the method, the Science Advisory Board (SAB) indicated that, for most chemicals, the approach may be overly protective. However, they noted that there are specific instances when the chronic RfD may be based on endpoints of toxicity that are specific to children (e.g. fluoride and nitrates) or when the dose-response is steep (i.e., the dosage difference between the no-observed-adverse-effects level [NOAEL] and an adverse effects level is small). Thus, for the purposes of screening, EPA Region 9 has adopted this approach for calculating soil PRGs for noncarcinogenic health concerns.

Industrial Soil PRGs

In the *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (Supplemental SSL Guidance, EPA 2001a), two different soil ingestion rates are assumed for non-construction workers: 100 mg/day is assumed for outdoor workers whereas 50 mg/day is assumed for indoor workers. The default value of 100 mg/day for outdoor workers is also recommended by EPA's Technical Review Workgroup for Lead (TRW), and it reflects increased exposures to soils for outdoor workers relative to their indoor counterparts. For more on this, please see the Supplemental SSL Guidance available at the following website:

http://www.epa.gov/superfund/resources/soil/index.htm

Because the Region 9 PRGs are generic and intended for screening sites early in the investigation process (often before site-specific information is available), we have chosen to use the 100 mg/day soil ingestion (i.e. outdoor worker) assumption to calculate industrial soil PRGs. The appropriateness of this assumption for a particular site may be evaluated when additional information becomes available regarding site conditions or site development.

4.3 Soils - Dermal Contact

Dermal Contact Assumptions

Exposure factors for dermal contact with soil are based on recommendations in *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Interim Guidance* (USEPA 2004). Recommended RME (reasonable maximum exposure) defaults for adult workers' skin surface areas (3300 cm^2/day) and soil adherence factors (0.2 mg/cm^2) now differ from the defaults recommended for adult residents (5700 cm^2/day, 0.07 mg/cm^2) as noted in Exhibit 4-1. This is due to differences in the range of activities experienced by workers versus residents.

Dermal Absorption

Chemical-specific skin absorption values recommended by the Superfund Dermal Workgroup were applied when available. Chemical-specific values are included for the following chemicals: arsenic, cadmium, chlordane, 2,4-D, DDT, lindane, TCDD, PAHs, PCBs, and pentachlorophenols.

The *Supplemental Guidance for Dermal Risk Assessment* (USEPA 2004) recommends a default dermal absorption factor for semivolatile organic compounds of 10% as a screening method for the majority of SVOCs without dermal absorption factors. Default dermal absorption values for other chemicals (VOCs and inorganics) are not recommended in this new guidance. Therefore, the assumption of 1% for inorganics and 10% for volatiles is no longer included in the PRG Table. This change has minimal impact on the final risk-based calculations because human exposure to VOCs and inorganics in soils is generally driven by other pathways of exposure.

4.4 Soils - Vapor and Particulate Inhalation

Agency toxicity criteria indicate that risks from exposure to some chemicals via inhalation far outweigh the risk via ingestion; therefore soil PRGs have been designed to address this pathway

as well. The models used to calculate PRGs for inhalation of volatiles/particulates are based on updates to risk assessment methods presented in RAGS Part B (USEPA 1991a) and are identical to the *Soil Screening Guidance: User's Guide and Technical Background Document* (USEPA 1996a,b).

It should be noted that the soil-to-air pathway that is evaluated in the PRGs calculations is based on inhalation exposures that result from the volatilization or particulate emissions of chemicals from soil to outdoor air. **The soil PRG calculations do not evaluate potential for volatile contaminants in soil to migrate indoors. For more on the subsurface vapor intrusion pathway please see Section 4.1.**

To address the soil-to-outdoor air pathways, the PRG calculations incorporate volatilization factors (VF_s) for volatile contaminants and particulate emission factors (PEF) for nonvolatile contaminants. These factors relate soil contaminant concentrations to air contaminant concentrations that may be inhaled on-site. The VF_s and PEF equations can be broken into two separate models: an emission model to estimate emissions of the contaminant from the soil and a dispersion model to simulate the dispersion of the contaminant in the atmosphere.

The box model in RAGS Part B has been replaced with a dispersion term (Q/C) derived from a modeling exercise using meteorological data from 29 locations across the United States because the box model may not be applicable to a broad range of site types and meteorology and does not utilize state-of-the-art techniques developed for regulatory dispersion modeling. The dispersion model for both volatiles and particulates is the AREA-ST, an updated version of the Office of Air Quality Planning and Standards, Industrial Source Complex Model, ISC2. However, different Q/C terms are used in the VF and PEF equations. Los Angeles was selected as the 90th percentile data set for volatiles and Minneapolis was selected as the 90th percentile data set for fugitive dusts (USEPA 1996 a,b). A default source size of 0.5 acres was chosen for the PRG calculations. This is consistent with the default exposure area over which Region 9 typically averages contaminant concentrations in soils. If unusual site conditions exist such that the area source is substantially larger than the default source size assumed here, an alternative Q/C could be applied (see USEPA 1996a,b).

Volatilization Factor for Soils

Volatile chemicals, defined as those chemicals having a Henry's Law constant greater than 10^{-5} (atm-m^3/mol) and a molecular weight less than 200 g/mole, were screened for inhalation exposures using a volatilization factor for soils (VF_s). Please note that VF_s's and other physical-chemical data for VOCs are contained in the InterCalc Tables at the EPA Region 9 PRG website.

The emission terms used in the VF_s are chemical-specific and were calculated from physical-chemical information obtained from several sources. The priority of these sources were as follows: *Soil Screening Guidance* (USEPA 1996a,b), *Superfund Chemical Data Matrix* (USEPA 1996c), *Fate and Exposure Data* (Howard 1991), *Subsurface Contamination Reference Guide* (EPA 1990a), and *Superfund Exposure Assessment Manual* (SEAM, EPA 1988). When there was a choice between a measured or a modeled value (e.g. Koc), our default was to use modeled values. In those cases where Diffusivity Coefficients (Di) were not provided in existing literature, Di's were calculated using Fuller's Method described in SEAM. A surrogate term was required for some chemicals that lacked physico-chemical information. In these cases, a proxy chemical of similar structure was used that may over- or under-estimate the PRG for soils.

Equation 4-9 forms the basis for deriving generic soil PRGs for the inhalation pathway. The following parameters in the standardized equation can be replaced with specific site data to develop a simple site-specific PRG

- Source area
- Average soil moisture content
- Average fraction organic carbon content
- Dry soil bulk density

The basic principle of the VF_s model (Henry's law) is applicable only if the soil contaminant concentration is at or below soil saturation "sat". Above the soil saturation limit, the model cannot predict an accurate VF-based PRG. How these particular cases are handled, depends on whether the contaminant is liquid or solid at ambient soil temperatures (see Section 4.6).

Particulate Emission Factor for Soils

Inhalation of chemicals adsorbed to respirable particles (PM_{10}) were assessed using a default PEF equal to 1.316×10^9 m^3/kg that relates the contaminant concentration in soil with the concentration of respirable particles in the air due to fugitive dust emissions from contaminated soils. The generic PEF was derived using default values in Equation 4-11, which corresponds to a receptor point concentration of approximately 0.76 ug/m^3. The relationship is derived by Cowherd (1985) for a rapid assessment procedure applicable to a typical hazardous waste site where the surface contamination provides a relatively continuous and constant potential for emission over an extended period of time (e.g. years). This represents an annual average emission rate based on wind erosion that should be compared with chronic health criteria; it is not appropriate for evaluating the potential for more acute exposures.

The impact of the PEF on the resultant PRG concentration (that combines soil exposure pathways for ingestion, skin contact, and inhalation) can be assessed by accessing the Region 9 PRG website and viewing the pathway-specific soil concentrations listed in the InterCalc Tables. Equation 4-11 forms the basis for deriving a generic PEF for the inhalation pathway. For more details regarding specific parameters used in the PEF model, the reader is referred to *Soil Screening Guidance: Technical Background Document* (USEPA 1996a).

Note: the generic PEF evaluates windborne emissions and does not consider dust emissions from traffic or other forms of mechanical disturbance that could lead to greater emissions than assumed here.

4.5 Soils - Migration to Groundwater

The methodology for calculating SSLs for the migration to groundwater was developed to identify chemical concentrations in soil that have the potential to contaminate groundwater. Migration of contaminants from soil to groundwater can be envisioned as a two-stage process: (1) release of contaminant in soil leachate and (2) transport of the contaminant through the underlying soil and aquifer to a receptor well. The SSL methodology considers both of these fate and transport mechanisms.

SSLs are backcalculated from acceptable ground water concentrations (i.e. nonzero MCLGs, MCLs, or risk-based PRGs). First, the acceptable groundwater concentration is multiplied by a

dilution factor to obtain a target leachate concentration. For example, if the dilution factor is 10 and the acceptable ground water concentration is 0.05 mg/L, the target soil leachate concentration would be 0.5 mg/L. The partition equation (presented in the *Soil Screening Guidance* document) is then used to calculate the total soil concentration (i.e. SSL) corresponding to this soil leachate concentration.

The SSL methodology was designed for use during the early stages of a site evaluation when information about subsurface conditions may be limited. Because of this constraint, the methodology is based on conservative, simplifying assumptions about the release and transport of contaminants in the subsurface. For more on SSLs, and how to calculate site-specific SSLs versus generic SSLs presented in the PRG Table, the reader is referred to the *Soil Screening Guidance* document (USEPA 1996a,b).

4.6 Soil Saturation Limit

The soil saturation concentration "sat" corresponds to the contaminant concentration in soil at which the absorptive limits of the soil particles, the solubility limits of the soil pore water, and saturation of soil pore air have been reached. Above this concentration, the soil contaminant may be present in free phase, i.e., nonaqueous phase liquids (NAPLs) for contaminants that are liquid at ambient soil temperatures and pure solid phases for compounds that are solid at ambient soil temperatures.

Equation 4-10 is used to calculate "sat" for each volatile contaminant. As an update to RAGS HHEM, Part B (USEPA 1991a), this equation takes into account the amount of contaminant that is in the vapor phase in soil in addition to the amount dissolved in the soil's pore water and sorbed to soil particles.

Chemical-specific "sat" concentrations must be compared with each VF-based PRG because a basic principle of the PRG volatilization model is not applicable when free-phase contaminants are present. How these cases are handled depends on whether the contaminant is liquid or solid at ambient temperatures. Liquid contaminant that have a VF-based PRG that exceeds the "sat" concentration are set equal to "sat" whereas for solids (e.g., PAHs), soil screening decisions are based on the appropriate PRGs for other pathways of concern at the site (e.g., ingestion).

4.7 Tap Water - Ingestion and Inhalation

Calculation of PRGs for ingestion and inhalation of contaminants in domestic water is based on the methodology presented in RAGS HHEM, Part B (USEPA 1991a). Ingestion of drinking water is an appropriate pathway for all chemicals. For the purposes of this guidance, however, inhalation of volatile chemicals from water is considered routinely only for chemicals with a Henry's Law constant of 1×10^{-5} atm-m^3/mole or greater <u>and</u> with a molecular weight of less than 200 g/mole.

For volatile chemicals, an upperbound volatilization constant (VF_w) is used that is based on all uses of household water (e.g showering, laundering, and dish washing). Certain assumptions were made. For example, it is assumed that the volume of water used in a residence for a family of four is 720 L/day, the volume of the dwelling is 150,000 L and the air exchange rate is 0.25 air changes/hour (Andelman in RAGS Part B). Furthermore, it is assumed that the average transfer efficiency weighted by water use is 50 percent (i.e. half of the concentration of each

chemical in water will be transferred into air by all water uses). Note: the range of transfer efficiencies extends from 30% for toilets to 90% for dishwashers.

4.8 Default Exposure Factors

Default exposure factors were obtained primarily from RAGS Supplemental Guidance Standard Default *Exposure Factors* (OSWER Directive, 9285.6-03) dated March 25, 1991 and more recent information from U.S. EPA's Office of Solid Waste and Emergency Response, U.S. EPA's Office of Research and Development, and California EPA's Department of Toxic Substances Control (see Exhibit 4-1).

Because contact rates may be different for children and adults, carcinogenic risks during the first 30 years of life were calculated using age-adjusted factors ("adj"). Use of age-adjusted factors are especially important for soil ingestion exposures, which are higher during childhood and decrease with age. However, for purposes of combining exposures across pathways, additional age-adjusted factors are used for inhalation and dermal exposures. These factors approximate the integrated exposure from birth until age 30 combining contact rates, body weights, and exposure durations for two age groups - small children and adults. Age-adjusted factors were obtained from RAGS PART B or developed by analogy (see derivations next page).

For soils only, noncarcinogenic contaminants are evaluated in children separately from adults. No age-adjustment factor is used in this case. The focus on children is considered protective of the higher daily intake rates of soil by children and their lower body weight. For maintaining consistency when evaluating soils, dermal and inhalation exposures are also based on childhood contact rates.

(1) ingestion([mg-yr]/[kg-d]:

$$IFS_{adj} = \frac{ED_c \times IRS_c}{BW_c} + \frac{(ED_r - ED_c) \times IRS_a}{BW_a}$$

(2) skin contact([mg-yr]/[kg-d]:

$$SFS_{adj} = \frac{ED_c \times AF \times SA_c}{BW_c} + \frac{(ED_r - ED_c) \times AF \times SA_a}{BW_a}$$

(3) inhalation ([m^3-yr]/[kg-d]):

$$InhF_{adj} = \frac{ED_c \times IRA_c}{BW_c} + \frac{(ED_r - ED_c) \times IRA_a}{BW_a}$$

EXHIBIT 4-1
STANDARD DEFAULT FACTORS

Symbol	Definition (units)	Default	Reference
CSFo	Cancer slope factor oral (mg/kg-d)-1	--	IRIS, PPRTV, HEAST, NCEA, or California
CSFi	Cancer slope factor inhaled (mg/kg-d)-1	--	IRIS, PPRTV, HEAST, NCEA, or California
RfDo	Reference dose oral (mg/kg-d)	--	IRIS, PPRTV, HEAST, NCEA, or California
RfDi	Reference dose inhaled (mg/kg-d)	--	IRIS, PPRTV, HEAST, NCEA, or California
TR	Target cancer risk	10^{-6}	--
THQ	Target hazard quotient	1	--
BWa	Body weight, adult (kg)	70	RAGS (Part A), EPA 1989 (EPA/540/1-89/002)
BWc	Body weight, child (kg)	15	Exposure Factors, EPA 1991 (OSWER No. 9285.6-03)
ATc	Averaging time - carcinogens (days)	25550	RAGS(Part A), EPA 1989 (EPA/540/1-89/002)
ATn	Averaging time - noncarcinogens (days)	ED*365	
SAa	Exposed surface area for soil/dust (cm^2/day)		Dermal Assessment, EPA 2004 (EPA/540/R-99/005)
	– adult resident	5700	
	– adult worker	3300	
SAc	Exposed surface area, child in soil (cm^2/day)	2800	Dermal Assessment, EPA 2004 (EPA/540/R-99/005)
AFa	Adherence factor, soils (mg/cm^2)		Dermal Assessment, EPA 2004 (EPA/540/R-99/005)
	– adult resident	0.07	
	– adult worker	0.2	
AFc	Adherence factor, child (mg/cm^2)	0.2	Dermal Assessment, EPA 2004 (EPA/540/R-99/005)
ABS	Skin absorption defaults (unitless):		
	– semi-volatile organics	0.1	Dermal Assessment, EPA 2004 (EPA/540/R-99/005)
	– volatile organics	--	Dermal Assessment, EPA 2004 (EPA/540/R-99/005)
	– inorganics	--	Dermal Assessment, EPA 2004 (EPA/540/R-99/005)
IRAa	Inhalation rate - adult (m^3/day)	20	Exposure Factors, EPA 1991 (OSWER No. 9285.6-03)
IRAc	Inhalation rate - child (m^3/day)	10	Exposure Factors, EPA 1997 (EPA/600/P-95/002Fa)
IRWa	Drinking water ingestion - adult (L/day	2	RAGS(Part A), EPA 1989 (EPA/540/1-89/002)
IRWc	Drinking water ingestion - child (L/day)	1	PEA, Cal-EPA (DTSC, 1994)
IRSa	Soil ingestion - adult (mg/day)	100	Exposure Factors, EPA 1991 (OSWER No. 9285.6-03)
IRSc	Soil ingestion - child (mg/day),	200	Exposure Factors, EPA 1991 (OSWER No. 9285.6-03)
IRSo	Soil ingestion - occupational (mg/day)	100	Soil Screening Guidance (EPA 2001a)
EFr	Exposure frequency - residential (d/y)	350	Exposure Factors, EPA 1991 (OSWER No. 9285.6-03)
EFo	Exposure frequency - occupational (d/y)	250	Exposure Factors, EPA 1991 (OSWER No. 9285.6-03)
EDr	Exposure duration - residential (years)	30[a]	Exposure Factors, EPA 1991 (OSWER No. 9285.6-03)
EDc	Exposure duration - child (years)	6	Exposure Factors, EPA 1991 (OSWER No. 9285.6-03)
EDo	Exposure duration - occupational (years)	25	Exposure Factors, EPA 1991 (OSWER No. 9285.6-03)
	Age-adjusted factors for carcinogens:		
IFSadj	Ingestion factor, soils ([mg-yr]/[kg-d])	114	RAGS(Part B), EPA 1991 (OSWER No. 9285.7-01B)
SFSadj	Dermal factor, soils ([mg-yr]/[kg-d])	361	By analogy to RAGS (Part B)
InhFadj	Inhalation factor, air ([m^3-yr]/[kg-d])	11	By analogy to RAGS (Part B)
IFWadj	Ingestion factor, water ([L-yr]/[kg-d])	1.1	By analogy to RAGS (Part B)
VFw	Volatilization factor for water (L/m^3)	0.5	RAGS(Part B), EPA 1991 (OSWER No. 9285.7-01B)
PEF	Particulate emission factor (m^3/kg)	See below	Soil Screening Guidance (EPA 1996a,b)
VFs	Volatilization factor for soil (m^3/kg)	See below	Soil Screening Guidance (EPA 1996a,b)
sat	Soil saturation concentration (mg/kg)	See below	Soil Screening Guidance (EPA 1996a,b)

Footnote:
[a]Exposure duration for lifetime residents is assumed to be 30 years total. For carcinogens, exposures are combined for children (6 years) and adults (24 years).

4.9 Standardized Equations

The equations used to calculate the PRGs for carcinogenic and noncarcinogenic contaminants are presented in Equations 4-1 through 4-8. The PRG equations update RAGS Part B equations. The methodology backcalculates a soil, air, or water concentration level from a target risk (for carcinogens) or hazard quotient (for noncarcinogens). For completeness, the soil equations combine risks from ingestion, skin contact, and inhalation simultaneously. **Note: the InterCalc Tables available at the EPA Region 9 PRG website also includes pathway-specific concentrations, should the user decide against combining specific exposure pathways; or, the user wants to identify the relative contribution of each pathway to exposure.**

To calculate PRGs for volatile chemicals in soil, a chemical-specific volatilization factor is calculated per Equation 4-9. Because of its reliance on Henry's law, the VF_s model is applicable only when the contaminant concentration in soil is at or below saturation (i.e. there is no free-phase contaminant present). Soil saturation ("sat") corresponds to the contaminant concentration in soil at which the adsorptive limits of the soil particles and the solubility limits of the available soil moisture have been reached. Above this point, pure liquid-phase contaminant is expected in the soil. If the PRG calculated using VF_s was greater than the calculated sat, the PRG was set equal to sat, in accordance with *Soil Screening Guidance* (USEPA 1996 a,b). The equation for deriving sat is presented in Equation 4-10.

PRG EQUATIONS

Soil Equations: For soils, equations were based on three exposure routes (ingestion, skin contact, and inhalation).

Equation 4-1: Combined Exposures to Carcinogenic Contaminants in Residential Soil

$$C(mg/kg) = \frac{TR \times AT_c}{EF_r \left[\left(\frac{IFS_{adj} \times CSF_o}{10^6 mg/kg} \right) + \left(\frac{SFS_{adj} \times ABS \times CSF_o}{10^6 mg/kg} \right) + \left(\frac{InhF_{adj} \times CSF_i}{VF_s^a} \right) \right]}$$

Equation 4-2: Combined Exposures to Noncarcinogenic Contaminants in Residential Soil

$$C(mg/kg) = \frac{THQ \times BW_c \times AT_n}{EF_r \times ED_c \left[\left(\frac{1}{RfD_o} \times \frac{IRS_c}{10^6 mg/kg} \right) + \left(\frac{1}{RfD_o} \times \frac{SA_c \times AF \times ABS}{10^6 mg/kg} \right) + \left(\frac{1}{RfD_i} \times \frac{IRA_c}{VF_s^a} \right) \right]}$$

Equation 4-3: Combined Exposures to Carcinogenic Contaminants in Industrial Soil

$$C(mg/kg) = \frac{TR \times BW_a \times AT_c}{EF_o \times ED_o \left[\left(\frac{IRS_o \times CSF_o}{10^6 mg/kg} \right) + \left(\frac{SA_a \times AF \times ABS \times CSF_o}{10^6 mg/kg} \right) + \left(\frac{IRA_a \times CSF_i}{VF_s^a} \right) \right]}$$

Footnote:
[a]Use VF_s for volatile chemicals (defined as having a Henry's Law Constant [atm-m^3/mol] greater than 10^{-5} and a molecular weight less than 200 grams/mol) or PEF for non-volatile chemicals.

Equation 4-4: Combined Exposures to Noncarcinogenic Contaminants in Industrial Soil

$$C(mg/kg) = \frac{THQ \times BW_a \times AT_n}{EF_o \times ED_o [(\frac{1}{RfD_o} \times \frac{IRS_o}{10^6 mg/kg}) + (\frac{1}{RfD_o} \times \frac{SA_a \times AF \times ABS}{10^6 mg/kg}) + (\frac{1}{RfD_i} \times \frac{IRA_a}{VF_s^a})]}$$

Tap Water Equations:

Equation 4-5: Ingestion and Inhalation Exposures to Carcinogenic Contaminants in Water

$$C(ug/L) = \frac{TR \times AT_c \times 1000 ug/mg}{EF_r [(IFW_{adj} \times CSF_o) + (VF_w \times InhF_{adj} \times CSF_i)]}$$

Equation 4-6: Ingestion and Inhalation Exposures to Noncarcinogenic Contaminants in Water

$$C(ug/L) = \frac{THQ \times BW_a \times AT_n \times 1000 ug/mg}{EF_r \times ED_r [(\frac{IRW_a}{RfD_o}) + (\frac{VF_w \times IRA_a}{RfD_i})]}$$

Air Equations:

Equation 4-7: Inhalation Exposures to Carcinogenic Contaminants in Air

$$C(ug/m^3) = \frac{TR \times AT_c \times 1000 ug/mg}{EF_r \times InhF_{adj} \times CSF_i}$$

Equation 4-8: Inhalation Exposures to Noncarcinogenic Contaminants in Air

$$C(ug/m^3) = \frac{THQ \times RfD_i \times BW_a \times AT_n \times 1000 ug/mg}{EF_r \times ED_r \times IRA_a}$$

Footnote:

[a]Use VF_s for volatile chemicals (defined as having a Henry's Law Constant [atm-m^3/mol] greater than 10^{-5} and a molecular weight less than 200 grams/mol) or PEF for non-volatile chemicals.

SOIL-TO-AIR VOLATILIZATION FACTOR (VF_s)

Equation 4-9: Derivation of the Volatilization Factor

$$VF_s\,(m^3/kg) = (Q/C) \times \frac{(3.14 \times D_A \times T)^{1/2}}{(2 \times \rho_b \times D_A)} \times 10^{-4}\,(m^2/cm^2)$$

where:

$$D_A = \frac{[\,(\Theta_a^{10/3} D_i H' + \Theta_w^{10/3} D_w)\,/\,n^2\,]}{\rho_B K_d + \Theta_w + \Theta_a H'}$$

Parameter	Definition (units)	Default
VF_s	Volatilization factor (m^3/kg)	--
D_A	Apparent diffusivity (cm^2/s)	--
Q/C	Inverse of the mean conc. at the center of a 0.5-acre square source ($g/^{M2}$-s per kg/m^3)	68.81
T	Exposure interval (s)	9.5×10^8
ρ_b	Dry soil bulk density (g/cm^3)	1.5
Θ_a	Air filled soil porosity (L_{air}/L_{soil})	0.28 or n-Θ_w
n	Total soil porosity (L_{pore}/L_{soil})	0.43 or 1 - (ρ_b/ρ_s)
Θ_w	Water-filled soil porosity (L_{water}/L_{soil})	0.15
ρ_s	Soil particle density (g/cm^3)	2.65
Di	Diffusivity in air (cm^2/s)	Chemical-specific
H	Henry's Law constant (atm-m^3/mol)	Chemical-specific
H'	Dimensionless Henry's Law constant	Calculated from H by multiplying by 41 (USEPA 1991a)
D_w	Diffusivity in water (cm^2/s)	Chemical-specific
K_d	Soil-water partition coefficient (cm^3/g) = $K_{oc} f_{oc}$	Chemical-specific
K_{oc}	Soil organic carbon-water partition coeffieient (cm^3/g)	Chemical-specific
f_{oc}	Fraction organic carbon in soil (g/g)	0.006 (0.6%)

SOIL SATURATION CONCENTRATION (sat)

Equation 4-10: Derivation of the Soil Saturation Limit

$$sat = \frac{S}{\rho_b} \left(K_d \rho_b + \Theta_w + H' \Theta_a\right)$$

Parameter	Definition (units)	Default
sat	Soil saturation concentration (mg/kg)	--
S	Solubility in water (mg/L-water)	Chemical-specific
ρ_b	Dry soil bulk density (kg/L)	1.5
n	Total soil porosity (L_{pore}/L_{soil})	0.43 or 1 - (ρ_b/ρ_s)
ρ_s	Soil particle density (kg/L)	2.65
K_d	Soil-water partition coefficient (L/kg)	K_{oc} x f_{oc} (chemical-specific)
k_{oc}	Soil organic carbon/water partition coefficient (L/kg)	Chemical-specific
f_{oc}	Fraction organic carbon content of soil (g/g)	0.006 or site-specific
Θ_w	Water-filled soil porosity (L_{water}/L_{soil})	0.15
Θ_a	Air filled soil porosity (L_{air}/L_{soil})	0.28 or n-Θ_w
w	Average soil moisture content (kg_{water}/kg_{soil} or L_{water}/kg_{soil})	0.1
H	Henry's Law constant (atm-m^3/mol)	Chemical-specific
H'	Dimensionless Henry's Law constant	H x 41, where 41 is a units conversion factor

SOIL-TO-AIR PARTICULATE EMISSION FACTOR (PEF)

Equation 4-11: Derivation of the Particulate Emission Factor

$$PEF(m^3/kg) = Q/C \times \frac{3600 s/h}{0.036 \times (1-V) \times (U_m/U_t)^3 \times F(x)}$$

Parameter	Definition (units)	Default
PEF	Particulate emission factor (m^3/kg)	1.316×10^9
Q/C	Inverse of the mean concentration at the center of a 0.5-acre-square source (g/m^2-s per kg/m^3)	90.80
V	Fraction of vegetative cover (unitless)	0.5
U_m	Mean annual windspeed (m/s)	4.69
U_t	Equivalent threshold value of windspeed at 7 m (m/s)	11.32
F(x)	Function dependent on U_m/U_t derived using Cowherd (1985) (unitless)	0.194

REFERENCES

ASTM. 1995. *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites.* Designation E 1739 - 95. Philadelphia, Pennsylvania.

Calabrese, E.J., H. Pastides, R. Barnes, et al. 1989. How much soil do young children ingest: an epidemiologic study. In: *Petroleum Contaminated Soils,* Vol. 2. E.J. Calabrese and P.T. Kostecki, eds. pp. 363-417. Chelsea, MI, Lewis Publishers.

California EPA. 1994. *Preliminary Endangerment Assessment Guidance Manual.* (PEA) Department of Toxic Substances Control, Sacramento, California.

California EPA. 1996. *Guidance for Ecological Risk Assessment at Hazardous Waste Sites and Permitted Facilities, Part A: Overview.* Department of Toxic Substances Control, Sacramento, California.

Cowherd, C., G. Muleski, P. Engelhart, and D. Gillette. 1985. *Rapid Assessment of Exposure to Particulate Emission from Surface Contamination.* EPA/600/8-85/002. Prepared for Office of Health and Environmental Assessment, U.S. Environmental Protection Agency, Washington, DC. NTIS PB85-1922197AS.

Davis, S., P. Waller, R. Buschom, J. Ballou, and P. White. 1990. Quantitative estimates of soil ingestion in normal ehildren between the ages of 2 and 7 years: population-based estimates using Al, Si, and Ti as soil tracer elements. *Archives of Environmental Health* 45:112-122.

Howard, P.H. 1990. *Handbook of Environmental Fate and Exposure Data for Organic Chemicals.* Lewis Publishers, Chelsea Miehigan.

U.S. EPA. 1988. *Superfund Exposure Assessment Manual.* EPA/540/1-88/001. Office of Emergency and Remedial Response, Washington, DC.

U.S. EPA. 1990a. *Subsurface Contamination Reference Guide.* EPA/540/2-90/011. Office of Emergency and Remedial Response, Washington, DC.

U.S. EPA 1990b. *Exposure Factors Handbook.* EPA/600/8089/043. Office of Health and Environmental Assessment, Washington, DC.

U.S. EPA. 1991a. *Risk Assessment Guidance for Superfund Volume 1: Human Health Evaluation Manual (Part B, Development of Risk-Based Preliminary Remediation Goals).* Publication 9285.7-01B. Office of Emergency and Remedial Response, Washington, DC. NTIS PB92-963333.

U.S. EPA. 1991b. *Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors.* Publication 9285.6-03. Office of Emergeney and Remedial Response, Washington, DC. NTIS PB91-921314.

U.S. EPA. 1992a *Technical Support Document for Land Application of Sewage Sludge; Volumes I and II.* Office of Water, Washington, DC. 822/R-93-001a,b.

U.S. EPA. 1992b *Dermal Exposure Assessment: Principles and Applications.* EPA/600/8-91/011B. Office of Health and Environmental Assessment, Washington, DC.

U.S. EPA 1994a. *Estimating Exposure to Dioxin-Like Compounds.* U.S. EPA Office of Research and Development, EPA/600/6-88/005B.

U.S. EPA 1994b. *Role of Ecological Assessment in the Baseline Risk Assessment.* OSWER Directive No. 9285.7-17. Office of Solid Waste and Emergency Response, Washington, DC.

U.S. EPA. 1996a. *Soil Screening Guidance: Technical Background Document.* EPA/540/R-95/128. Office of Emergency and Remedial Response, Washington, DC. PB96-963502.

U.S. EPA. 1996b. *Soil Screening Guidance: User's Guide.* EPA/540/R-96/018. Office of Emergency and Remedial Response, Washington, DC. PB96-963505.

REFERENCES

U.S. EPA 1996c. *Superfund Chemical Data Matrix*. EPA/540/R-96/028. Office of Solid Waste and Emergency Response, Washington, DC. PB94-963506.

U.S. EPA. 1997a. *Health Effects Assessment Summary Tables* (HEAST): Annual Update, FY 1997. National Center For Environmental Assessment (NCEA), Office of Research and Development and Office of Emergency and Remedial Response, Washington, DC.

U.S. EPA. 1997b. *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments, Interim Final*. EPA/540/R-97/006. Office of Solid Waste and Emergency Response, Washington, DC. PB97-963211.

U.S. EPA. 2001a. *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, Interim Guidance*. OSWER 9355.4-24.

U.S. EPA. 2001B. *Guidance for Characterizing Background Chemicals in Soil at Superfund Sites* (Draft) June 2001, EPA/ 540/R-01/003. Office of Solid Waste and Emergency Response, Washington, DC.

U.S. EPA. 2002. *Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)*, Draft. EPA/530/F/02/052.

U.S. EPA. 2004. *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)*, Final. EPA/540/R/99/005. Office of Solid Waste and Emergency Response, Washington, DC. PB99-963312.

Van Wijnen, J.H., P. Clausing and B. Brunekreef. 1990. Estimated soil ingestion by children. *Environmental Research*, 51:147-162.

APPENDIX D.1

ALUMINUM

Table D.1-1 contains the Descriptive Statistics for Site and Background Aluminum concentrations for UXO 5. From Table D.1-1 it can be seen that the mean for the site Aluminum concentration is less than the mean background Aluminum concentration. Also the median site Aluminum concentration is smaller than the background Aluminum concentration.

Variable	Descriptive Statistics UXO 5					
	Valid N	Mean	Median	Minimum	Maximum	Std.Dev.
Aluminum Background	8	9751.25	9700.00	8240.00	12300.00	1260.81
Aluminum Site	19	7227.37	4430.00	1130.00	15500.00	4977.69

Table D.1-1

Figure D.1-1 contains the side by side Box Plots for the site and background Aluminum concentrations. From these figures it can be seen that the median site Aluminum concentration is smaller than the Aluminum background concentration. It can also be seen that the lower quartile of the background is more than the upper quartile for the site concentration.

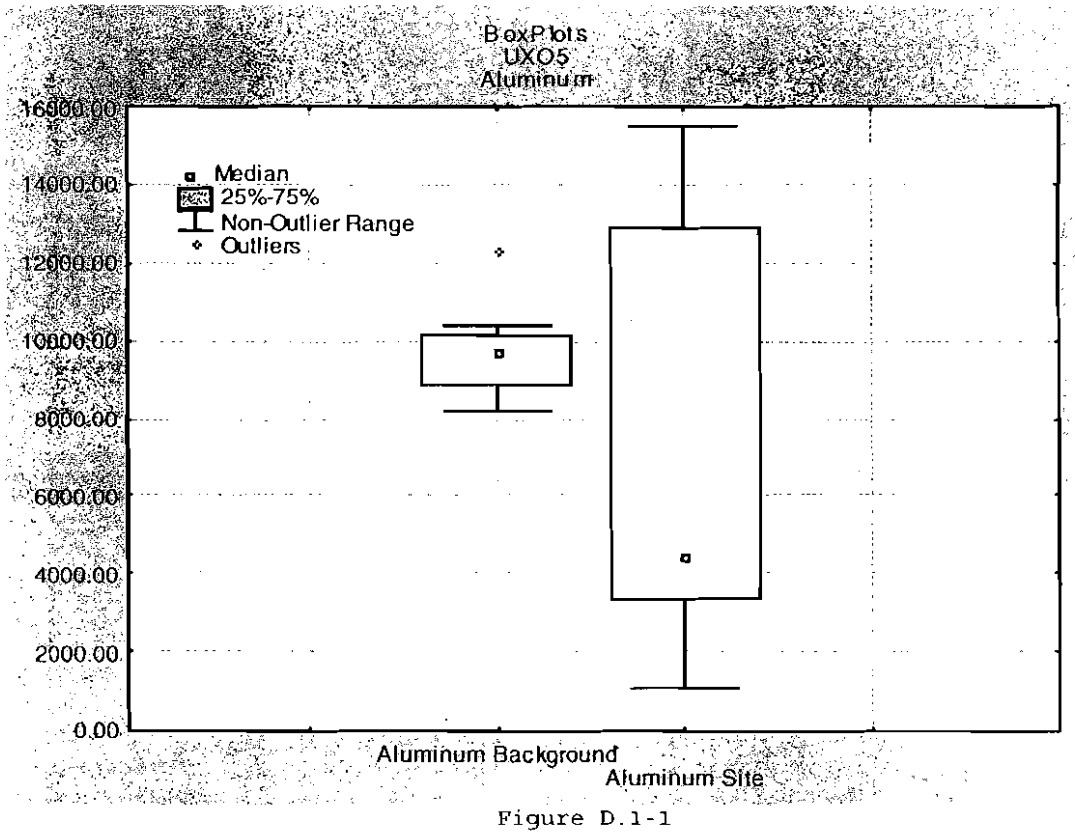


Figure D.1-1

Figure D.1-2 contains the 95% confidence intervals for site and background Aluminum concentrations for UXO 5. From this figure it can be seen that the mean of the site is smaller than the background mean. Also, the UCL for the site mean is roughly similar to the background mean.

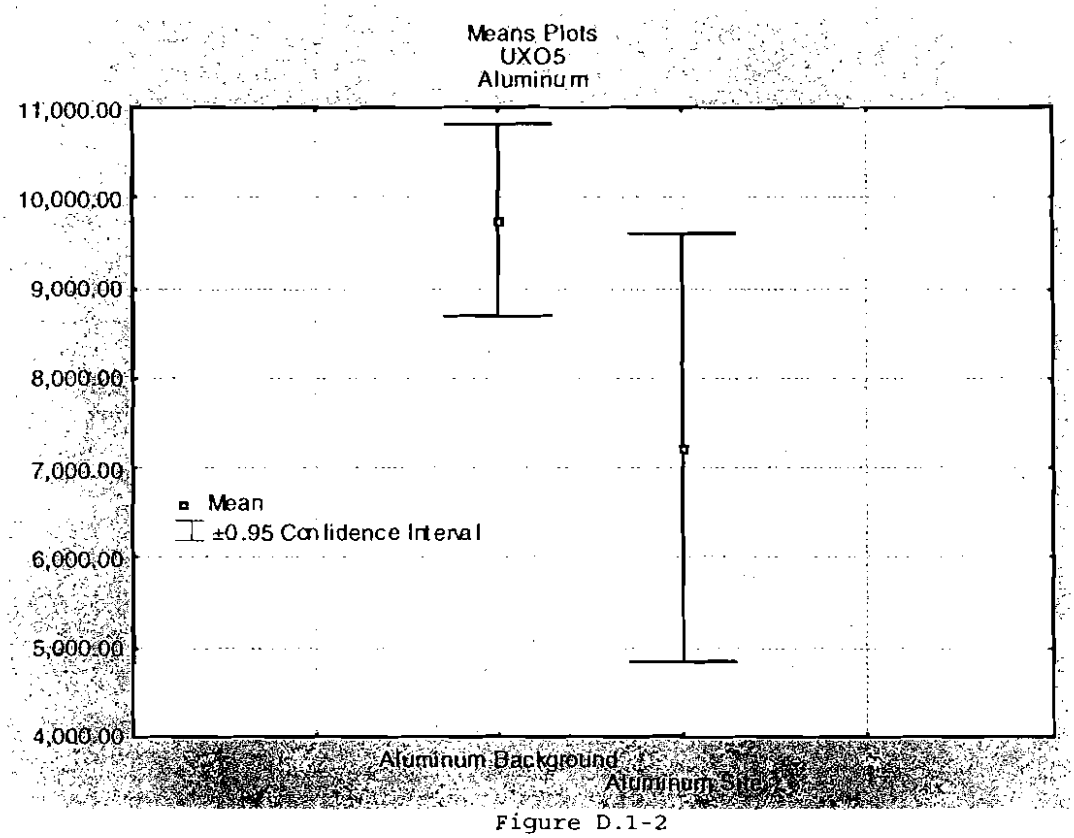


Figure D.1-2

Figures D.1-3 and D.1-4 show the normal probability plots and corresponding Shapiro Wilks test for normality. If the data is normal then the data points will roughly follow a linear pattern. The Shapiro Wilks test is a formal Statistical test of normality. The hypothesis being that the data is normally distributed. If the p-value for the test is less than 0.10 then the data is considered to be not normally distributed. From Figure D.1-3 it can be seen that the background Aluminum concentrations roughly follow the linear pattern and the p-value for the Shapiro Wilk test is 0.37. Thus it is concluded that the background Aluminum concentrations are normally distributed. From figure D.1-4 it can be seen that the site Aluminum concentrations do not follow a linear pattern and the p-value for the Shapiro Wilk Test is 0.01. Therefore, it is concluded that the site Aluminum concentrations do not follow a normal distribution.

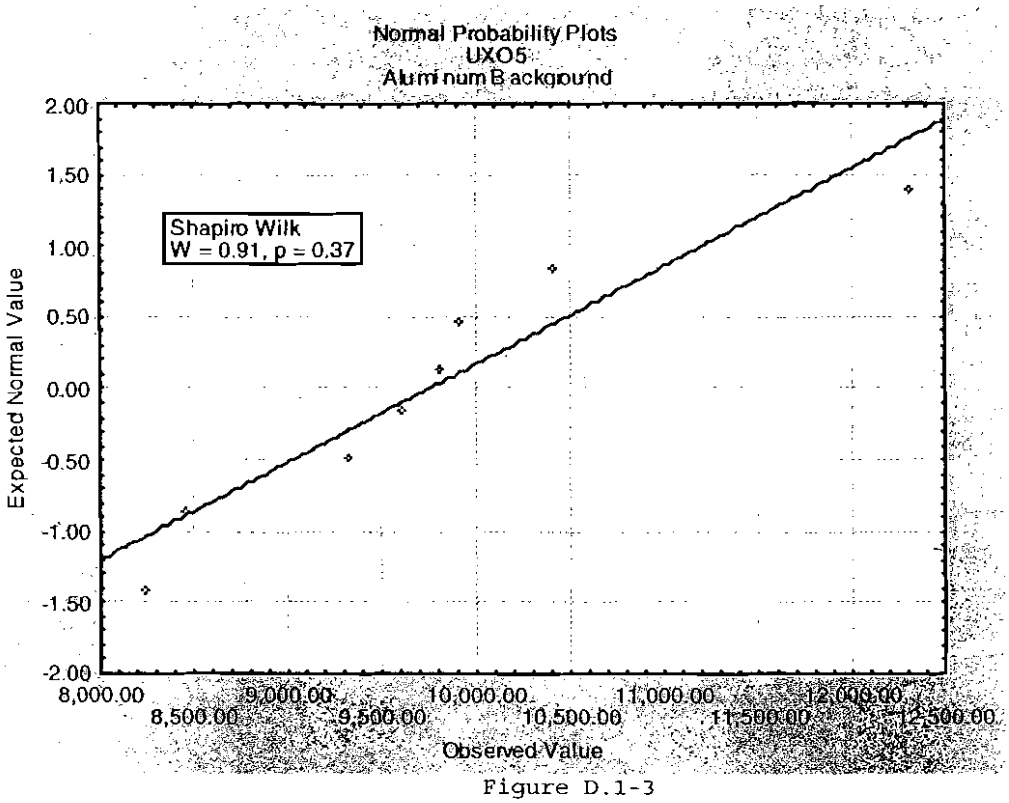


Figure D.1-3

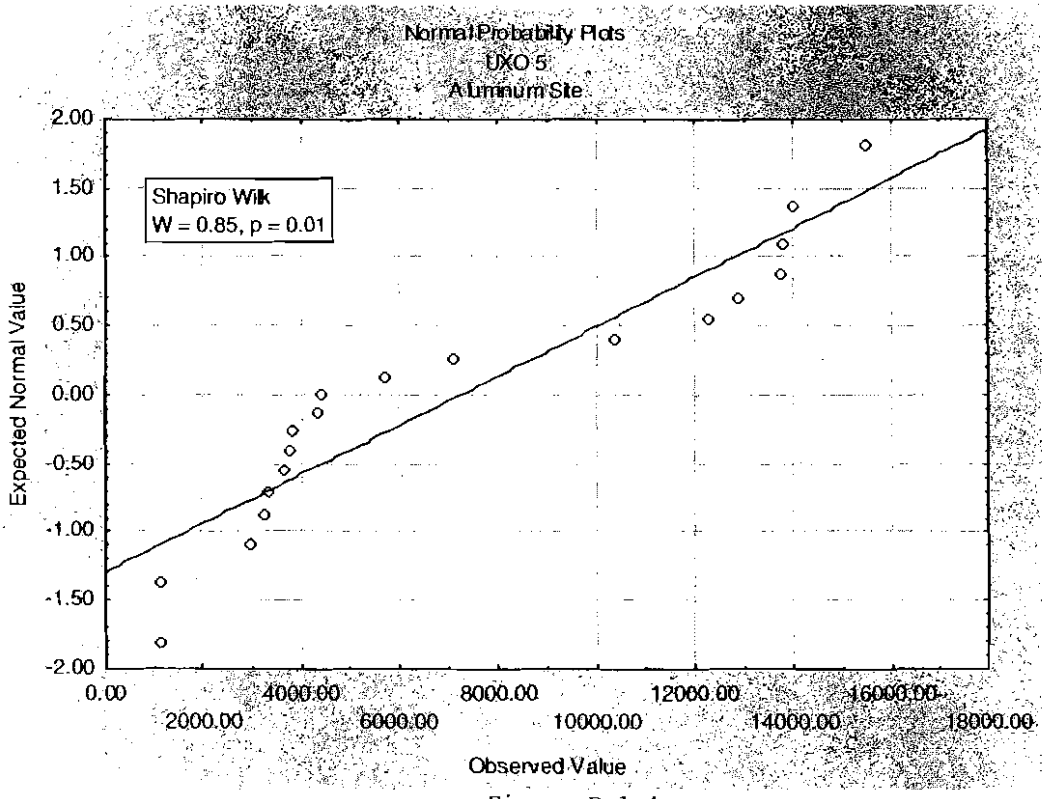


Figure D.1-4

Because the site Aluminum concentrations are not normally distributed the Nonparametric Wilcoxon Rank Sum test will be used to see if the median site

concentrations for Aluminum are larger than the median background concentrations. The hypothesis is that there is no difference between median values for the site Aluminum concentrations and background concentrations. The hypothesis of no difference will be rejected if the Test Statistic is greater than the Critical Value. Table D.1-2 contains the Test Statistic and Critical value for this comparison. From Table D.1-2 it can be seen that the Test Statistic is less than the Critical value. Therefore, we cannot reject the null hypothesis that there is no difference between site and background Aluminum concentrations. It is concluded that the site Aluminum concentrations are not larger than the background concentrations. This test was conducted with a significance level of 0.01 (alpha).

	Rank Sum
Site	244
Background	134

Test Statistic	Critical Value $_{0.01}$
54	120

Table D.1-2

APPENDIX D.2

ANTIMONY

Table D.2-1 contains the Descriptive Statistics for Site and Background Antimony concentrations for UXO 5. From Table D.2-1 it can be seen that the mean for the site Antimony concentration is 0.49 mg/kg less than the mean background Antimony concentration. Also the median site Antimony concentration is 0.04 mg/kg less than the background Antimony concentration.

Variable	Descriptive Statistics UXO 5					
	Valid N	Mean	Median	Minimum	Maximum	Std. Dev.
Antimony Background	8	1.06	0.29	0.18	5.60	1.88
Antimony Site	19	0.57	0.25	0.03	2.10	0.65

Table D.2-1

Figures D.2-1 and D.2-2 contain the side by side Box Plots for the site and background Antimony concentrations. From these figures it can be seen that the median Antimony concentrations are roughly equal. It can also be seen that the lower quartiles of the background and site Antimony concentrations are also roughly equal. The upper quartile for the site Antimony concentration is greater than the upper quartile for the background Antimony concentration.

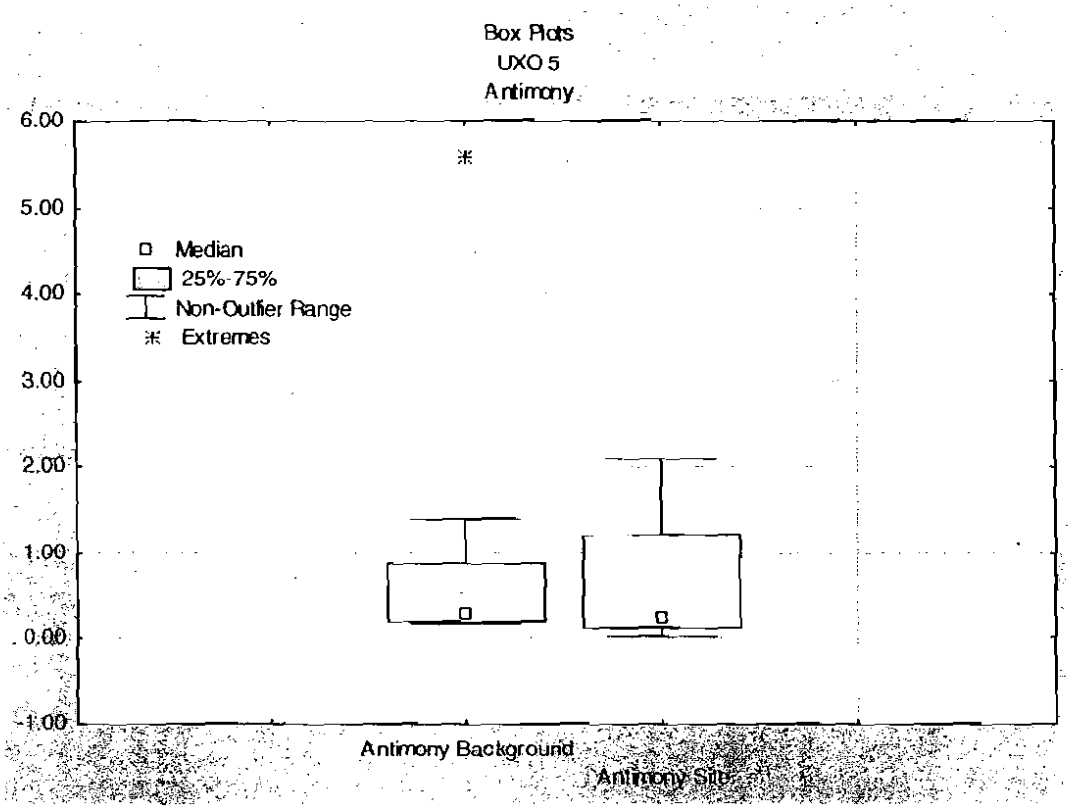


Figure D.2-1

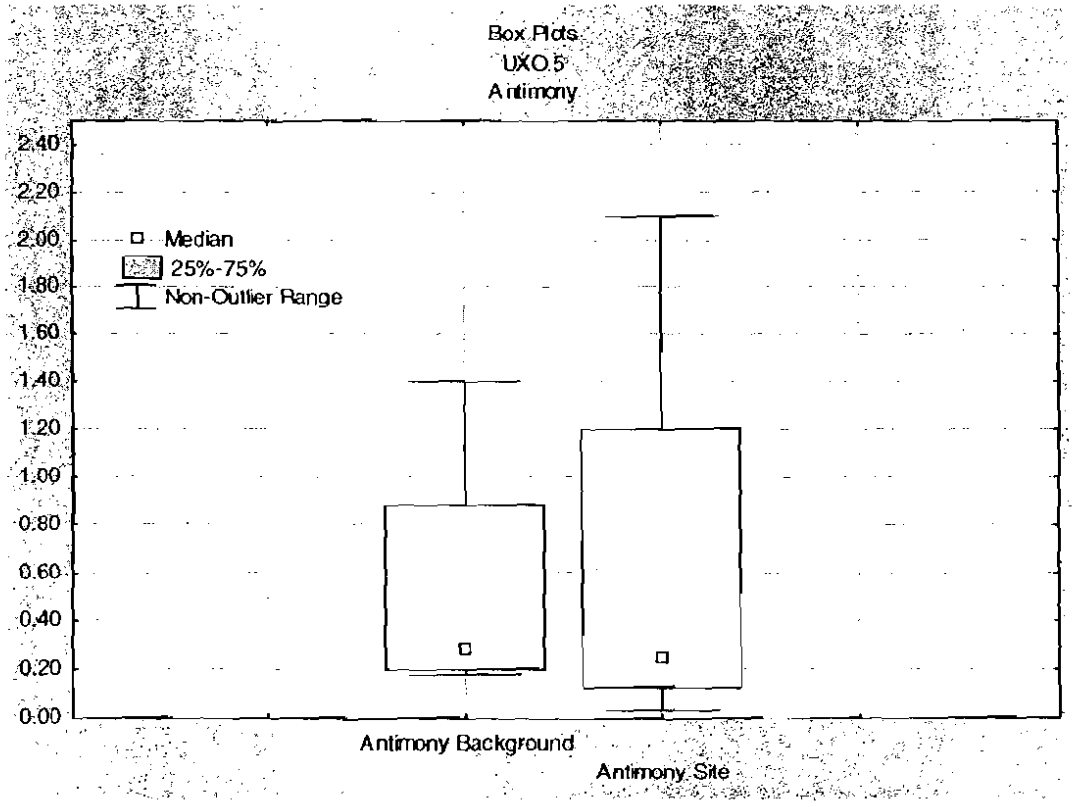


Figure D.2-2

Figure D.2-3 contains the 95% confidence intervals for site and background Antimony concentrations for UXO 5. From this figure it can be seen that the mean of the background is larger than the site mean. Also, the UCL for the background mean is higher than the UCL for the site mean.

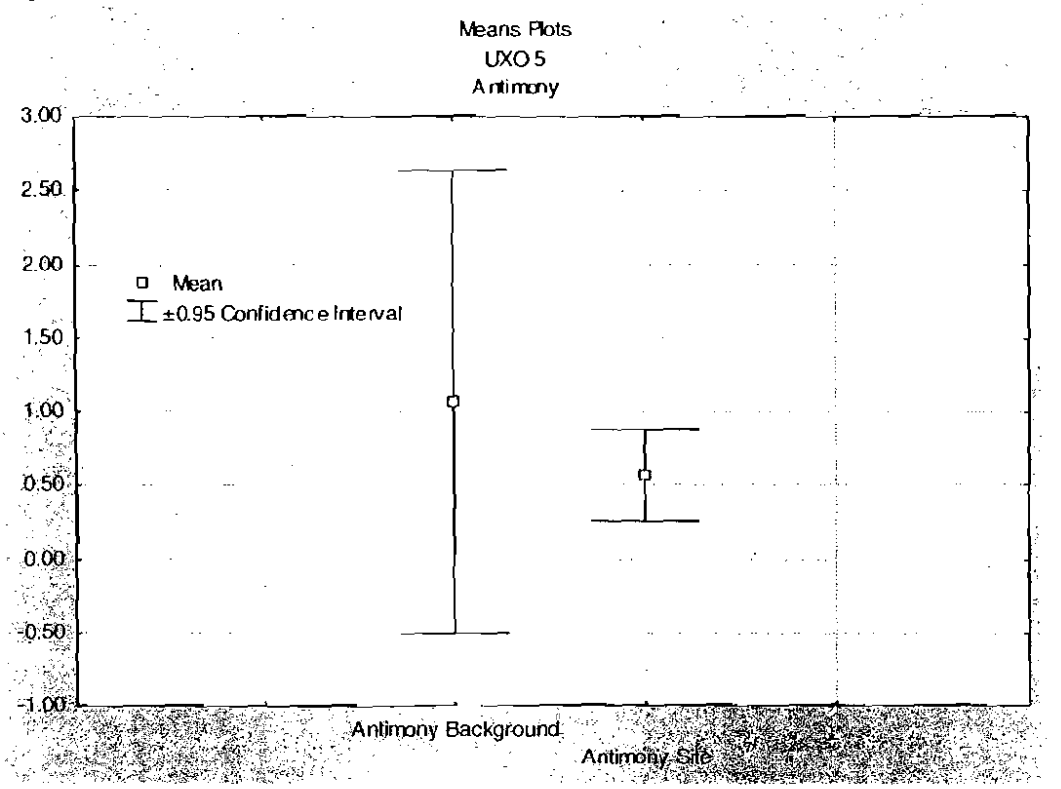


Figure D.2-3

Figures D.2-4 and D.2-5 show the normal probability plots and corresponding Shapiro Wilks test for normality. If the data is normal then the data points will roughly follow a linear pattern. The Shapiro Wilks test is a formal Statistical test of normality. The hypothesis being that the data is normally distributed. If the p-value for the test is less than 0.10 then the data is considered to be not normally distributed. From Figure D.2-4 it can be seen that the site Antimony concentrations depart from the linear pattern and that the p-value for the Shapiro Wilk test is 0.00. Thus it is concluded that the site Antimony concentrations are not normally distributed. From figure D.2-5 it can be seen that the background Antimony concentrations do not follow a linear pattern and the p-value for the Shapiro Wilk Test is 0.00. Therefore, it is concluded that the background Antimony concentrations do not follow a normal distribution.

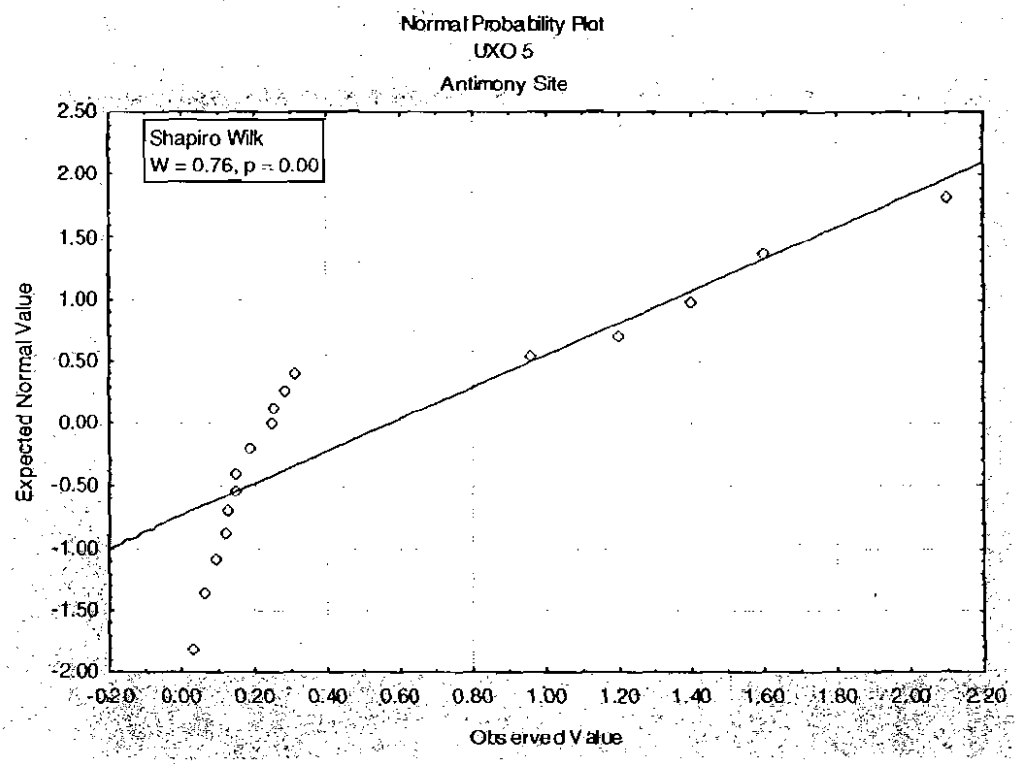


Figure D.2-4

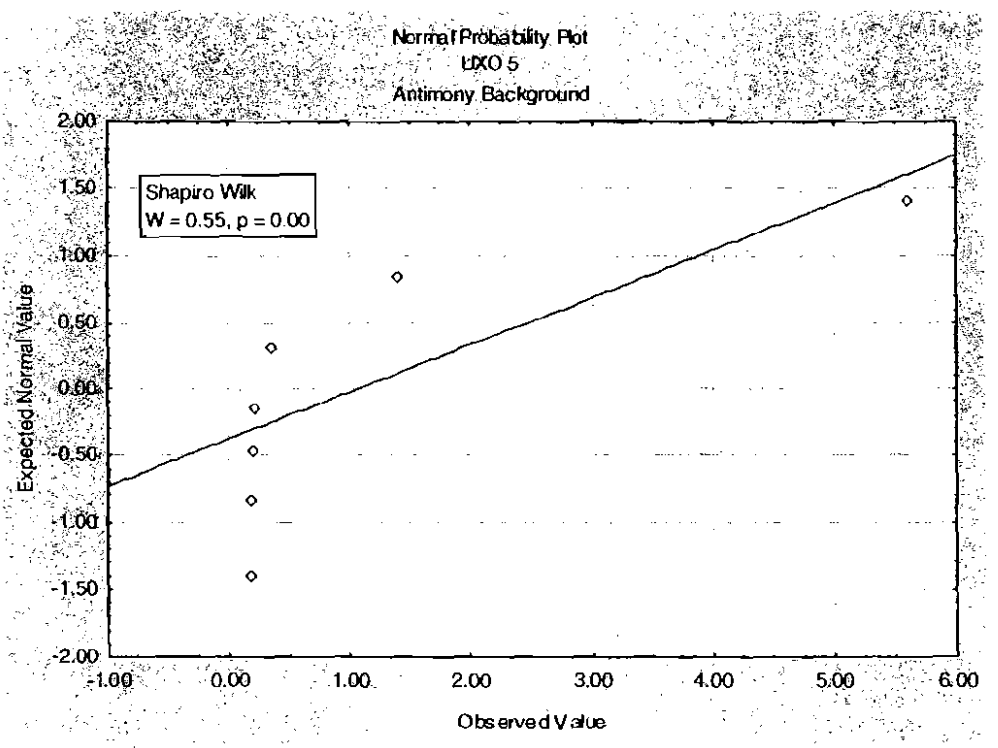


Figure D.2-5

Because the site and background Antimony concentrations are not normally distributed the Nonparametric Wilcoxon Rank Sum test will be used to see if the median site

concentrations for Antimony are larger than the median background concentrations. The hypothesis is that there is no difference between median values for the site Antimony concentrations and background Antimony concentrations. The hypothesis of no difference will be rejected if the Test Statistic is greater than the Critical Value. Table D.2-2 contains the Test Statistic and Critical value for this comparison. From Table D.2-2 it can be seen that the Test Statistic is less than the Critical value. Therefore, we cannot reject the null hypothesis that there is no difference between site and background Antimony concentrations. It is concluded that the site Antimony concentrations are not larger than the background Antimony concentrations. This test was conducted with a significance level of 0.01 (alpha).

	Rank Sum
Site	249
Background	129

Test Statistic	Critical Value $_{0.01}$
60	120

Table D.2-2

APPENDIX D.3

ARSENIC

Table D.3-1 contains the Descriptive Statistics for Site Arsenic concentrations and the Background Concentrations for UXO 5. From the descriptive statistics it can be seen that the mean concentration for the Arsenic Background concentrations is 6.31 and the mean Arsenic Site concentration is 5.45. The median concentration for site is 5.28 and for background it is 5.70.

Variable	Descriptive Statistics UXO 5					
	Valid N	Mean	Median	Minimum	Maximum	Std Dev
Arsenic Background	8	6.31	5.70	3.70	10.20	2.17
Arsenic Site	19	5.45	5.28	1.01	13.60	3.17

Table D.3-1

Figure D.3-1 contains the side by side Box Plots for the Site and Background Arsenic concentrations. From this figure it can be seen that the median Arsenic concentrations are roughly equal. It is also apparent that the upper and lower quartiles of the background concentrations are higher than the upper and lower quartiles of the site concentrations.

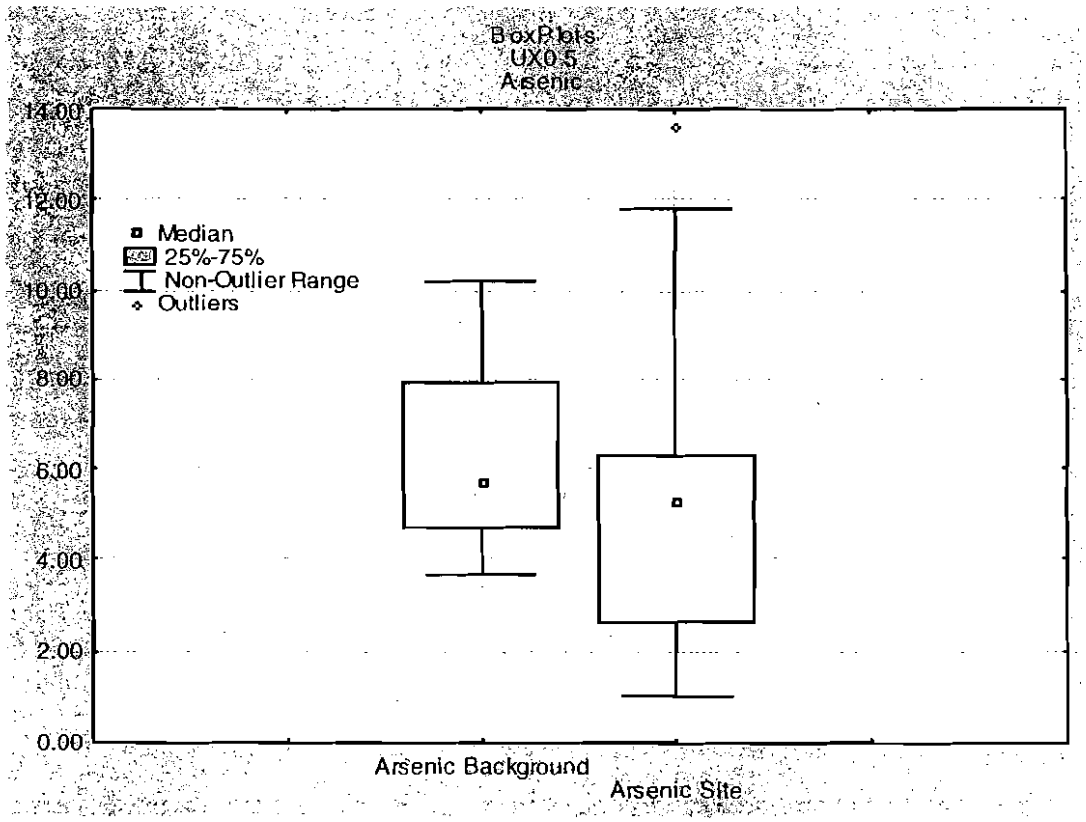


Figure D.3-1

Figure D.3-2 contains the 95% Confidence Intervals for the Site and Background Arsenic Concentrations for UXO 5. From this figure it can be seen that the UCL for the Background Arsenic Concentrations is higher than the UCL for the Site Arsenic Concentrations. Also apparent is that the mean background Arsenic concentration is higher than the site Arsenic Concentration.

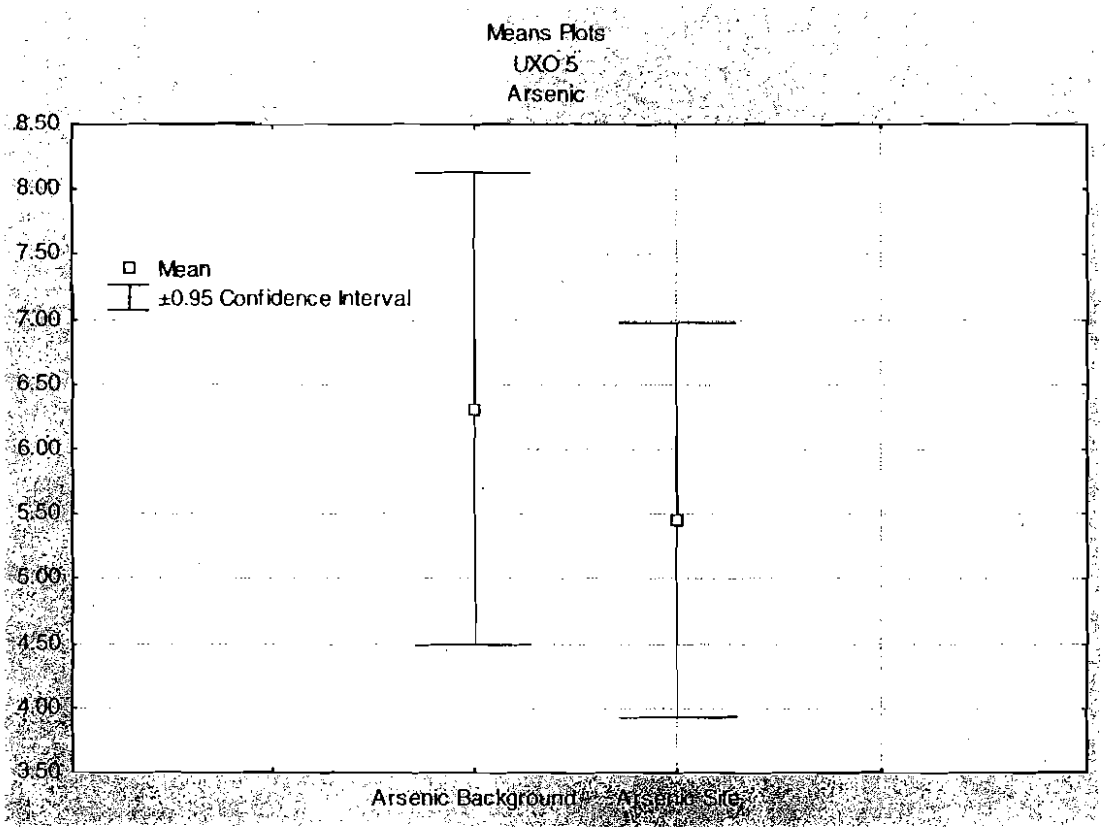


Figure D.3-2

Figures D.3-3 and D.3-4 show the normal probability plots and corresponding Shapiro Wilks test for normality. If the data is normal then the data points will roughly follow a linear pattern. The Shapiro Wilks test is a formal Statistical test of normality. The hypothesis being that the data is normally distributed. If the p-value for the test is less than 0.10 then the data is considered to be not normally distributed. From Figure D.3-3 it can be seen that the data depart from the linear pattern and the p-value for the Shapiro Wilks test is 0.04. Therefore the Site Arsenic concentrations are not normally distributed. From Figure D.3-4 it can be seen that the data roughly follow the linear pattern and the p-value for the Shapiro Wilks test is 0.55. Therefore the Background Arsenic concentrations are normally distributed.

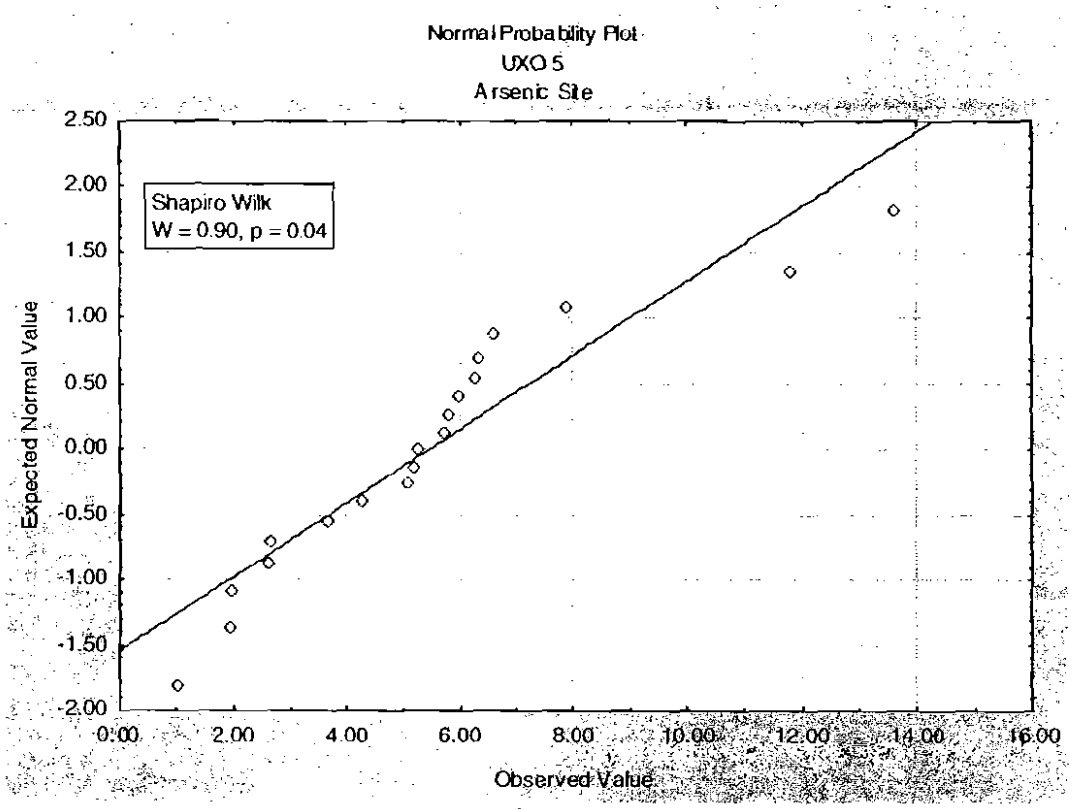


Figure D.3-3

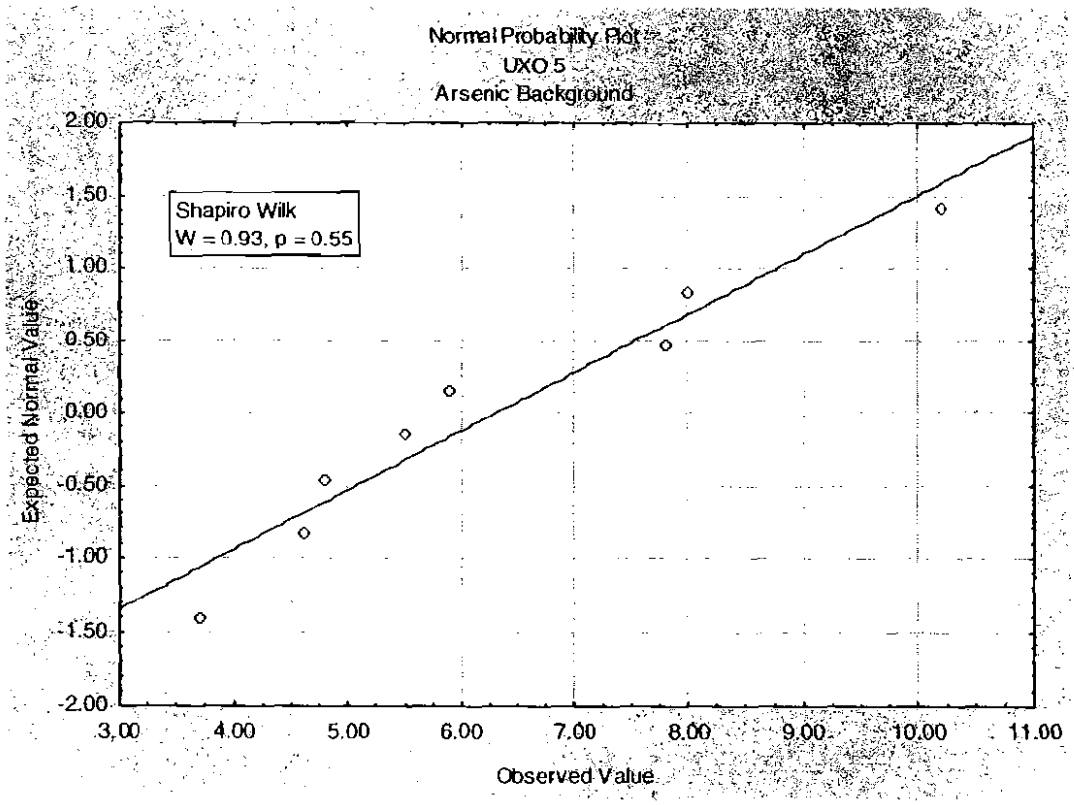


Figure D.3-4

Because the Site Concentrations are not normally distributed the Nonparametric Wilcoxon Rank Sum test will be used to see if the median site concentrations for Arsenic are larger than the median background concentrations. The hypothesis is that there is no difference between median values for the Site Arsenic concentrations and the Background Arsenic concentrations. The hypothesis that there is no difference between median Arsenic Concentrations is rejected if the Test Statistic is greater than the Critical Value. Table D.3-2 contains the Test Statistic and the Critical Value for the comparison between the Site and Background Arsenic Concentrations. From Table D.3-2 it can be seen that the Test Statistic is not greater than the Critical Value so it is concluded that the Site Arsenic Concentrations are not greater than the Background Arsenic Concentrations. This test was conducted with a significance level (alpha) of 0.01.

	Rank Sum
Site	250
Background	128

Test Statistic	Critical Value $_{0.01}$
60	184

Table D.3-2

APPENDIX D.4

BARIUM

Table D.4-1 contains the Descriptive Statistics for site and background Barium concentrations. From Table D.4-1 it can be seen that the mean site concentration is higher than the mean background concentration while the median background concentration is higher than then site median concentration.

Variable	Descriptive Statistics UXO 5					
	Valid N	Mean	Median	Minimum	Maximum	Std. Dev.
Barium Background	8	107.29	[illegible]	[illegible]	1580.00	33.98
Barium Site	19	137.85	[illegible]	[illegible]	1140.00	261.67

Table D.4-1

Figures D.4-1 and D.4-2 contain the side by side Box Plots for the site and background Barium concentrations. From these plots it can be seen that the median concentrations for the site are lower than the median concentrations for background. Also it can be noticed that the lower quartile for the background concentrations is relatively close to the upper quartile for the site Barium concentrations.

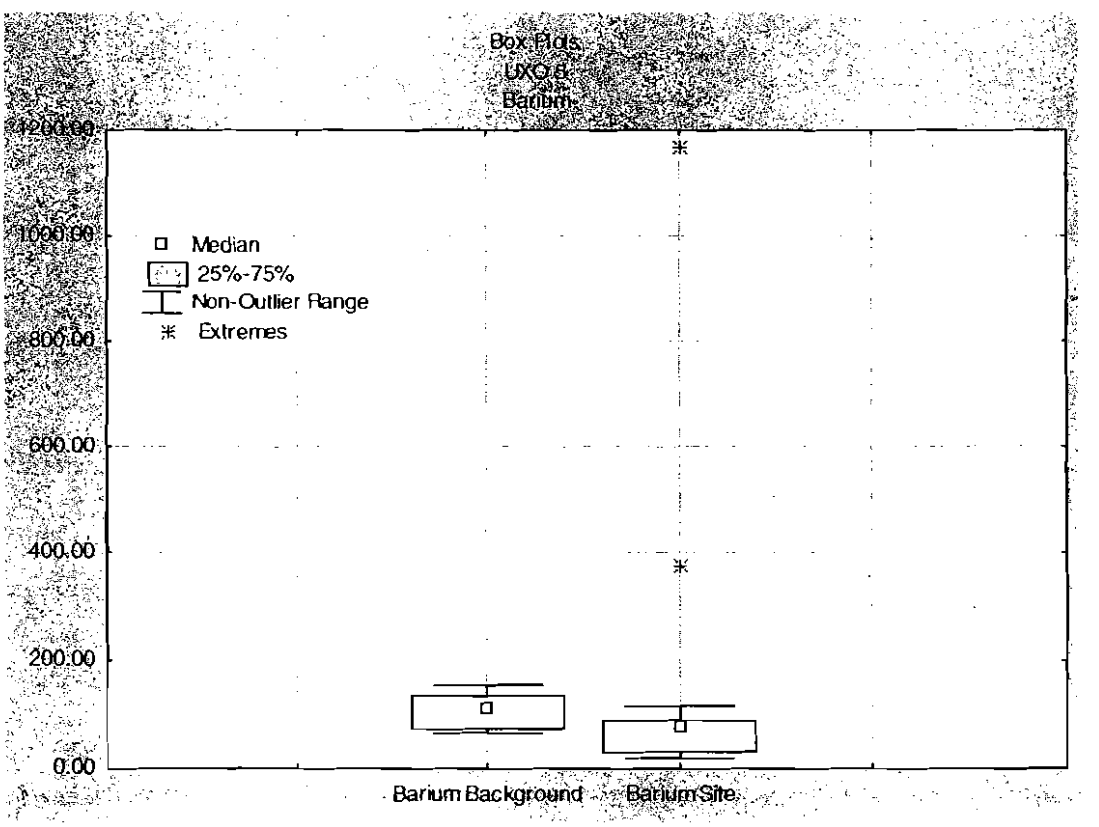


Figure D.4-1

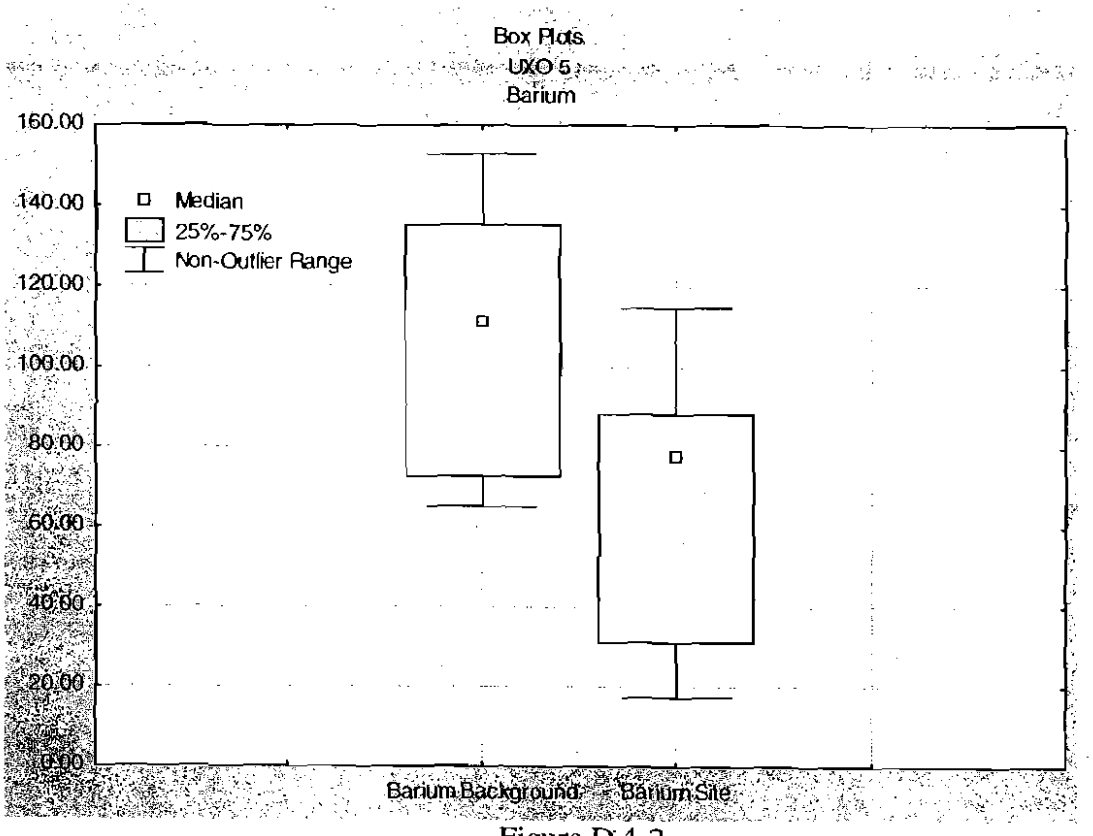


Figure D.4-2

Figure D.4-3 contains the 95% Confidence Intervals for the site and background Barium concentrations. From this figure it can be seen that the mean site concentration is greater than the mean background concentration. Also, the UCL for the background concentration is similar to the mean concentration of the site.

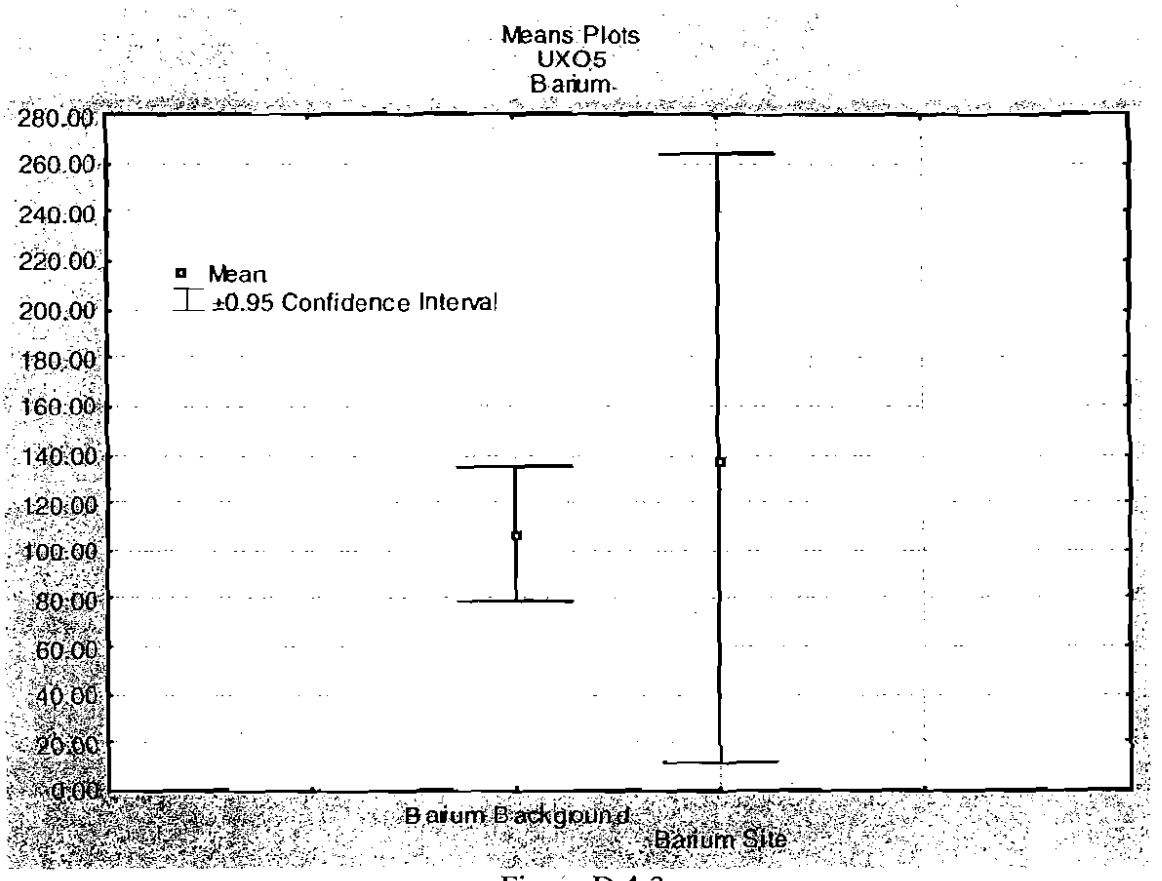


Figure D.4-3

Figures D.4-4 and D.4-5 show the normal probability plots and corresponding Shapiro Wilks test for normality. If the data is normal then the data points will roughly follow a linear pattern. The Shapiro Wilks test is a formal Statistical test of normality. The hypothesis being that the data is normally distributed. If the p-value for the test is less than 0.10 then the data is considered to be not normally distributed. From Figure D.4-4 it can be seen that the Background data roughly follow the linear pattern and the p-value for the Shapiro Wilk test is 0.40. Thus it can be concluded that the background barium concentrations are normally distributed. From Figure D.4-5 it can be seen that the site barium concentrations do not follow a linear pattern and the p-value for the Shapiro Wilks test is 0.00. Thus it is concluded that the Barium site concentrations are not normally distributed.

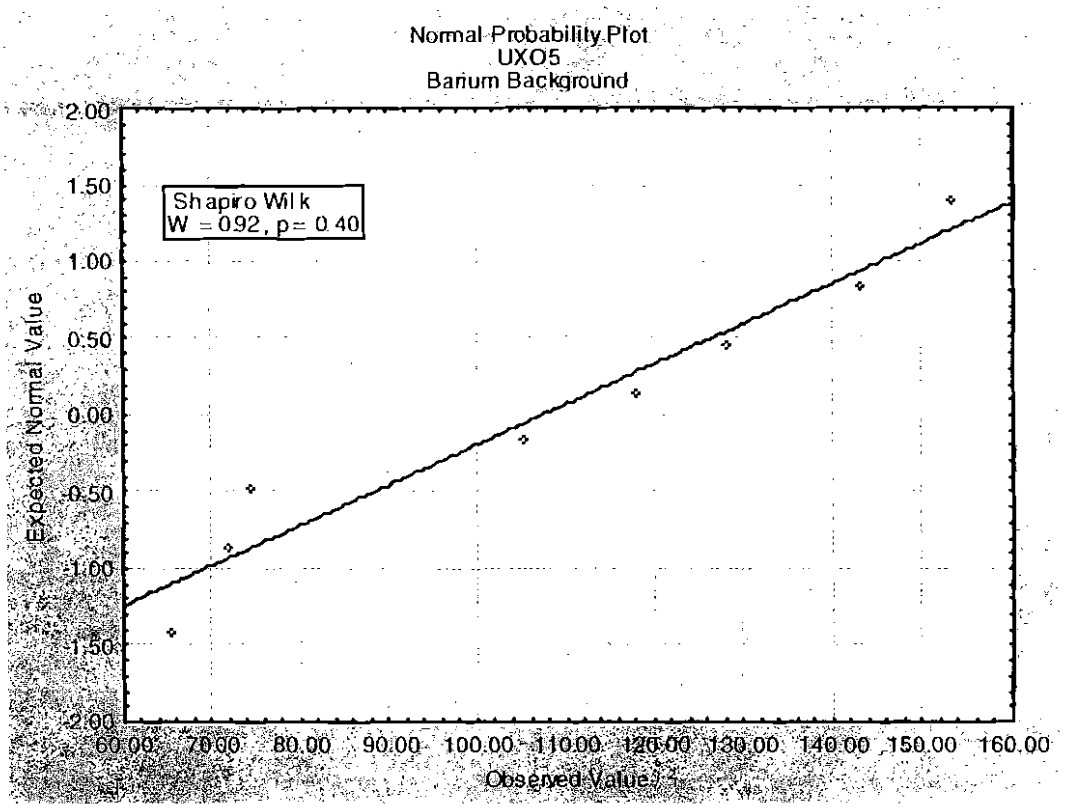


Figure D.4-4

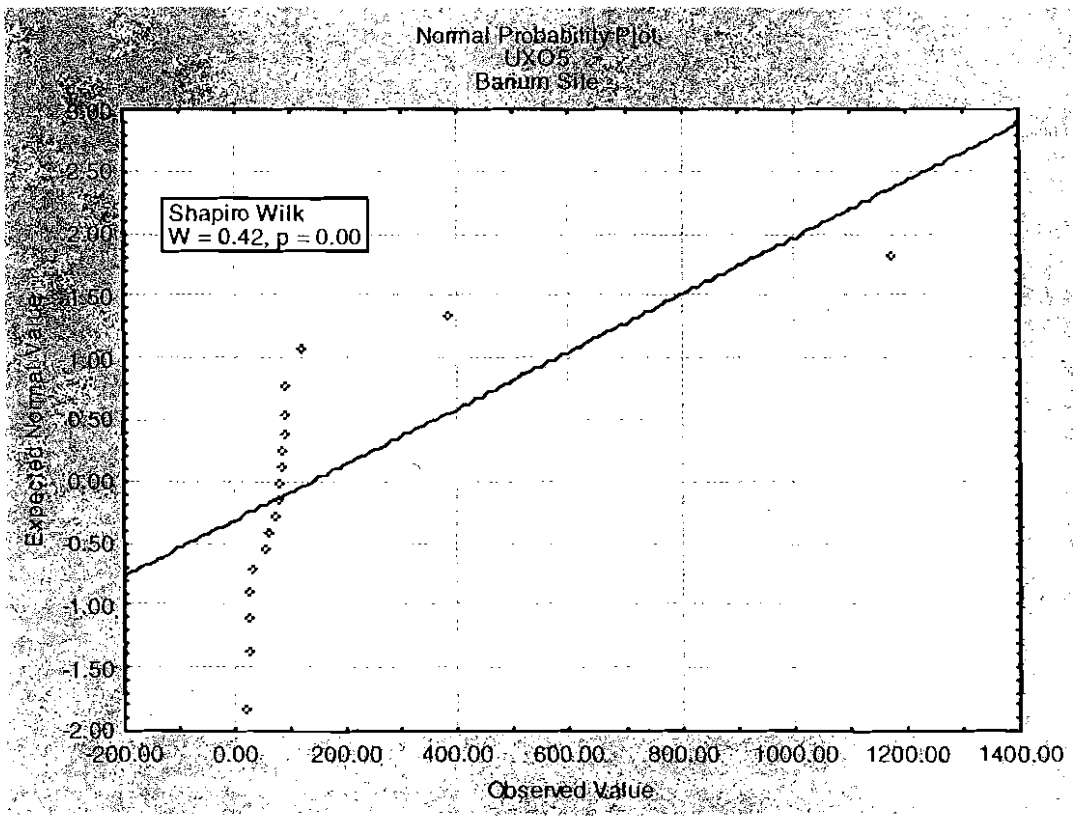


Figure D.4-5

Because the Site Concentrations are not normally distributed the Nonparametric Wilcoxon Rank Sum test will be used to see if the median site concentrations for Barium are larger than the median background concentrations. The hypothesis is that there is no difference between median values for the site and background Barium concentrations. The hypothesis will be rejected if the Test Statistic is great than the critical value. Table D.4-2 Contains the Test Statistic and the Critical Value for the comparison between the site and background Barium concentrations. From Table D.4-2 it can be seen that the Test Statistic is smaller than the Critical value. Therefore, we fail to reject the null hypothesis that there is no difference between the site and background Barium concentrations. This test was conducted with a significance level (alpha) of 0.01.

	Rank Sum
Site	234
Background	144

Test Statistic	Critical Value $_{0.01}$
44	120

Table D.4-2

APPENDIX D.5

CADMIUM

Table D.5-1 contains the Descriptive Statistics for the site and background Cadmium concentrations for UXO 5. From Table D.5-1 it can be seen that the mean and median site concentration are greater than the mean and median background concentration.

Variable	Descriptive Statistics UXO 5					
	Valid N	Mean	Median	Minimum	Maximum	Std.Dev.
Cadmium Background	8	0.95	0.78	0.10	3.60	1.15
Cadmium Site	19	4.12	2.18	1.61	38.40	8.31

Table D.5-1

Figures D.5-1 and D.5-2 contain the side by side Box Plots for the site and background Cadmium concentrations. From these plots it can be seen that the site concentrations are higher than the background concentrations. Also it becomes apparent that there is an extreme value for the site concentrations.

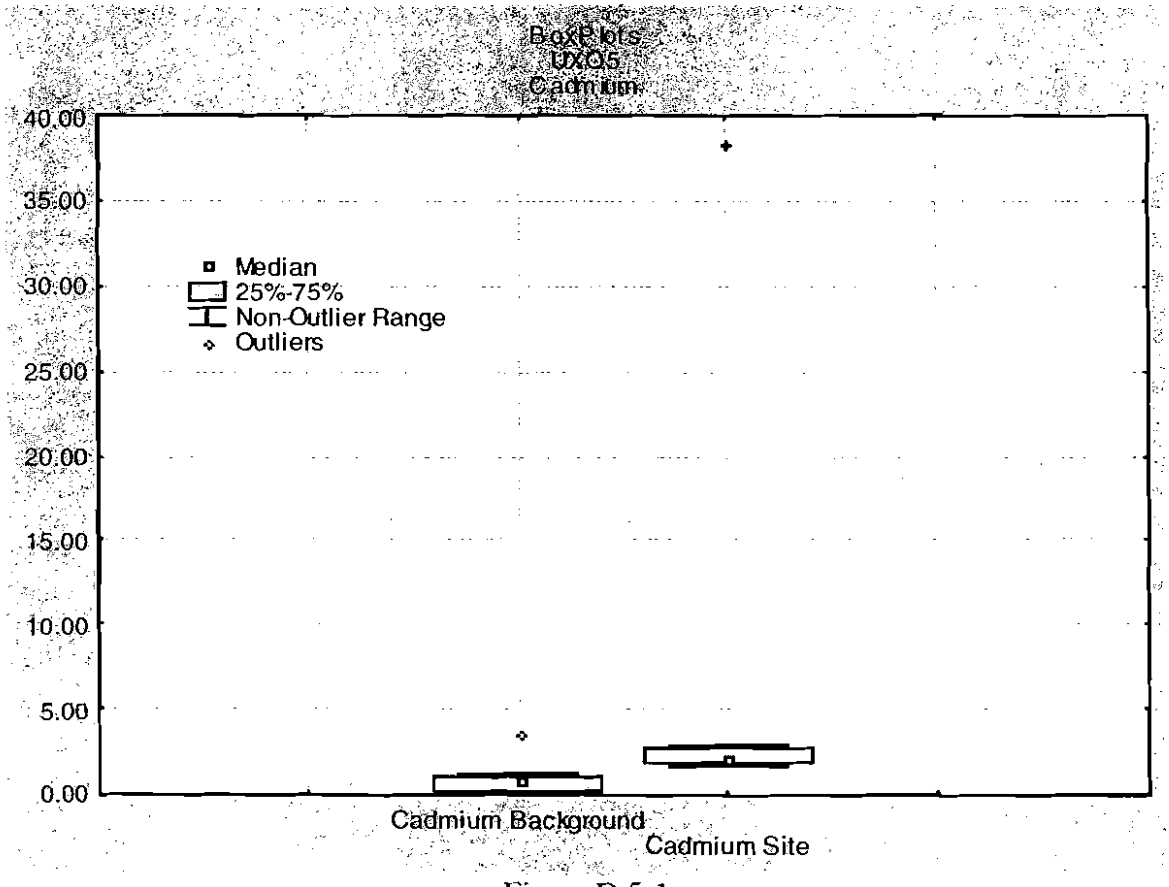


Figure D.5-1

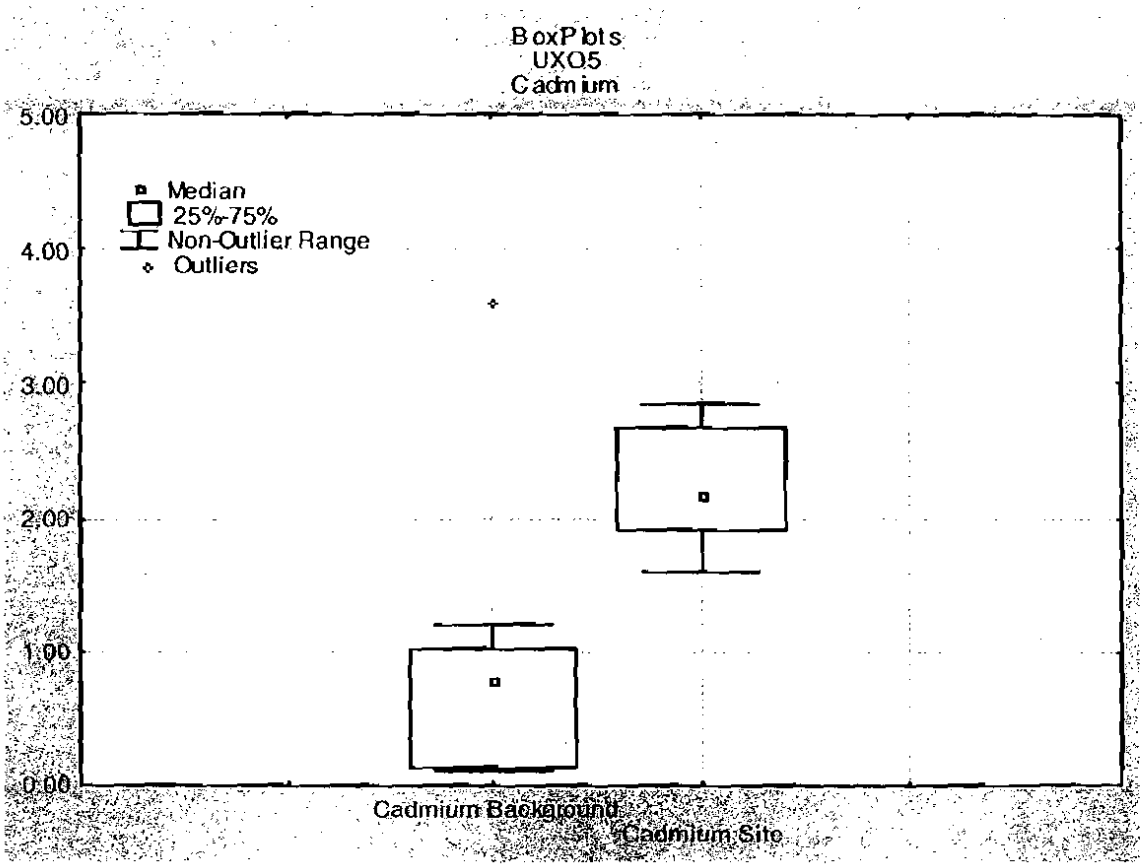


Figure D.5-2

Figure D.5-3 contains the 95% Confidence Intervals for the Site and Background Cadmium concentrations. From this figure it can be seen that the mean site concentration is greater than the mean background concentration. Also the UCL for the Background concentrations is less than the mean site concentration.

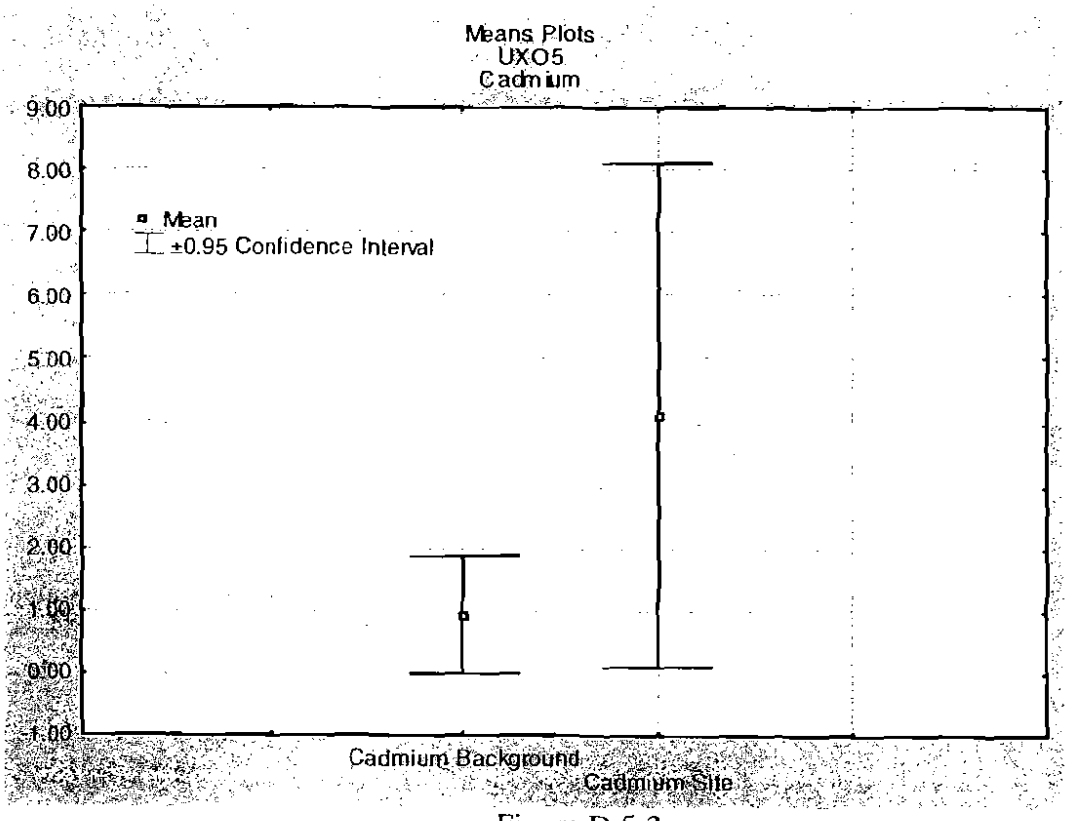


Figure D.5-3

Figures D.5-4 and D.5-5 show the normal probability plots and corresponding Shapiro Wilks test for normality. If the data is normal then the data points will roughly follow a linear pattern. The Shapiro Wilk test is a formal Statistical test of normality. The hypothesis being that the data is normally distributed. If the p-value for the test is less than 0.10 then the data is considered to be not normally distributed. From Figure D.5-4 it can be seen that the background data depart from the linear pattern and the p-value for the Shapiro Wilk test is 0.00. Thus it is concluded that the background data is not normally distributed. From Figure D.5-5 it can be seen that the site data does not follow a linear pattern and the Shapiro Wilk p-value is 0.00. Thus the site data is not normally distributed.

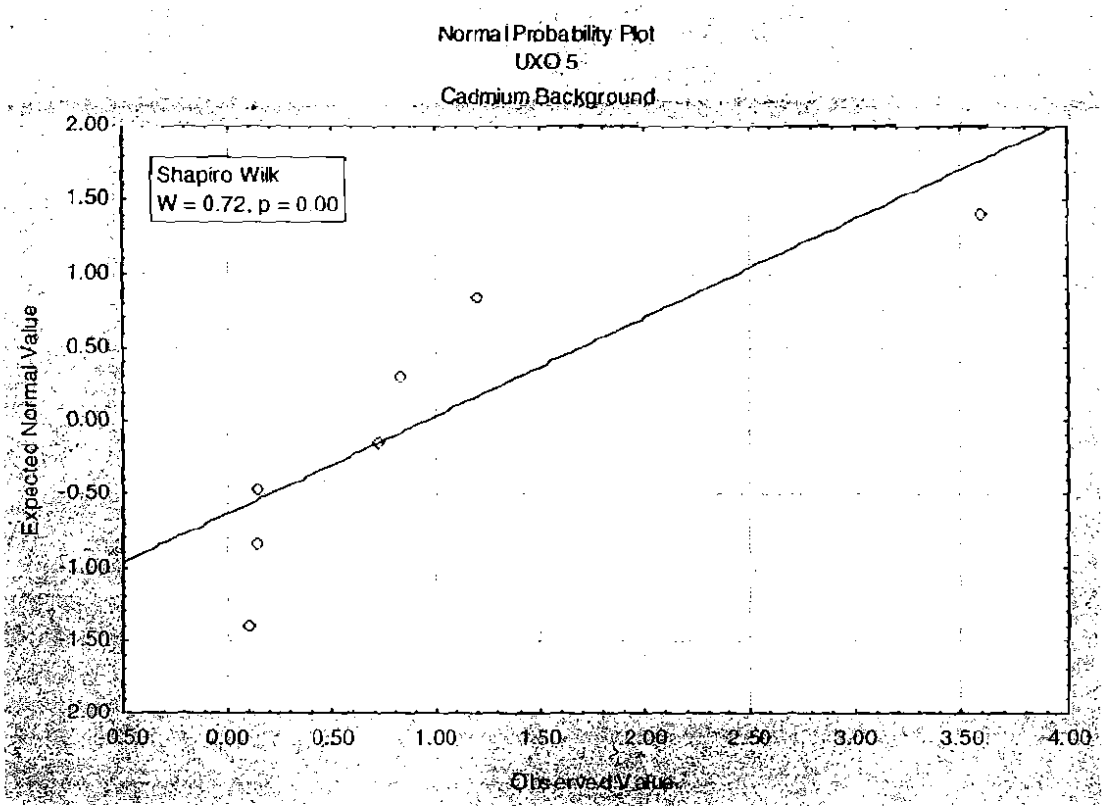


Figure D.5-4

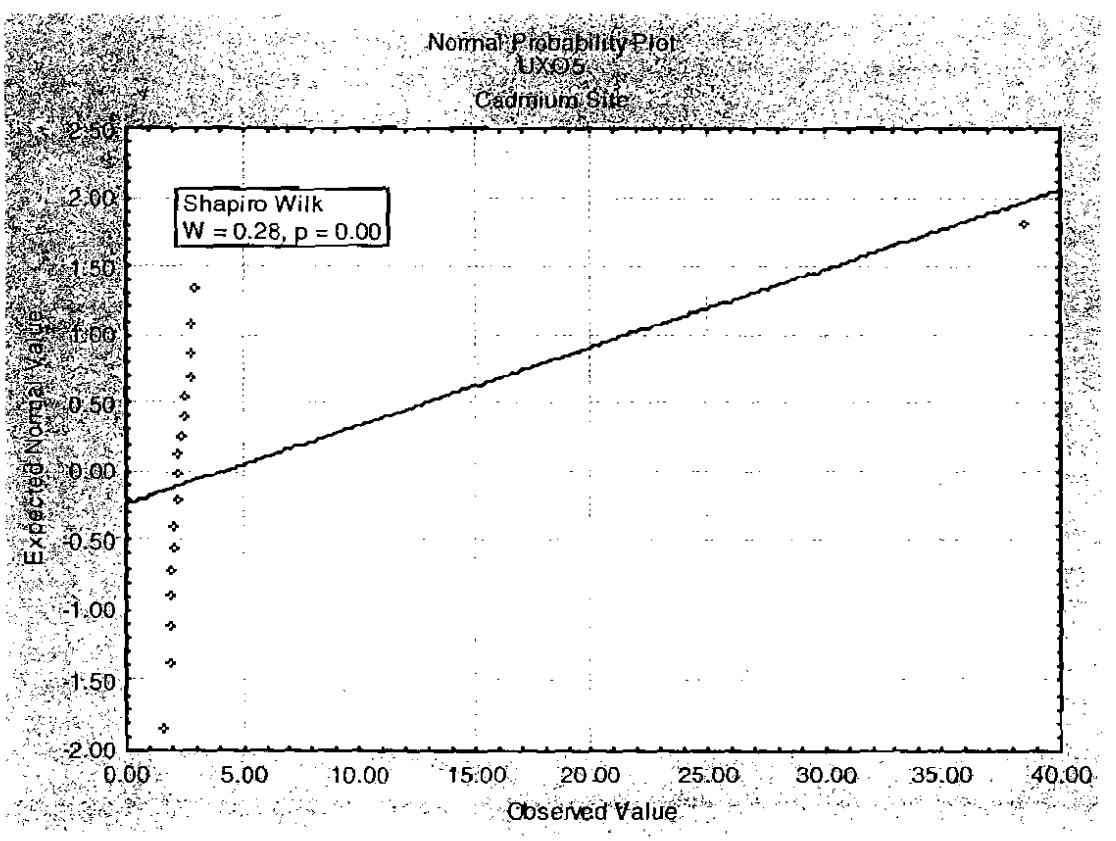


Figure D.5-5

Because the Site and Background concentrations are not normally distributed the Nonparametric Wilcoxon Rank Sum test will be used to see if the median concentrations for Cadmium are larger than the median background concentrations. The hypothesis is that there is no difference between median values for the site and background data. If the Test Statistic is greater than the Critical Value then this hypothesis is rejected and it is concluded that the site concentrations are greater than the background concentrations. Table D.5-2 contains the Test Statistic and Critical Value for the Cadmium comparison. From Table D.5-2 it can be seen that the Test Statistic is greater than the critical value. Thus it is concluded that the Site Cadmium Concentrations are greater than the Background Cadmium Concentrations. This test was conducted with a significance level (alpha) of 0.01.

	Rank Sum
Site	324
Background	54

Test Statistic	Critical Value $_{0.01}$
134	120

Table D.5-2

As seen in Figure D.5-6 (side by side Box Plots) there is an extreme value for the Site Cadmium concentrations. The Descriptive Statistics for Cadmium without this extreme value are presented in Table D.5-3. From this table it can be seen that while the mean and median site concentrations are higher than the background ground concentrations.

Variable	Descriptive Statistics UXO 5					
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	8	0.95	0.78	0.10	3.60	1.15
[redacted]	18	2.22	2.15	1.61	2.85	0.37

Table D.5-3

Figure D.5-6 contains the side by side Box Plots for the site and background Cadmium concentrations without the extreme value. From these plots it can be seen that the site concentrations are higher than the background concentrations.

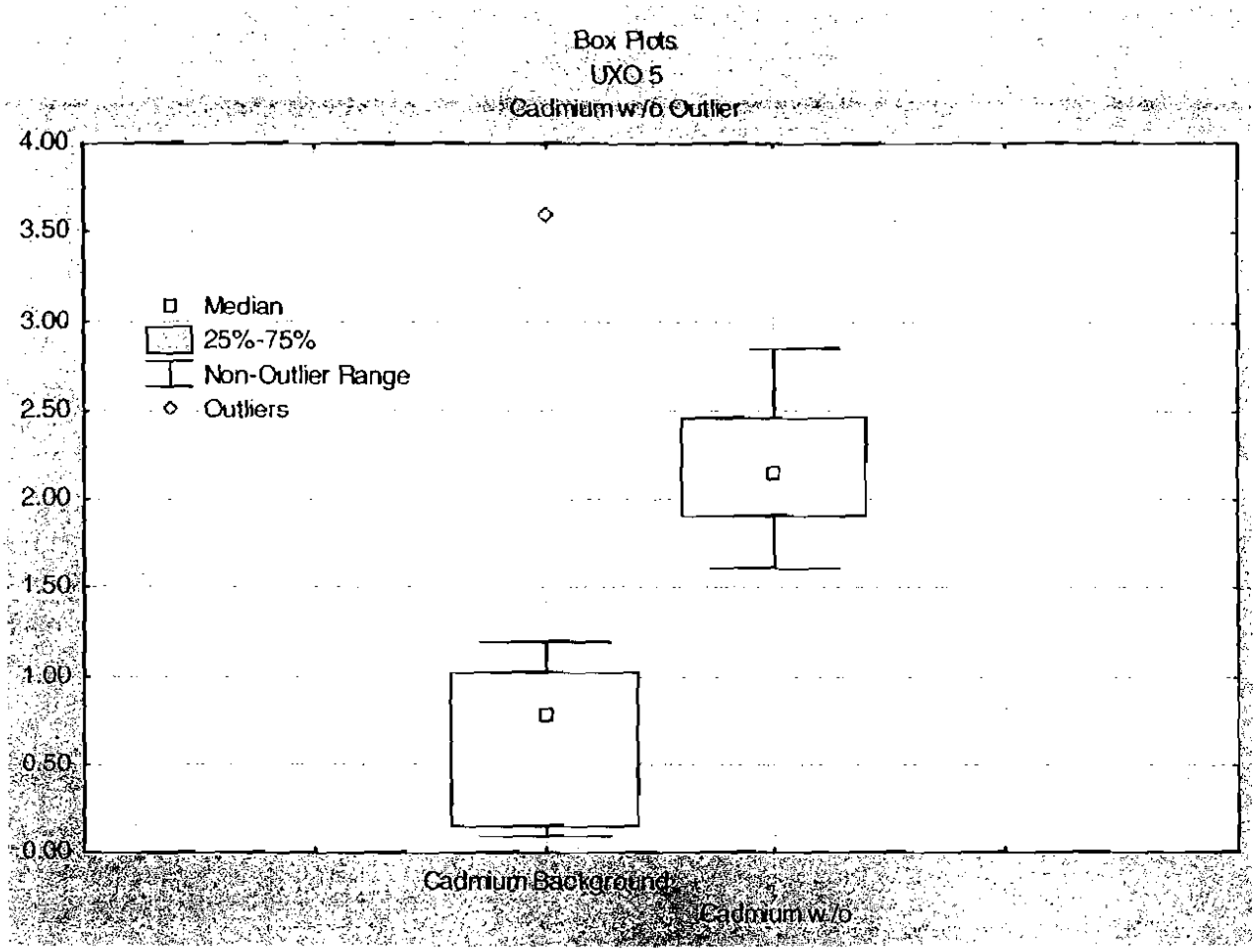


Figure D.5-6

Figure D.5-7 contains the 95% Confidence Intervals for the Site and Background Cadmium concentrations. From this figure it can be seen that the mean site concentration is greater than the mean background concentration. Also the UCL for the Background concentrations is less than the mean site concentration.

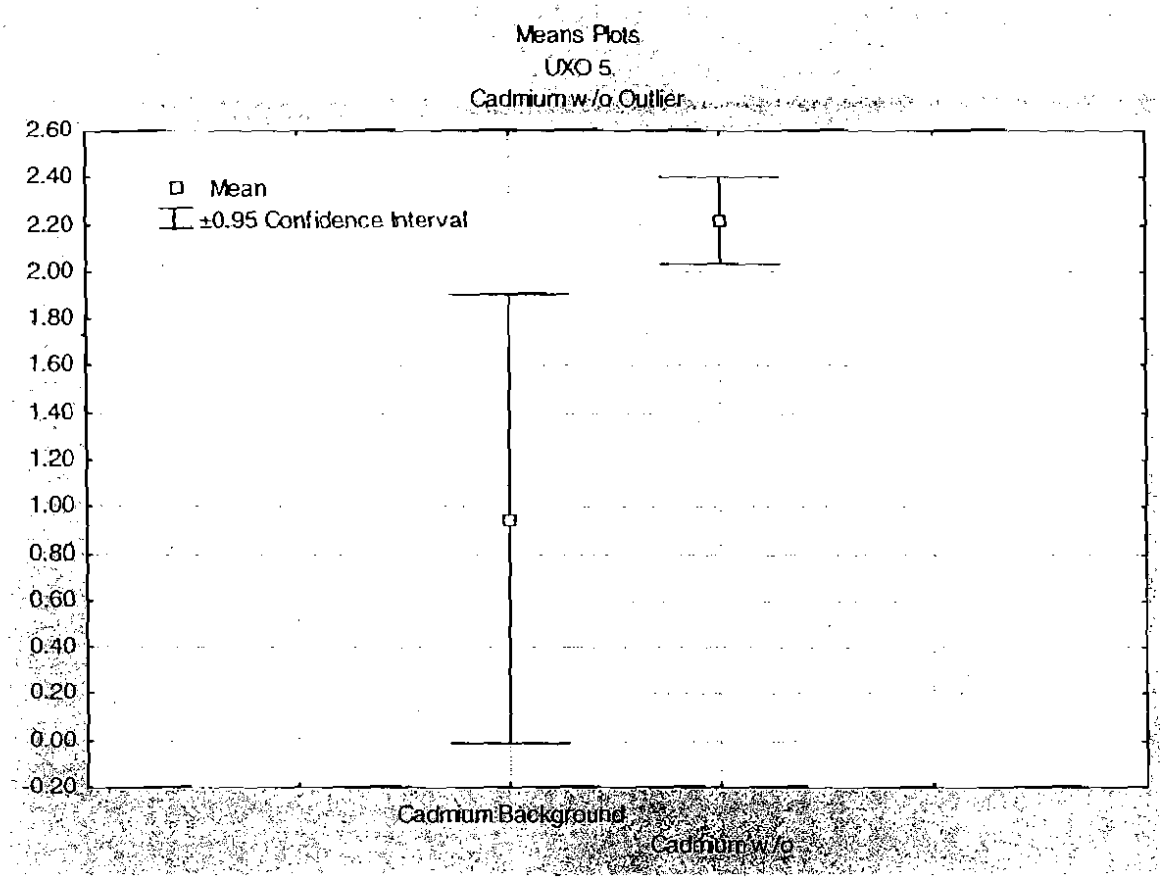


Figure D.5-7

Figures D.5-8 shows the normal probability plots and corresponding Shapiro Wilks test for normality. If the data is normal then the data points will roughly follow a linear pattern. The Shapiro Wilk test is a formal Statistical test of normality. The hypothesis being that the data is normally distributed. If the p-value for the test is less than 0.10 then the data is considered to be not normally distributed. From Figure D.5-8 it can be seen that the site data does follow a linear pattern and the Shapiro Wilk p-value is 0.35. Thus the site data is normally distributed.

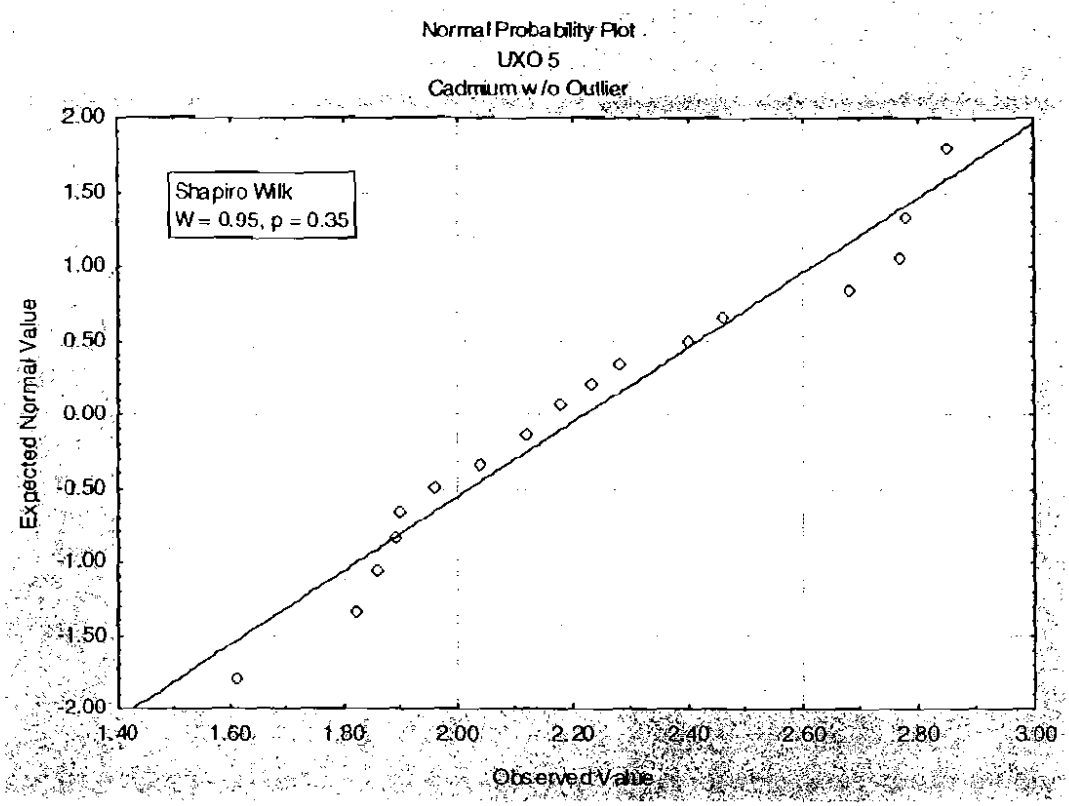


Figure D.5-8

Because the Background concentrations are not normally distributed the Nonparametric Wilcoxon Rank Sum test will be used to see if the median concentrations for Cadmium are larger than the median background concentrations. The hypothesis is that there is no difference between median values for the site and background data. If the Test Statistic is greater than the Critical Value then this hypothesis is rejected and it is concluded that the site concentrations are greater than the background concentrations. Table D.5-4 contains the Test Statistic and Critical Value for the Cadmium comparison. From Table D.5-4 it can be seen that the Test Statistic is greater than the critical value. Thus it is concluded that the Site Cadmium Concentrations are greater than the Background Cadmium Concentrations. This test was conducted with a significance level (alpha) of 0.01.

	Rank Sum
Site	54
Background	297

Test Statistic	Critical Value 0.01
126	114

Table D.5-4

APPENDIX D.6

CHROMIUM

Table D.6-1 contains the Descriptive Statistics for Site and Background Chromium concentrations for UXO 5. From Table D.6-1 it can be seen that the mean for the site Chromium concentration is larger than the mean background Chromium concentration. Also the median site Chromium concentration is larger than the background Chromium concentration.

Variable	Descriptive Statistics UXO 5					
	Valid N	Mean	Median	Minimum	Maximum	Std.Dev.
Chromium Background	8	14.05	14.05	9.20	17.80	3.15
Chromium Site	19	21.33	17.90	8.40	85.60	17.03

Table X

Figures D.6-1 and D.6-2 contain the side by side Box Plots for the site and background Chromium concentrations. From these figures it can be seen that the median site Chromium concentration is larger than the Chromium background concentration. It can also be seen that the upper quartile of the background is less than the median site concentration. It can also be noticed that there is an extreme value for the Chromium site concentrations.

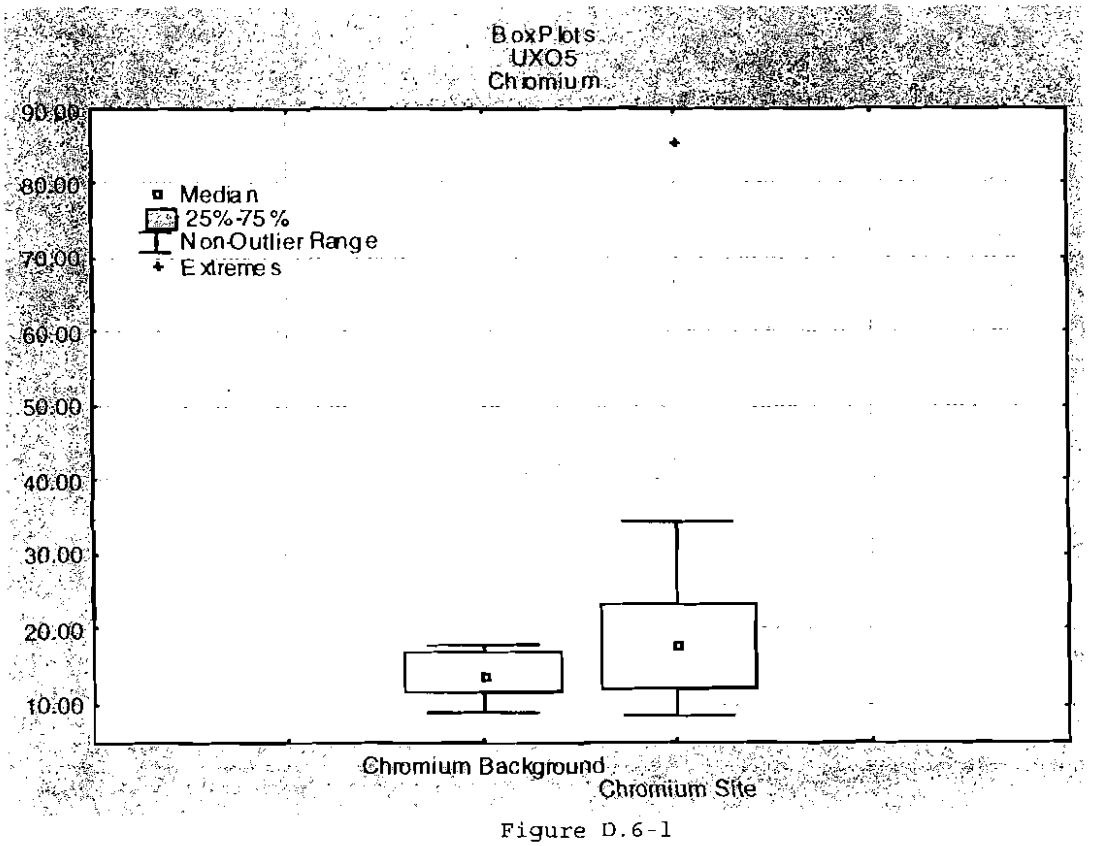


Figure D.6-1

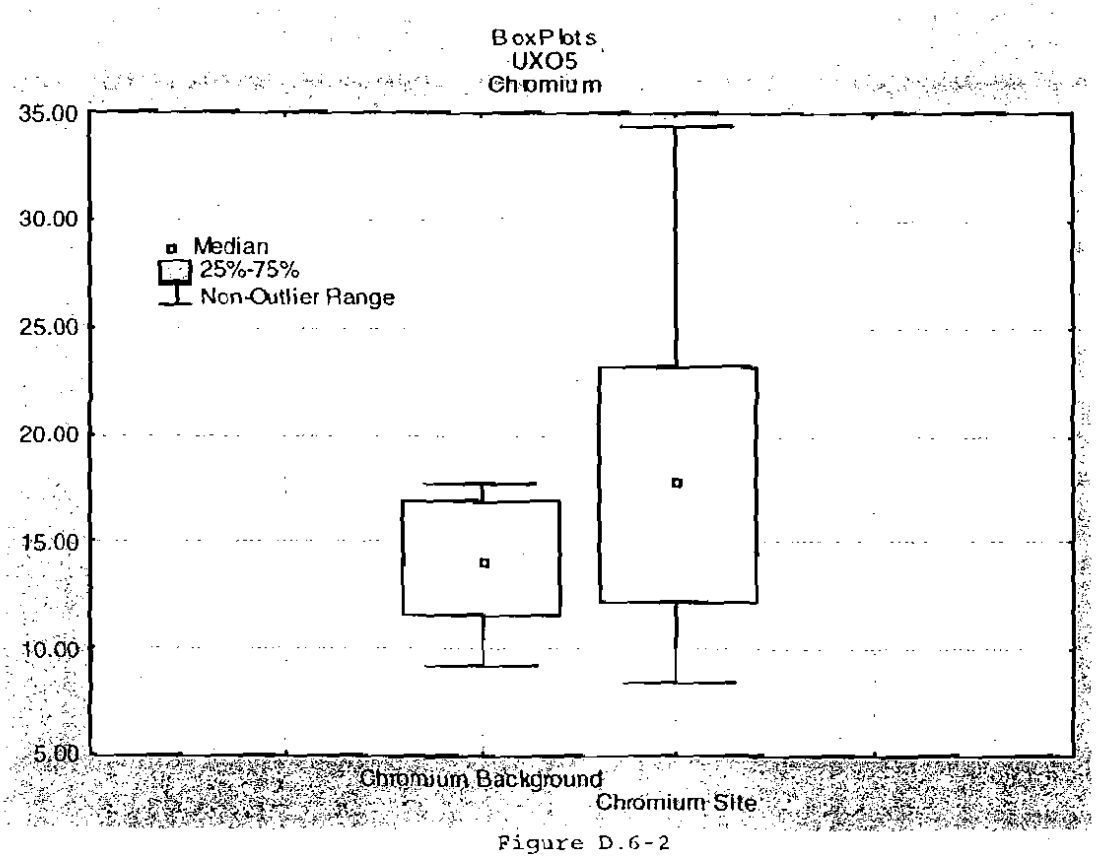


Figure D.6-2

Figure D.6-3 contains the 95% confidence intervals for site and background Chromium concentrations for UXO 5. From this figure it can be seen that the mean of the site is larger than the background mean. Also, the UCL for the background mean is less than the site mean.

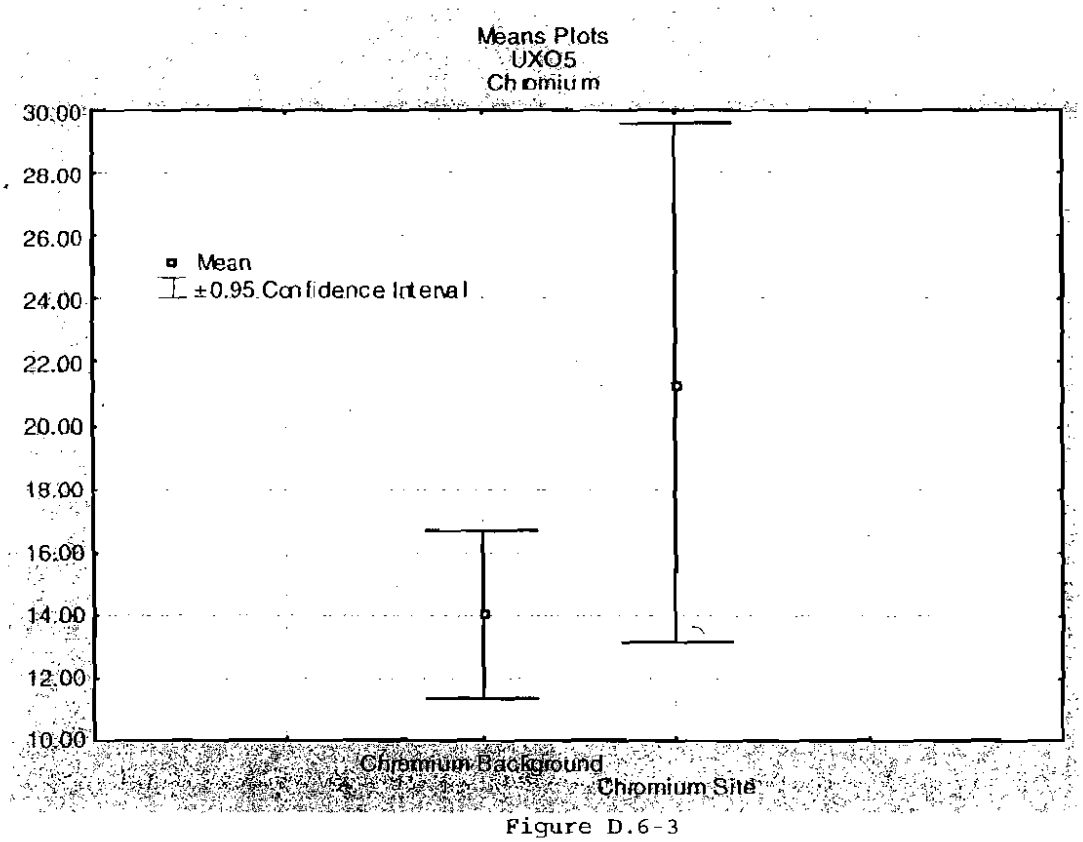


Figure D.6-3

Figures D.6-4 and D.6-5 show the normal probability plots and corresponding Shapiro Wilks test for normality. If the data is normal then the data points will roughly follow a linear pattern. The Shapiro Wilks test is a formal Statistical test of normality. The hypothesis being that the data is normally distributed. If the p-value for the test is less than 0.10 then the data is considered to be not normally distributed. From Figure D.6-4 it can be seen that the site Chromium concentrations depart from the linear pattern and that the p-value for the Shapiro Wilk test is 0.00. Thus it is concluded that the site Chromium concentrations are not normally distributed. From figure D.6-5 it can be seen that the background Chromium concentrations follow a linear pattern and the p-value for the Shapiro Wilk Test is 0.64. Therefore, it is concluded that the background Chromium concentrations follow a normal distribution.

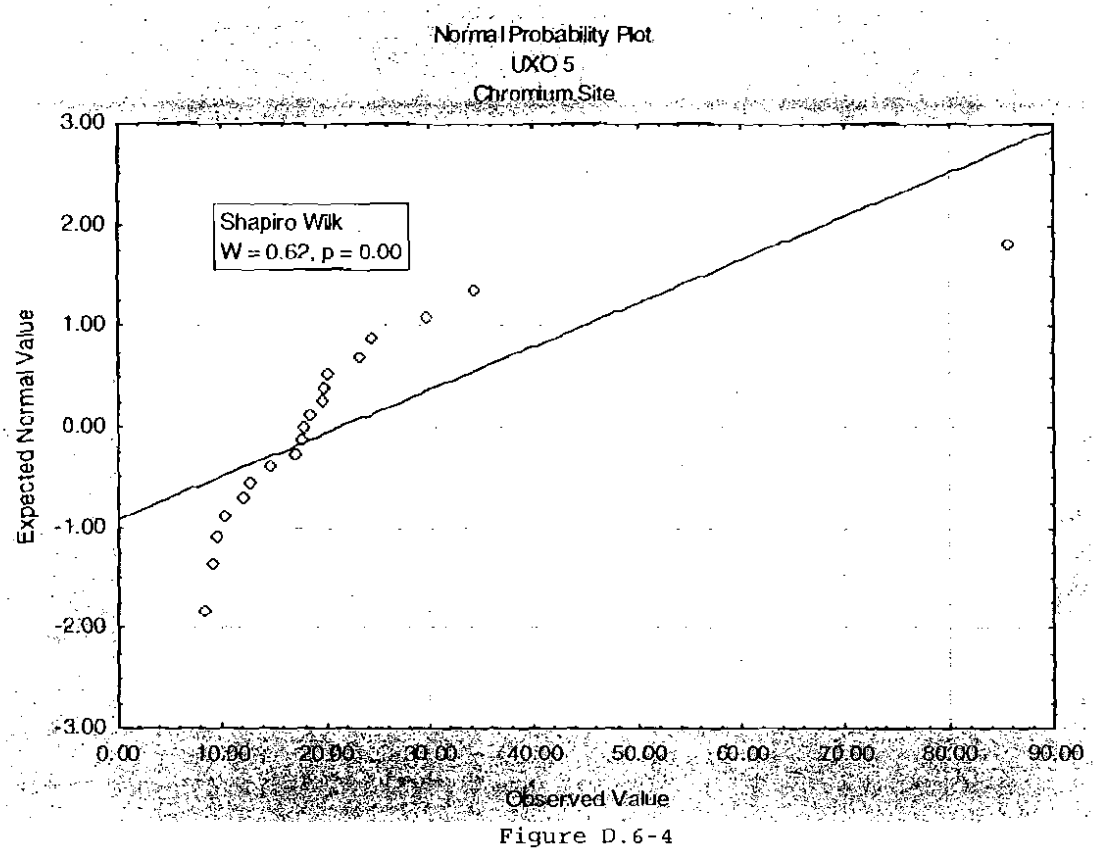


Figure D.6-4

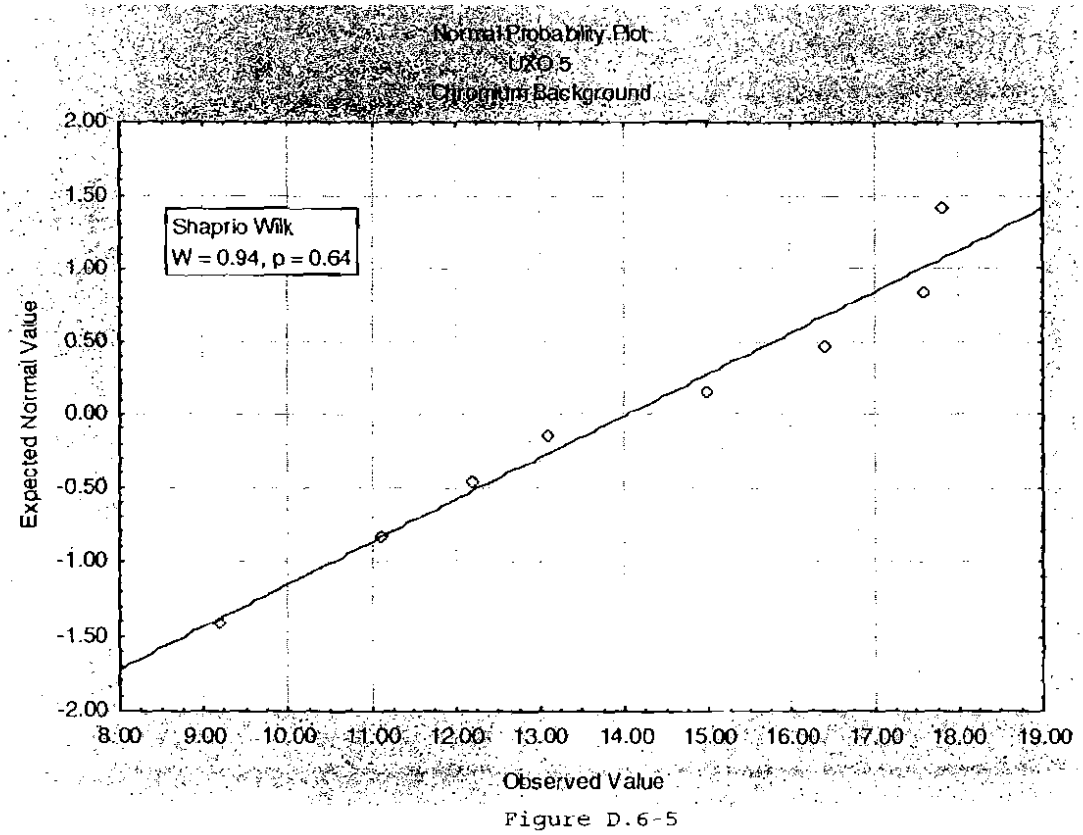


Figure D.6-5

Because the site Chromium concentrations are not normally distributed the Nonparametric Wilcoxon Rank Sum test will be used to see if the median site concentrations for Chromium are larger than the median background concentrations. The hypothesis is that there is no difference between median values for the site Chromium concentrations and background Chromium concentrations. The hypothesis of no difference will be rejected if the Test Statistic is greater than the Critical Value. Table D.6-2 contains the Test Statistic and Critical value for this comparison. From Table D.6-2 it can be seen that the Test Statistic is less than the Critical value. Therefore, we cannot reject the null hypothesis that there is no difference between site and background Chromium concentrations. It is concluded that the site Chromium concentrations are not larger than the background Chromium concentrations. This test was conducted with a significance level of 0.01 (alpha).

	Rank Sum
Site	295
Background	83

Test Statistic	Critical Value $_{0.01}$
105	120

Table D.6-2

APPENDIX D.7

COBALT

Table D.7-1 contains the Descriptive Statistics for site and background Cobalt concentrations. From Table D.7-1 it can be seen that the mean and median site concentration are lower than the mean and median background concentrations.

Variable	Descriptive Statistics UXO 5					
	Valid N	Mean	Median	Minimum	Maximum	Std. Dev.
Cobalt Background	8	13.73	13.60	8.40	27.10	6.09
Cobalt Site	19	7.90	7.23	1.75	16.60	4.71

Table D.7-1

Figure D.7-1 contains the side by side Box Plots for the site and background Cobalt concentrations. From these plots it can be seen that the median concentrations for the site are lower than the median concentrations for background. Also it can be noticed that the lower quartile for the background concentrations is relatively close to the upper quartile for the site Cobalt concentrations.

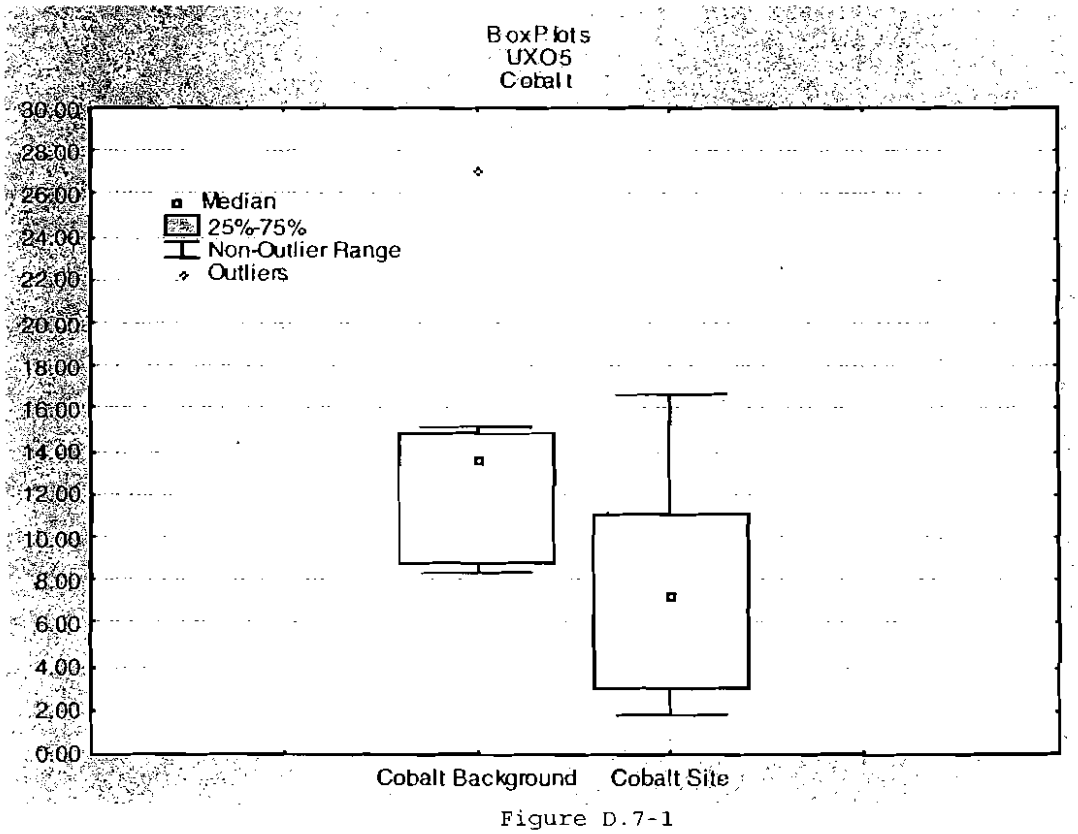


Figure D.7-1

Figure D.7-2 contains the 95% Confidence Intervals for the site and background Cobalt concentrations. From this figure it can be seen that the mean background concentration is

greater than the mean site concentration.

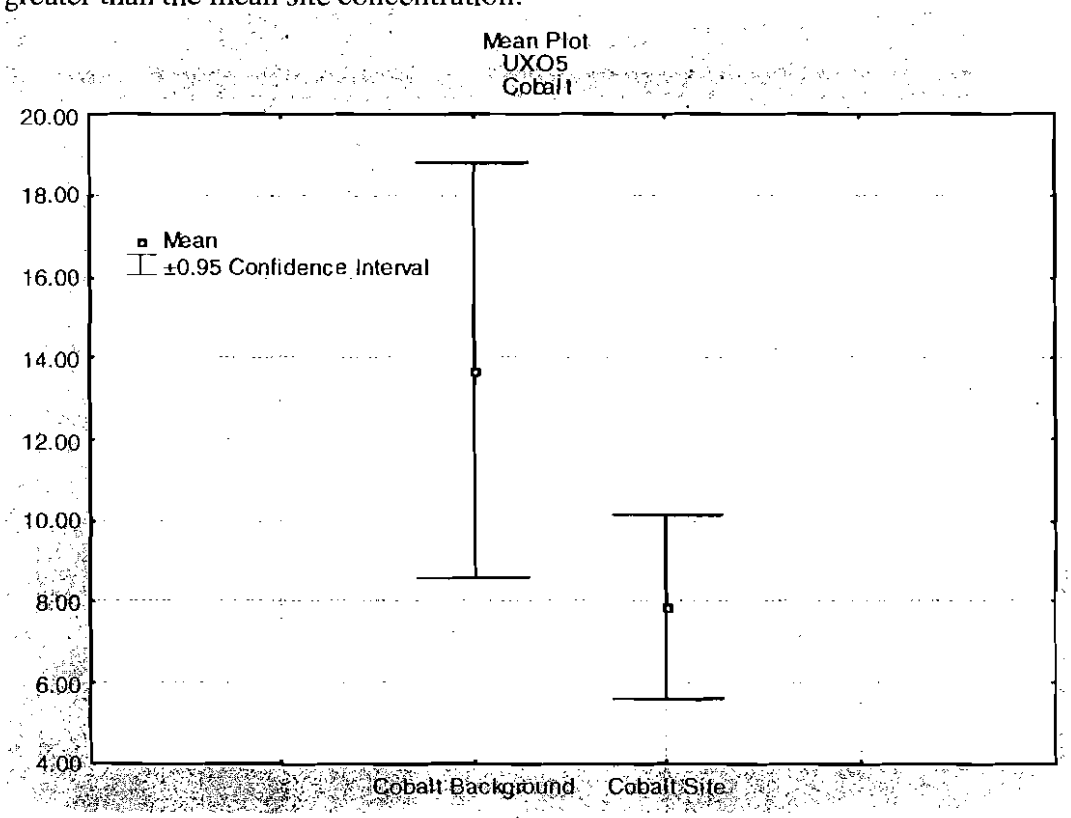


Figure D.7-2

Figures D.7-3 and D.7-4 show the normal probability plots and corresponding Shapiro Wilks test for normality. If the data is normal then the data points will roughly follow a linear pattern. The Shapiro Wilks test is a formal Statistical test of normality. The hypothesis being that the data is normally distributed. If the p-value for the test is less than 0.10 then the data is considered to be not normally distributed. From Figure D.7-3 it can be seen that the Background data do not roughly follow the linear pattern and the p-value for the Shapiro Wilk test is 0.03. Thus it can be concluded that the background Cobalt concentrations are not normally distributed. From Figure D.7-4 it can be seen that the site Cobalt concentrations do not follow a linear pattern and the p-value for the Shapiro Wilks test is 0.09. Thus it is concluded that the Cobalt site concentrations are not normally distributed.

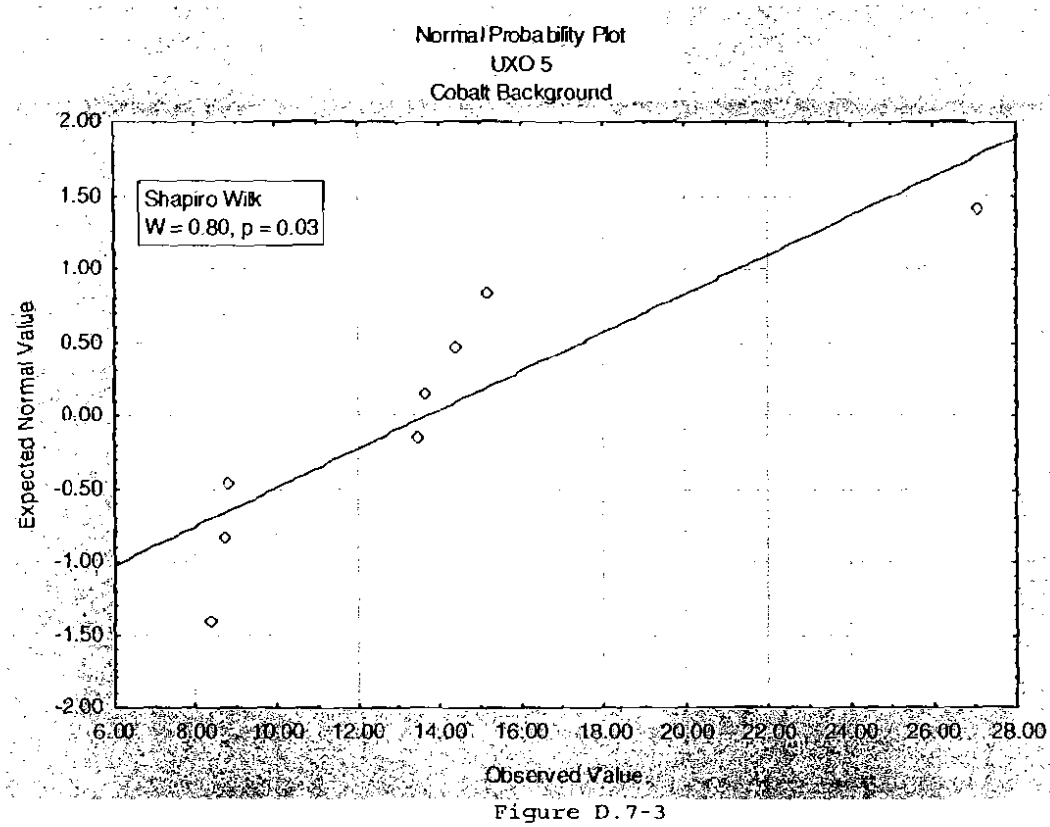


Figure D.7-3

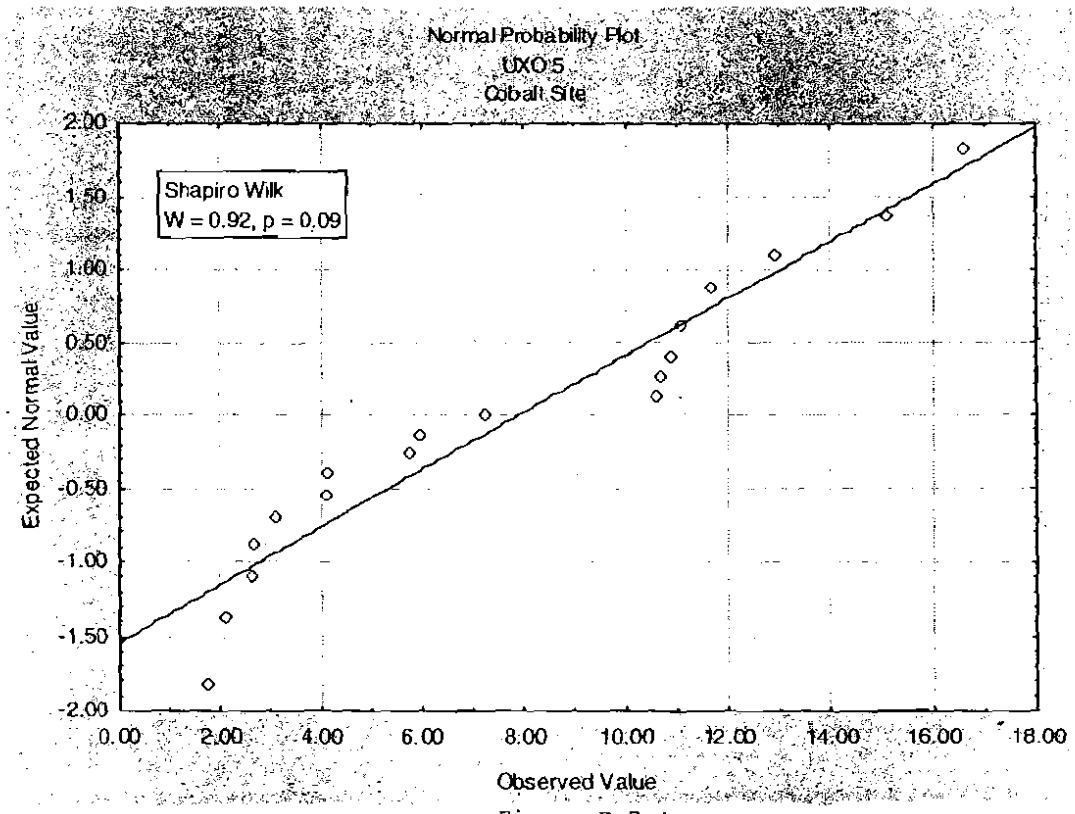


Figure D.7-4

Because the Site and Background Concentrations are not normally distributed the Nonparametric Wilcoxon Rank Sum test will be used to see if the median site concentrations for Cobalt are larger than the median background concentrations. The hypothesis is that there is no difference between median values for the site and background Cobalt concentrations. The hypothesis will be rejected if the Test Statistic is great than the critical value. Table D.7-2 Contains the Test Statistic and the Critical Value for the comparison between the site and background Cobalt concentrations. From Table D.7-2 it can be seen that the Test Statistic is smaller than the Critical value. Therefore, we fail to reject the null hypothesis that there is no difference between the site and background Cobalt concentrations. This test was conducted with a significance level (alpha) of 0.01.

	Rank Sum
Site	224
Background	154

Test Statistic	Critical Value $_{0.01}$
34	120

Table D.7-2

APPENDIX D.8

COPPER

Table D.8-1 contains the Descriptive Statistics for the Site Copper concentrations and Background Concentrations for UXO 5. From the descriptive statistics it can be seen that the mean concentrations for Site Copper concentrations is 21.17 and the mean background Copper concentration is 7.54. The median concentration for site Concentrations is 12.60 and the background median concentration is 7.60.

Variable	Descriptive Statistics UXO 5					
	Valid N	Mean	Median	Minimum	Maximum	Std Dev
Copper Background	8	7.54	7.60	6.50	8.10	0.53
Copper Site	19	21.17	12.60	3.99	156.00	35.12

Table D.8-1

Figures D.8-1 and D.8-2 contain side by side Box Plots for the Site and Background Copper concentrations. From these figures it can be seen that the Background Copper concentrations are lower than the Site Copper Concentrations. 75% of the Background Copper concentrations are less than 25% of the Site Copper Concentrations.

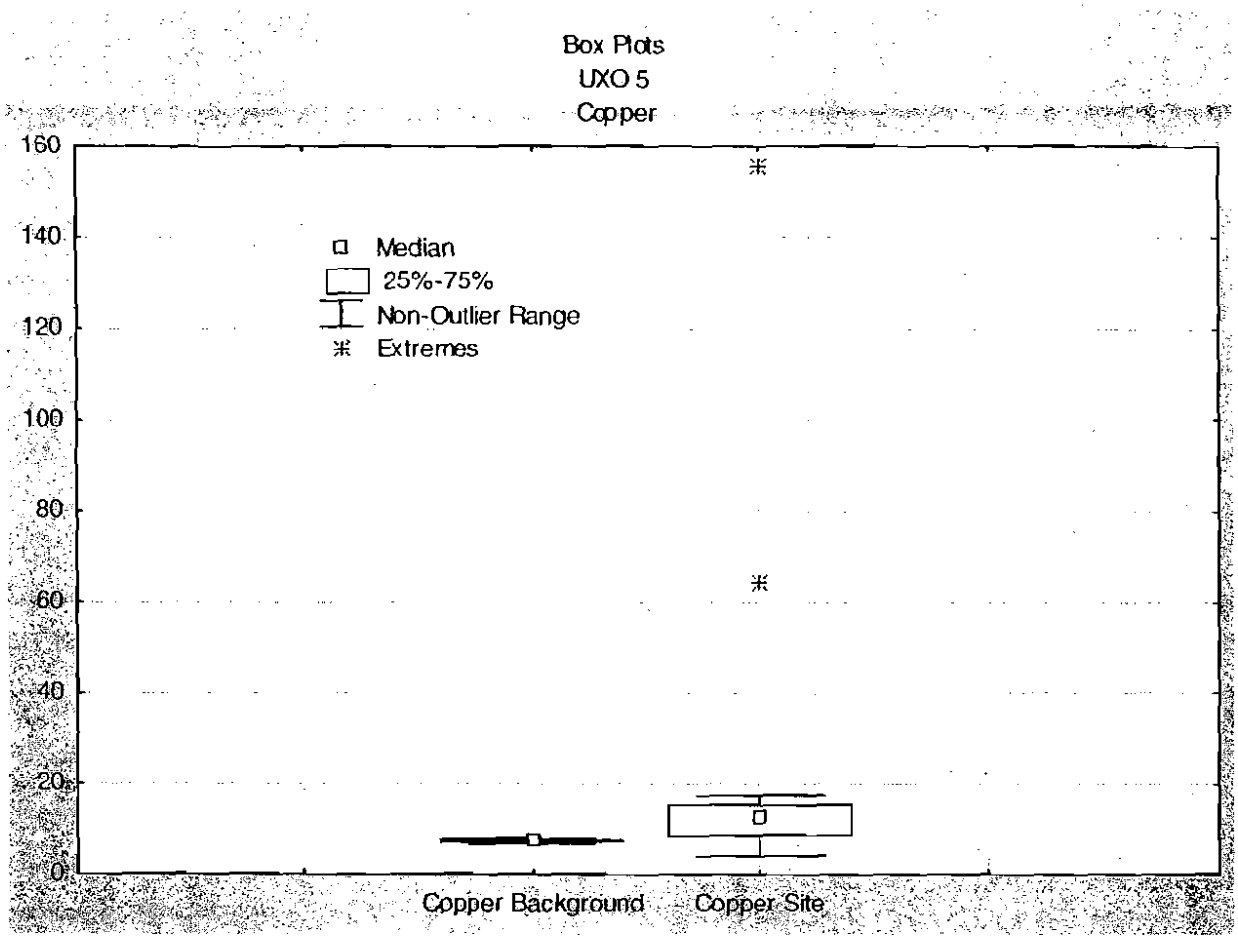

Box Plots
UXO 5
Copper
160
140
120
100
80
60
40
20
0
Median
25%-75%
Non-Outlier Range
Extremes
Copper Background
Copper Site

Figure D.8-1

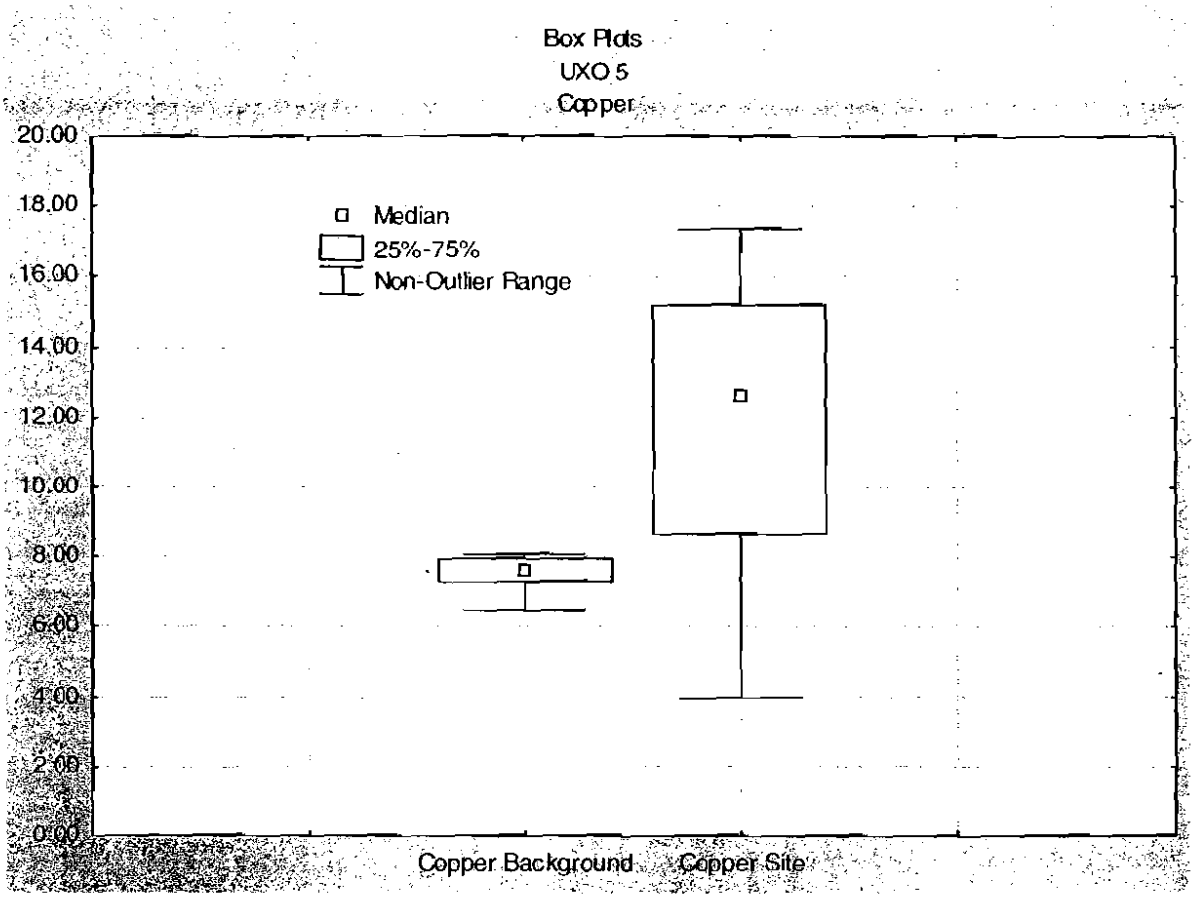


Figure D.8-2

Figure D.8-3 contains the 95% Confidence Intervals for the Site and Background Copper Concentrations for UXO 5. From this figure it can be seen that the mean concentration for the site is higher than the mean concentration for background. Also the 95% UCL for the Background concentrations is less than the mean concentration for the site concentrations.

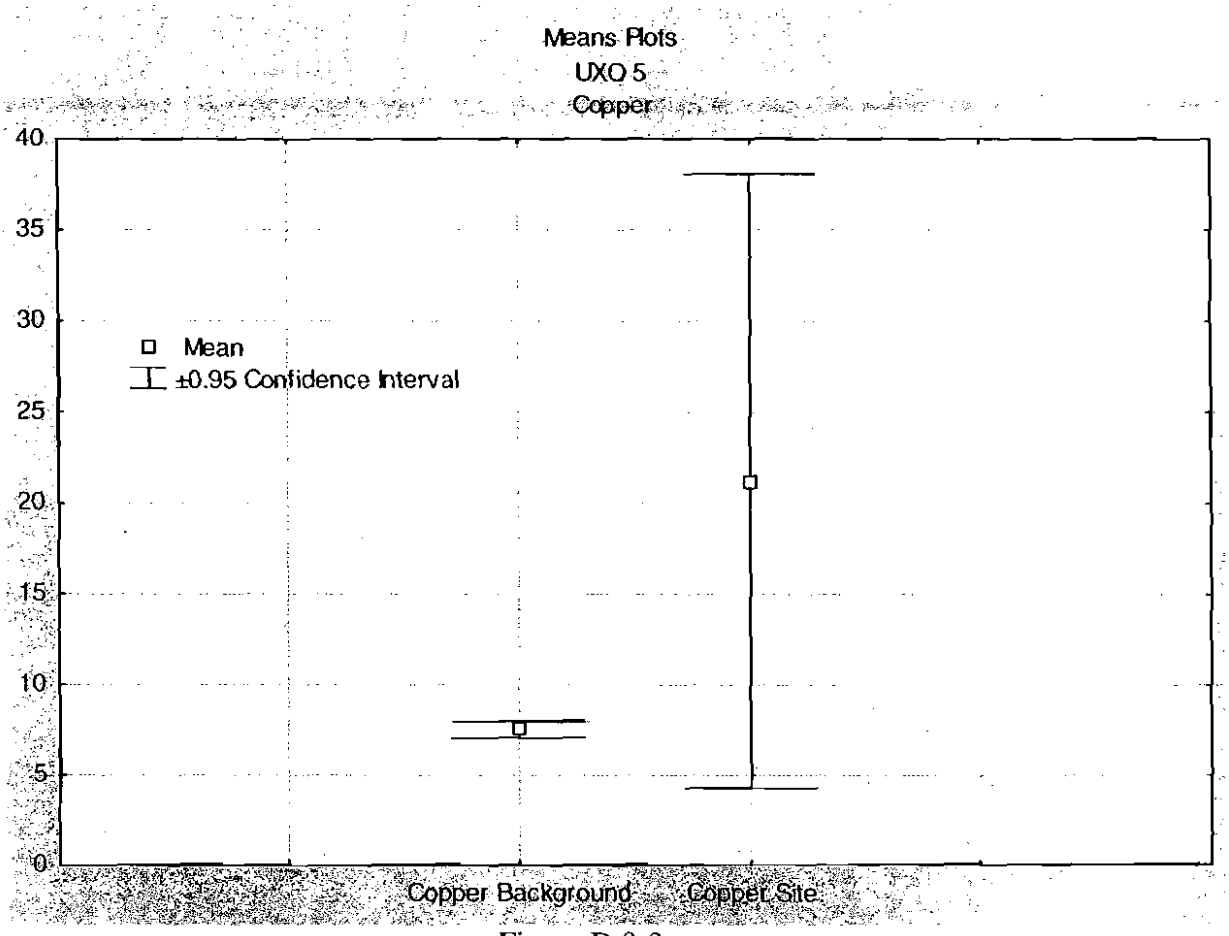


Figure D.8-3

Figures D.8-4 and D.8-5 show the normal probability plots and corresponding Shapiro Wilks test for normality. If the data is normal then the data points will roughly follow a linear pattern. The Shapiro Wilk test is a formal statistical test of normality. The hypothesis being that the data is normally distributed. If the p-value for the test is less than .10 then the data is considered to be not normally distributed. From Figure D.8-4 it can be seen that the data do not follow the linear line on the probability plot and that the p-value for the Shapiro Wilk test is 0.00. Therefore the Site Copper concentrations are not normally distributed. From Figure D.8-5 it can be seen that the data roughly follow the linear line and the p-value for the Shapiro Wilk Test is 0.30. Therefore the Background Copper Concentrations are considered to be normally distributed.

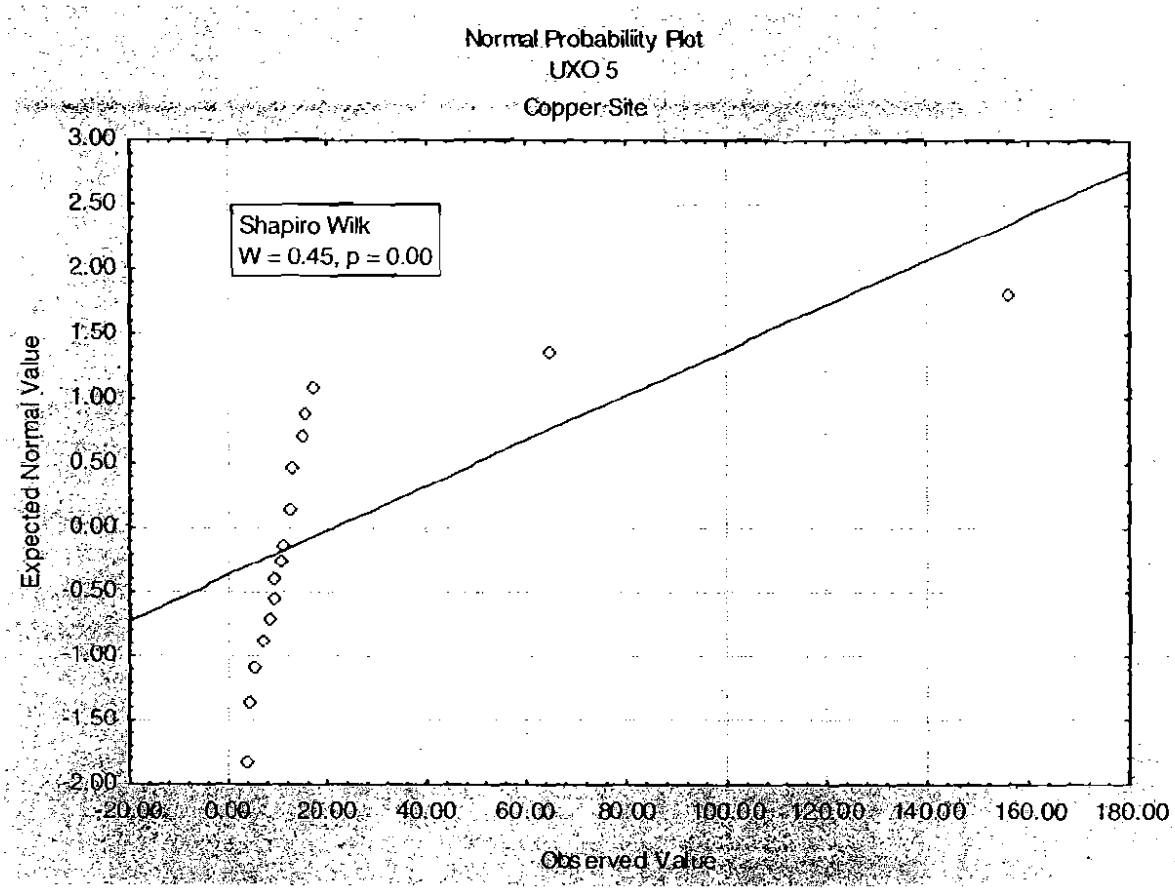

Normal Probability Plot
UXO 5
Copper Site
Shapiro Wilk
W = 0.45, p = 0.00
Expected Normal Value
Observed Value
3.00
2.50
2.00
1.50
1.00
0.50
0.00
-0.50
-1.00
-1.50
-2.00
-20.00
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
160.00
180.00

Figure D.8-4

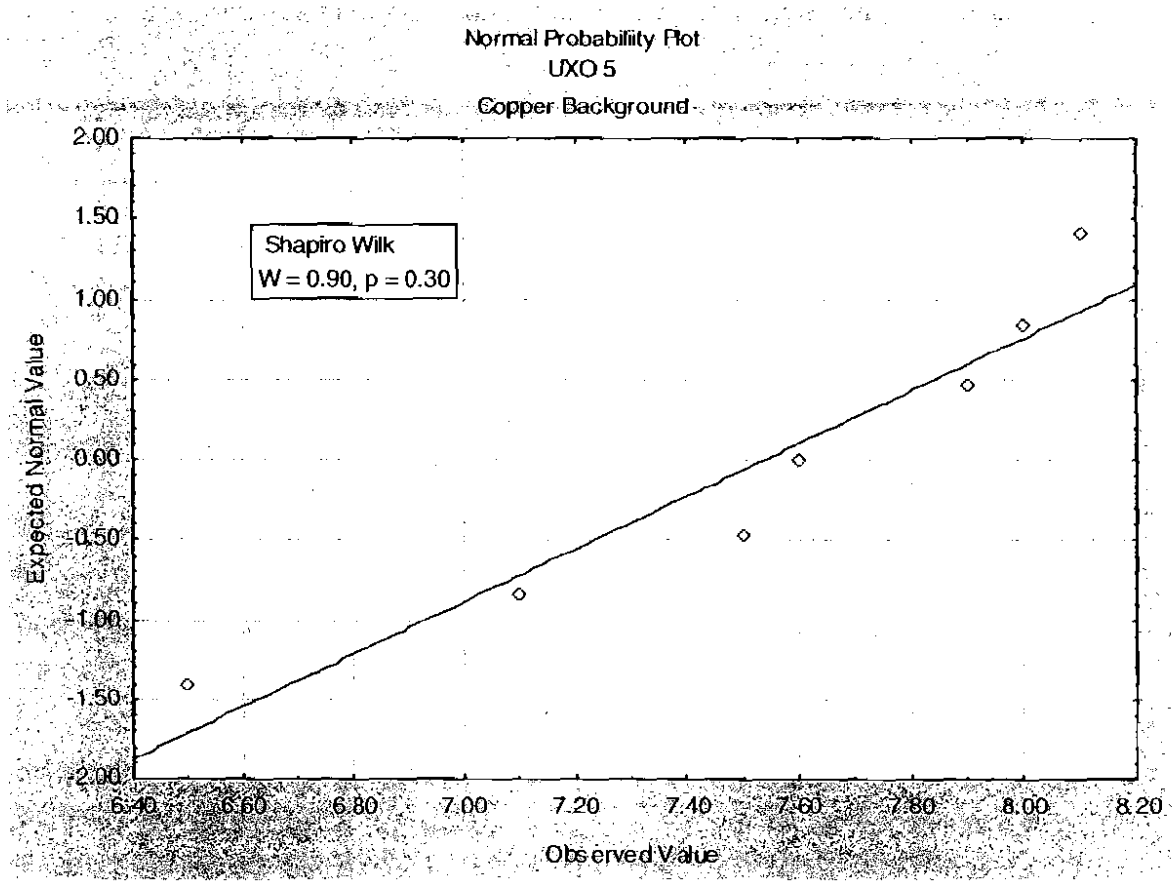


Figure D.8-5

Since the Site Concentrations are not normally distributed the Nonparameteric Wilcoxon Rank Sum test will be used to see if the median site Concentrations for Copper are larger than the median background Concentrations. The hypothesis is that there is no difference between median values for the Site Copper Concentrations and the Background Copper Concentrations. Table D.8-2 contains the rank sums for the Site and Background Copper Concentrations and the corresponding Test Statistic and Critical Value. The Hypothesis that there is no difference between median Copper Concentration is rejected if the Test Statistic is greater than the Critical value. From Table D.8-2 it can be seen that the Test Statistic is greater than the Critical Value so it is concluded that the Site Copper Concentrations are greater than the Background Copper Concentrations. This test was conducted with a significance level (alpha) of 0.01.

	Rank Sum
Site	311
Background	67

Test Statistic	Critical Value $_{0.01}$
121	120

Table D.8-2

APPENDIX D.9

LEAD

Table D.9-1 contains the Descriptive Statistics for the site and background Lead concentrations for UXO 5. From Table X it can be seen that the mean and median site concentration are greater than the mean and median background concentration with a difference of 30.27 and 0.95 respectively.

Variable	Descriptive Statistics UXO 5					
	Valid N	Mean	Median	Minimum	Maximum	Std. Dev.
Lead Background	8	15.89	15.45	12.30	20.60	3.10
Lead Site	19	46.16	16.40	5.50	597.00	133.54

Table D.9-1

Figures D.9-1 and D.9-2 contain the side by side Box Plots for the site and background Lead concentrations. From these plots it can be seen that the site median concentrations is slightly higher than the background concentrations. Also it becomes apparent that there is an extreme value for the site concentrations.

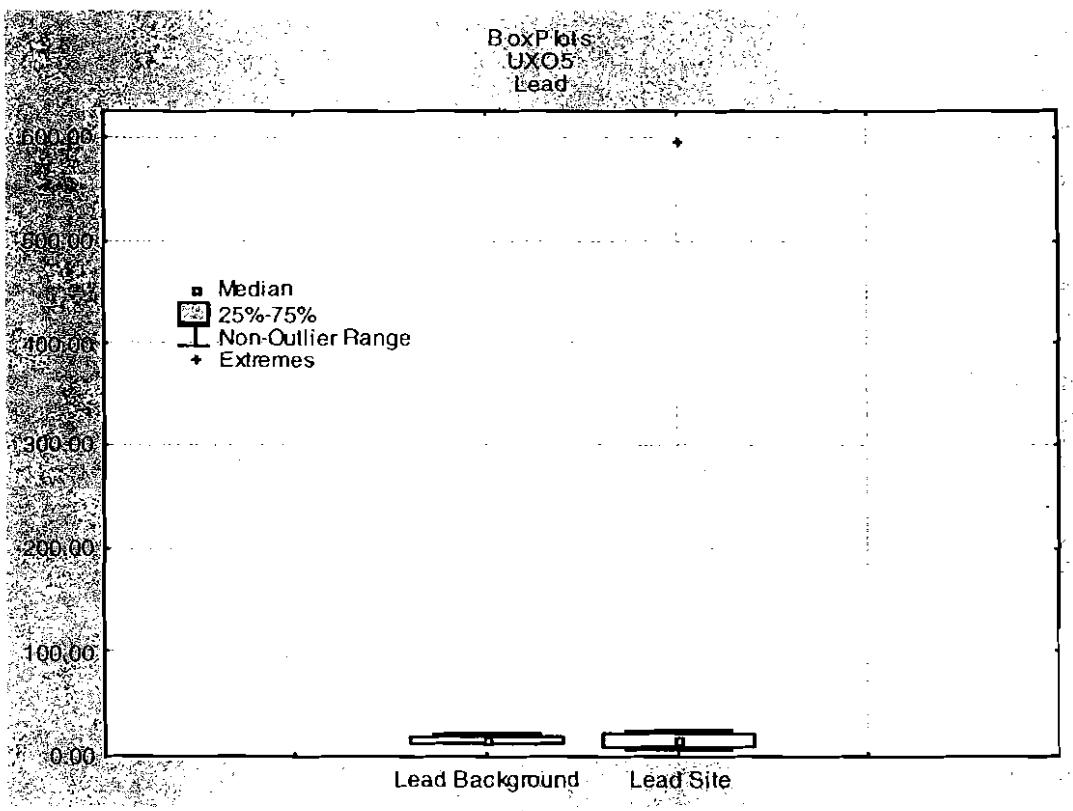


Figure D.9-1

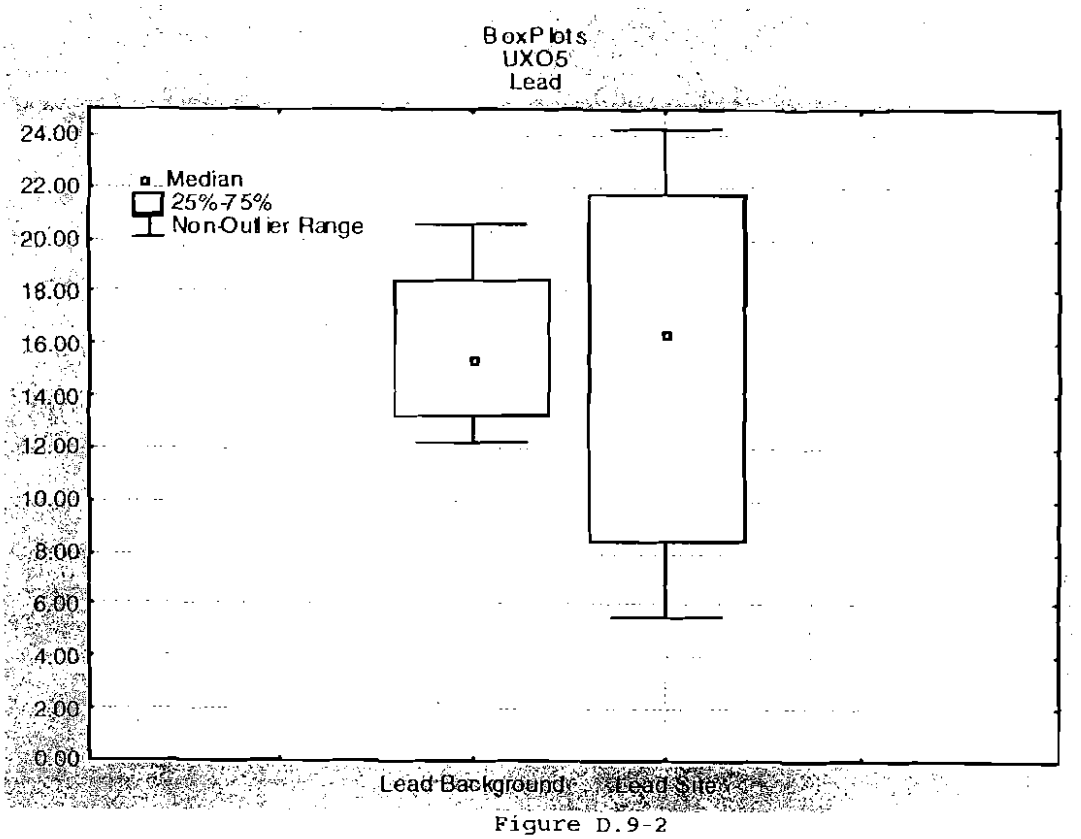


Figure D.9-2

Figure D.9-3 contains the 95% Confidence Intervals for the Site and Background Lead concentrations. From this figure it can be seen that the mean site concentration is greater than the mean background concentration. Also the UCL for the Background concentrations is less than the mean site concentration.

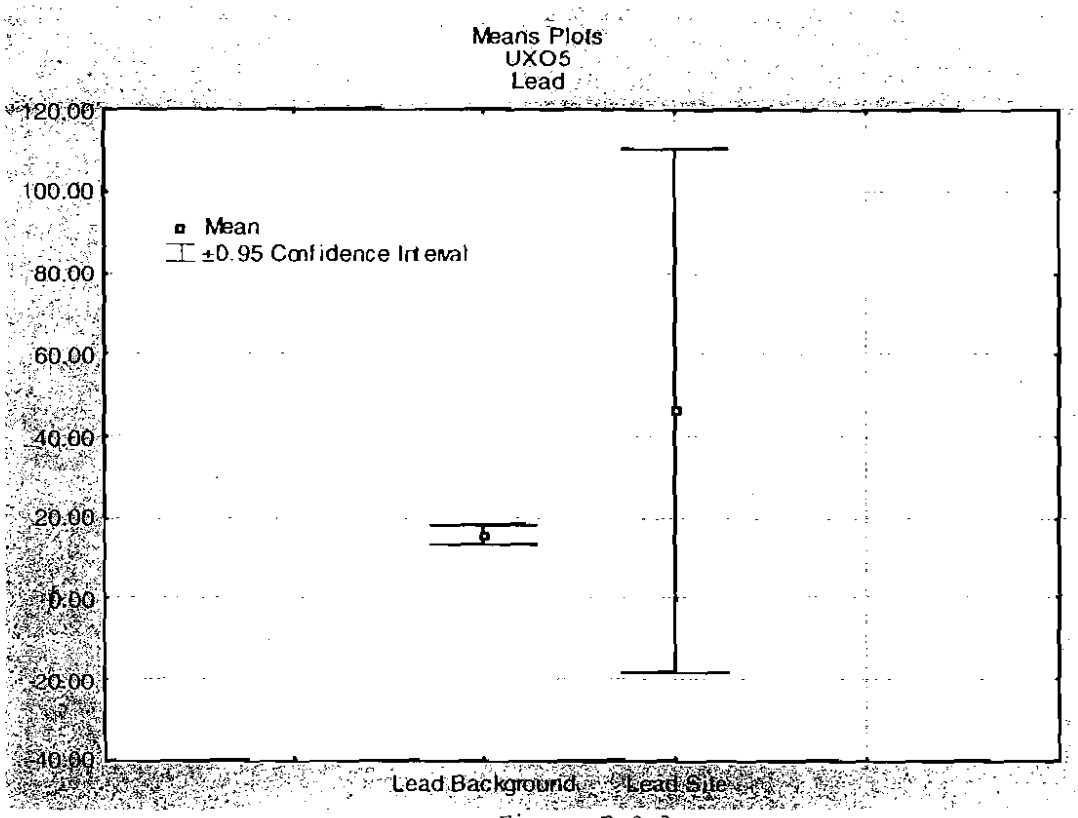


Figure D.9-3

Figures D.9-4 and D.9-5 show the normal probability plots and corresponding Shapiro Wilks test for normality. If the data is normal then the data points will roughly follow a linear pattern. The Shapiro Wilk test is a formal Statistical test of normality. The hypothesis being that the data is normally distributed. If the p-value for the test is less than 0.10 then the data is considered to be not normally distributed. From Figure D.9-4 it can be seen that the background data do not depart from the linear pattern and the p-value for the Shapiro Wilk test is 0.51. Thus it is concluded that the background data is normally distributed. From Figure D.9-5 it can be seen that the site data does not follow a linear pattern and the Shapiro Wilk p-value is 0.00. Thus the site data is not normally distributed.

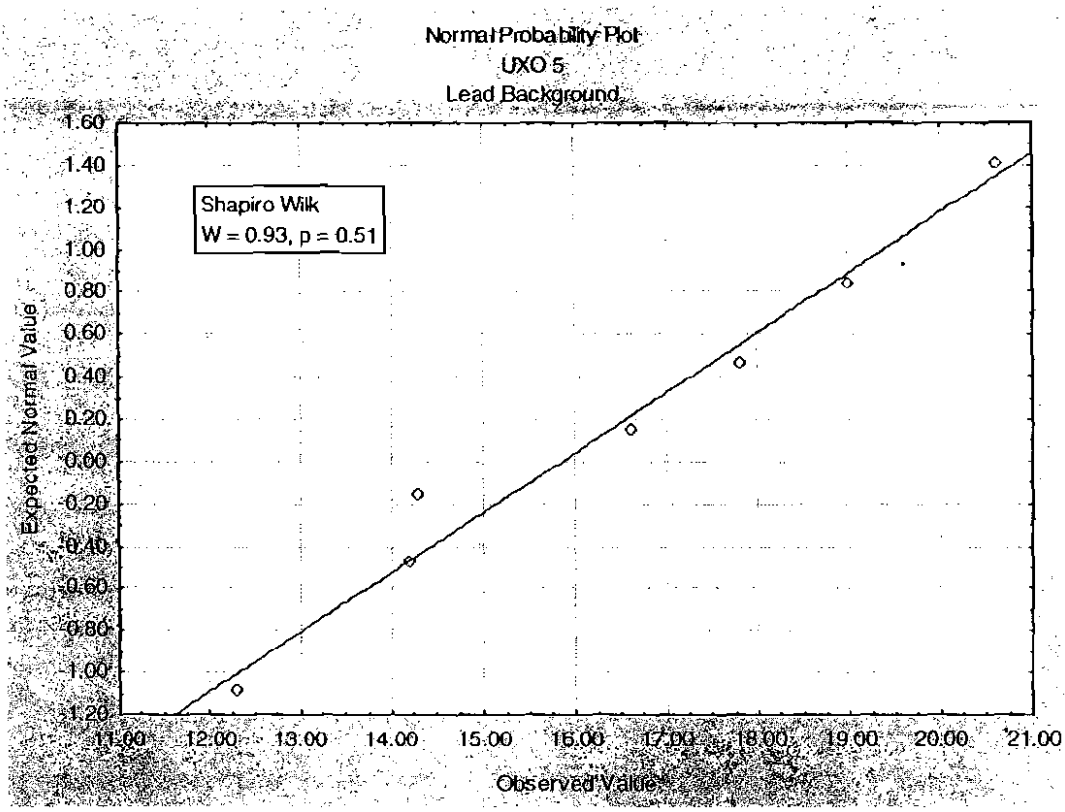


Figure D.9-4

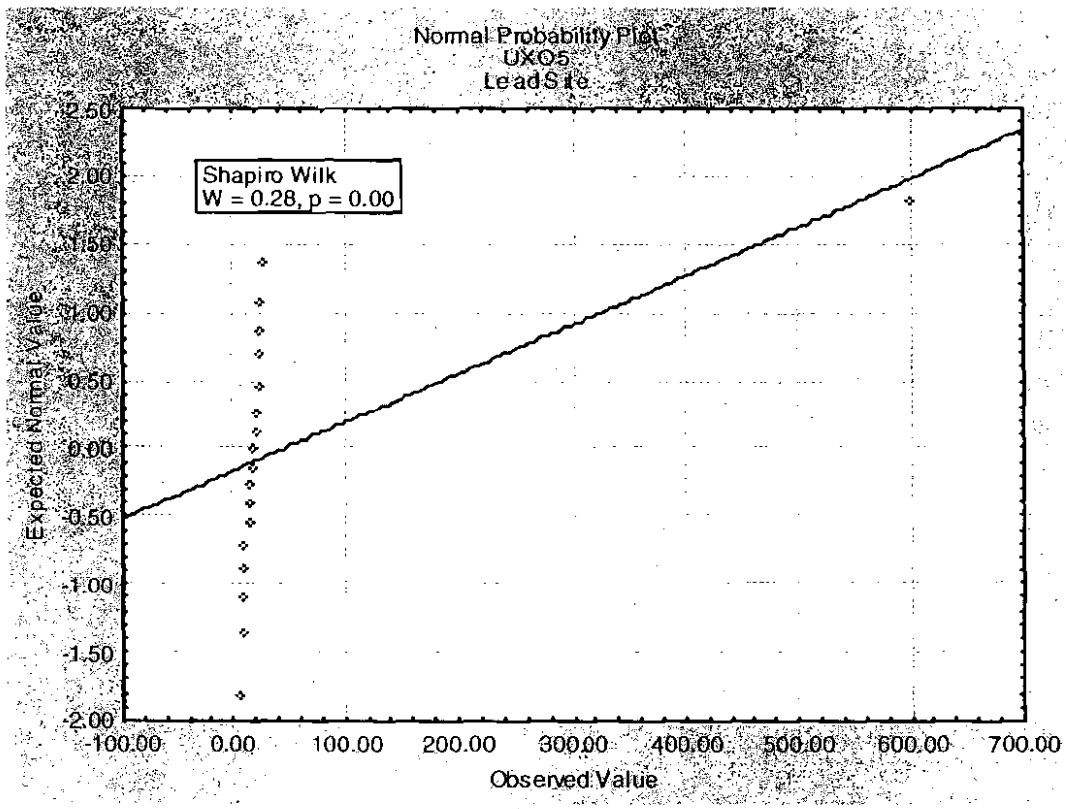


Figure D.9-5

Because the Site concentrations are not normally distributed the Nonparametric Wilcoxon Rank Sum test will be used to see if the median concentrations for Lead are larger than the median background concentrations. The hypothesis is that there is no difference between median values for the site and background data. If the Test Statistic is greater than the Critical Value then this hypothesis is rejected and it is concluded that the site concentrations are greater than the background concentrations. Table D.9-2 contains the Test Statistic and Critical Value for the Lead comparison. From Table D.9-2 it can be seen that the Test Statistic is less than the critical value. Thus it is concluded that the Site Lead Concentrations are not different from the Background Lead Concentrations. This test was conducted with a significance level (alpha) of 0.01.

	Rank Sum
Site	274
Background	105

Test Statistic	Critical Value $_{0.01}$
84	120

Table D.9-2

APPENDIX D.10

MANGANESE

Table D.10-1 contains the Descriptive Statistics for Site and Background Manganese concentrations for UXO 5. From Table D.10-1 it can be seen that the mean for the site Manganese concentration is less than the mean background Manganese concentration. Also the median site Manganese concentration is smaller than the background Manganese concentration.

Variable	Descriptive Statistics UXO 5					
	Valid N	Mean	Median	Minimum	Maximum	Std.Dev.
Manganese Background	8	1075.25	1115.50	304.00	1690.00	502.81
Manganese Site	19	426.08	395.00	98.10	1120.00	273.73

Table D.10-1

Figure D.10-1 contains the side by side Box Plots for the site and background Manganese concentrations. From these figures it can be seen that the median site Manganese concentration is smaller than the Manganese background concentration. It can also be seen that the lower quartile of the background is more than the upper quartile for the site concentration.

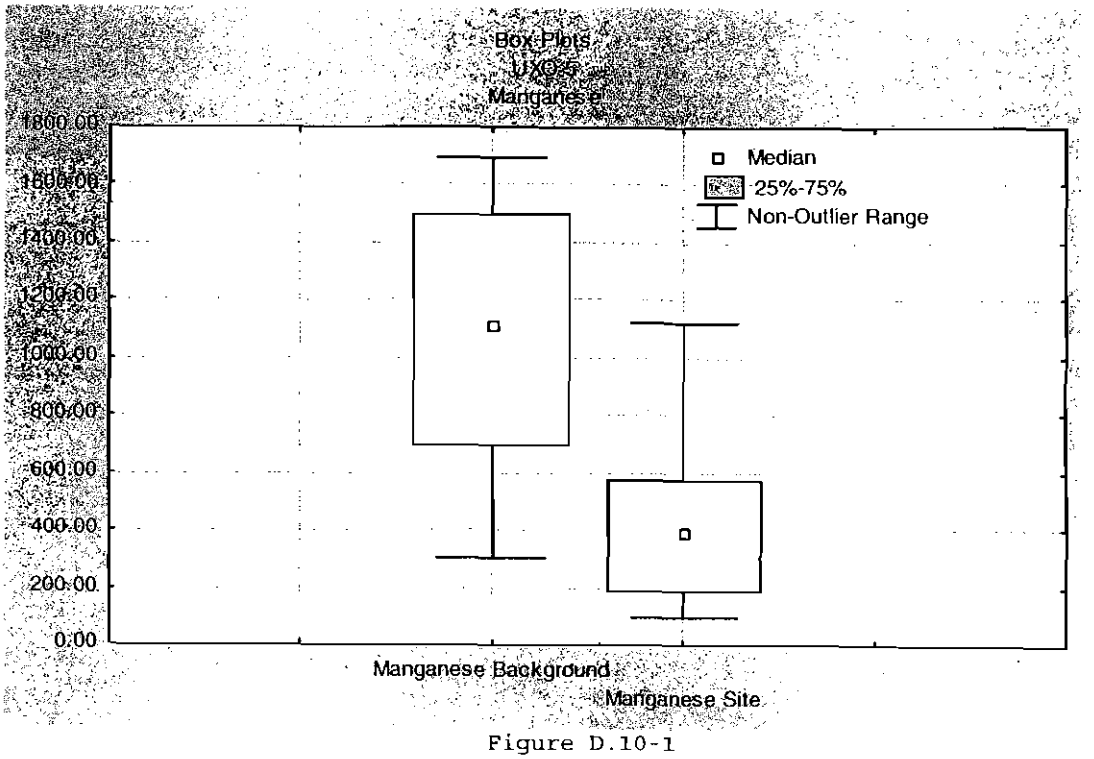


Figure D.10-1

Figure D.10-2 contains the 95% confidence intervals for site and background Manganese concentrations for UXO 5. From this figure it can be seen that the mean of the site is

smaller than the background mean. Also, the UCL for the site mean is less than the background LCL.

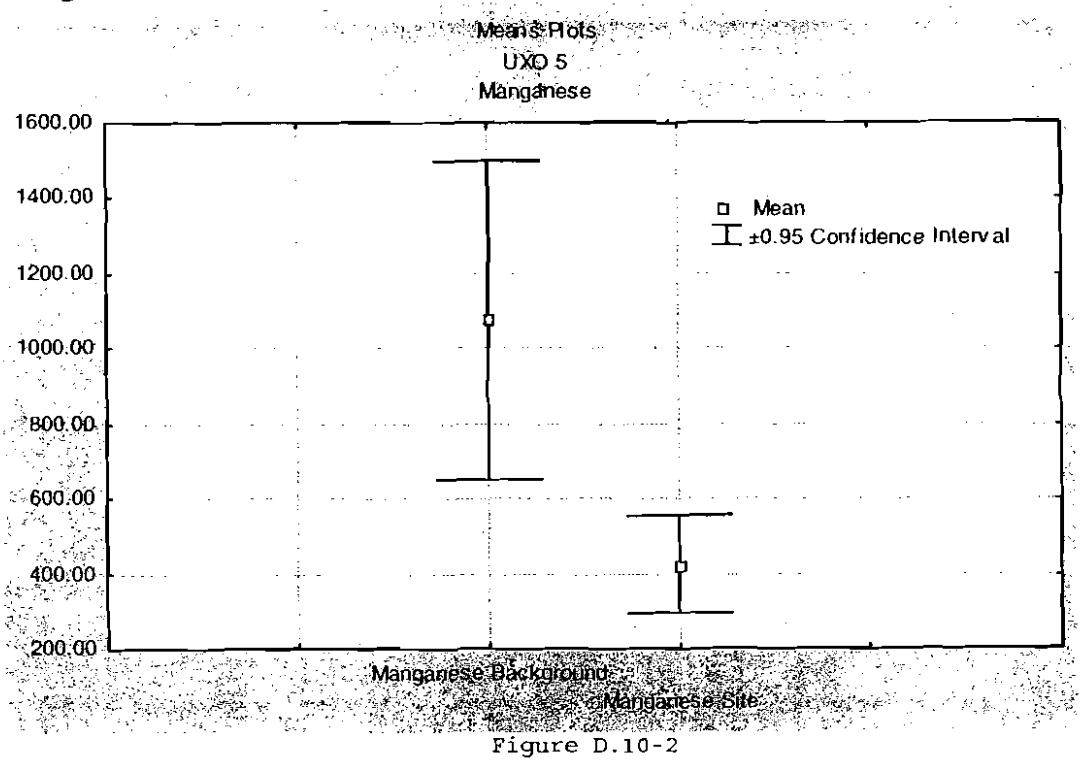


Figure D.10-2

Figures D.10-3 and D.10-4 show the normal probability plots and corresponding Shapiro Wilks test for normality. If the data is normal then the data points will roughly follow a linear pattern. The Shapiro Wilks test is a formal Statistical test of normality. The hypothesis being that the data is normally distributed. If the p-value for the test is less than 0.10 then the data is considered to be not normally distributed. From Figure D.10-3 it can be seen that the site Manganese concentrations roughly follow the linear pattern and the p-value for the Shapiro Wilk test is 0.09. Thus it is concluded that the site Manganese concentrations are normally distributed. From Figure D.10-4 it can be seen that the background Manganese concentrations follow a linear pattern and the p-value for the Shapiro Wilk Test is 0.42. Therefore, it is concluded that the background Manganese concentrations follow a normal distribution.

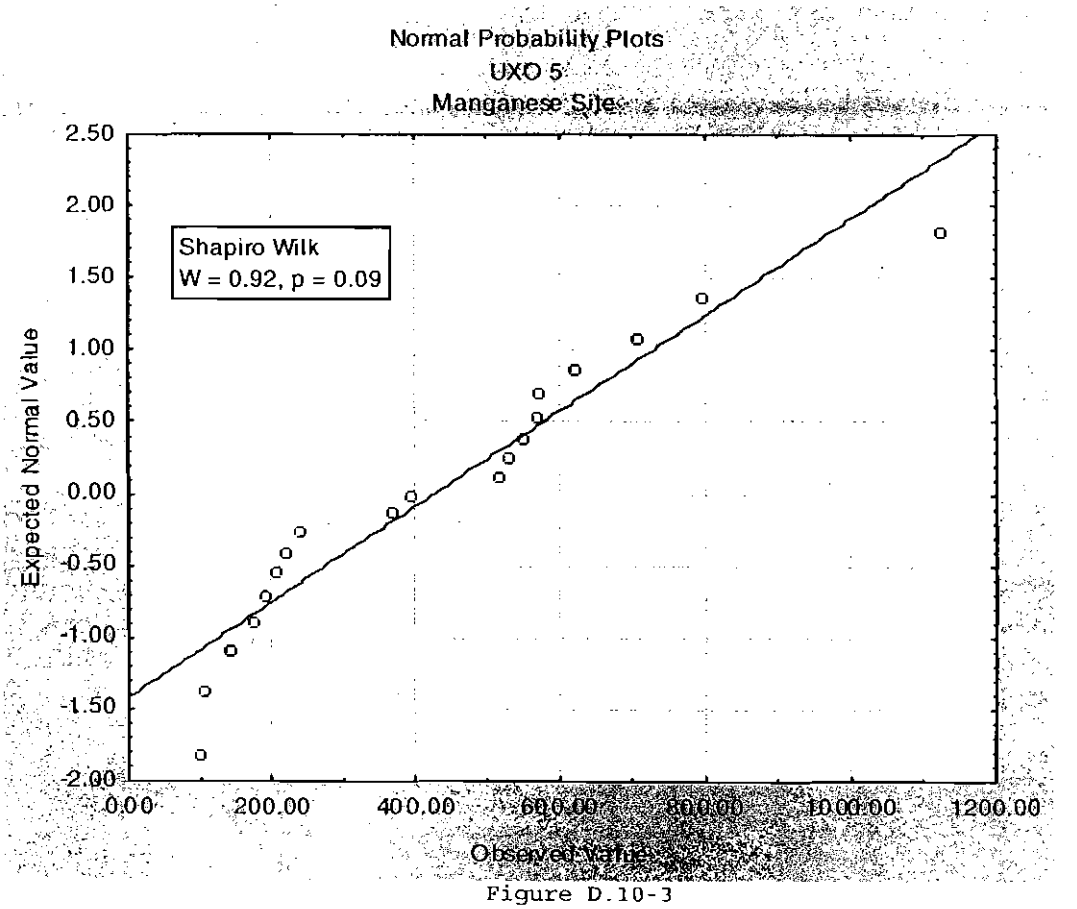


Figure D.10-3

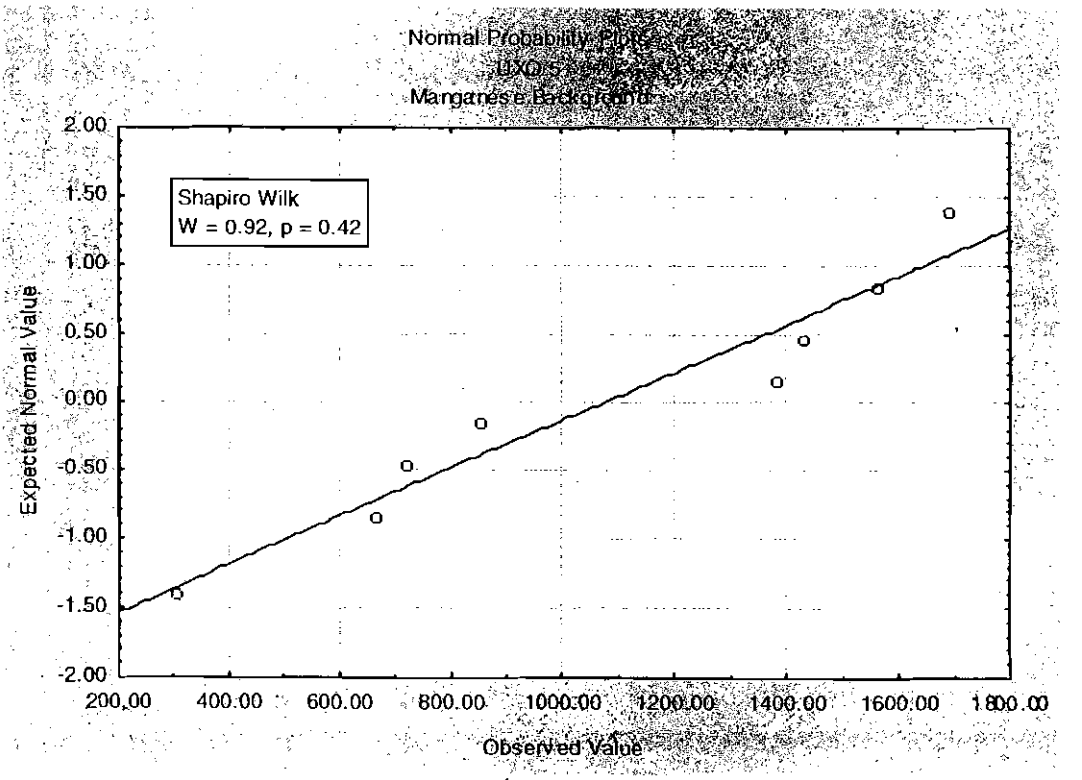


Figure D.10-4

Because the site Manganese concentrations are not normally distributed the Nonparametric Wilcoxon Rank Sum test will be used to see if the median site concentrations for Manganese are larger than the median background concentrations. The hypothesis is that there is no difference between median values for the site Manganese concentrations and background concentrations. The hypothesis of no difference will be rejected if the Test Statistic is greater than the Critical Value. Table D.10-2 contains the Test Statistic and Critical value for this comparison. From Table D.10-2 it can be seen that the Test Statistic is less than the Critical value. Therefore, we cannot reject the null hypothesis that there is no difference between site and background Manganese concentrations. It is concluded that the site Manganese concentrations are not larger than the background concentrations. This test was conducted with a significance level of 0.01 (alpha).

	Rank Sum
Site	207
Background	171

Test Statistic	Critical Value $_{0.01}$
17	120

Table D.10-2

APPENDIX D.11

NICKEL

Table D.11-1 contains the Descriptive Statistics for site and background Nickel concentrations. From Table D.11-1 it can be seen that the mean and median site concentration are higher than the mean and median background concentrations.

Variable	Descriptive Statistics UXO 5					
	Valid N	Mean	Median	Minimum	Maximum	Std. Dev.
Nickel Background	8	12.23	13.00	8.80	14.20	1.94
Nickel Site	19	18.87	18.00	9.75	34.10	6.87

Table D.11-1

Figure D.11-1 contains the side by side Box Plots for the site and background Nickel concentrations. From these plots it can be seen that the median concentrations for the site are higher than the median concentrations for background. The upper quartile for the background concentrations is slightly smaller than the lower quartile for the site concentrations.

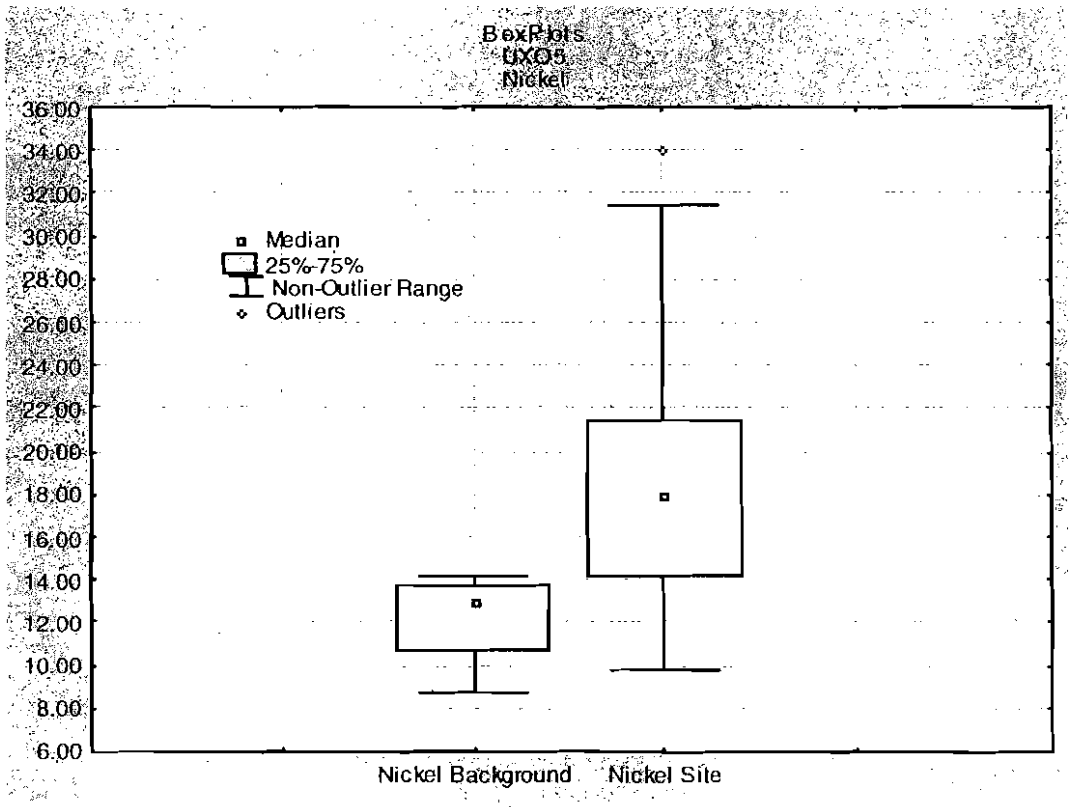


Figure D.11-1

Figure D.11-2 contains the 95% Confidence Intervals for the site and background Nickel concentrations. From this figure it can be seen that the mean background concentration is less than the mean site concentration.

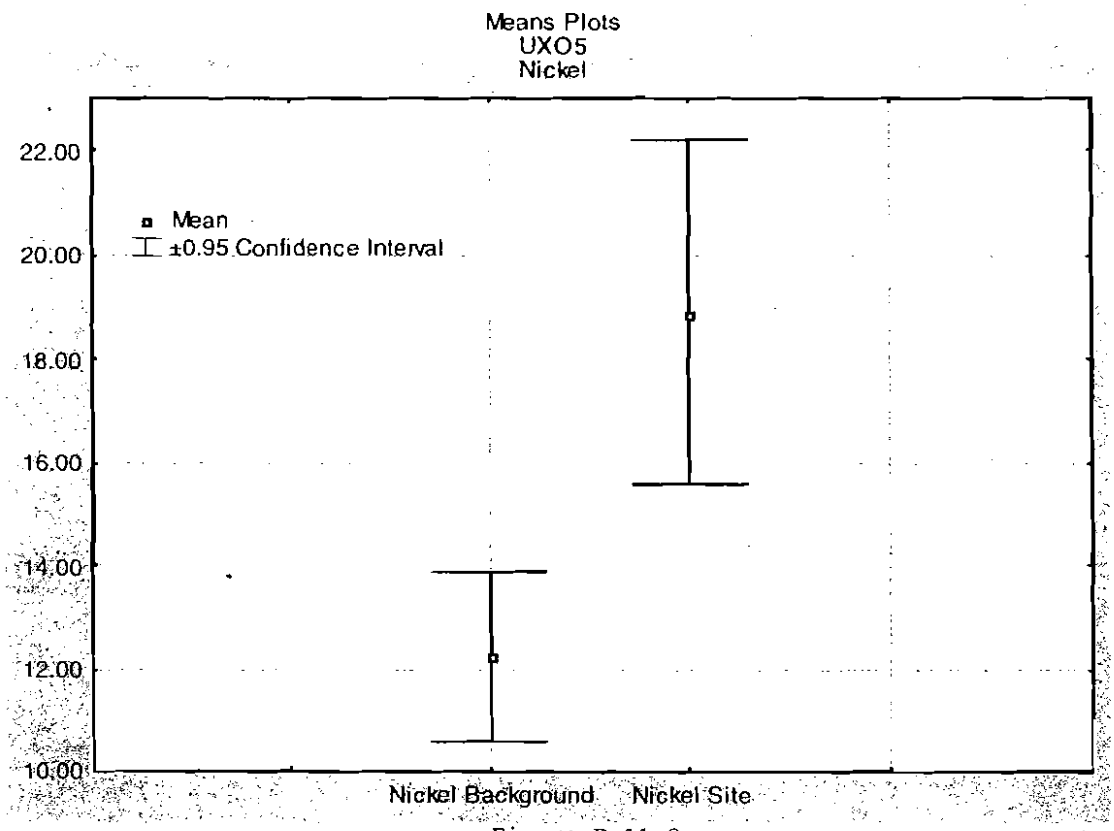


Figure D.11-2

Figures D.11-3 and D.11-4 show the normal probability plots and corresponding Shapiro Wilks test for normality. If the data is normal then the data points will roughly follow a linear pattern. The Shapiro Wilks test is a formal Statistical test of normality. The hypothesis being that the data is normally distributed. If the p-value for the test is less than 0.10 then the data is considered to be not normally distributed. From Figure D.11-3 it can be seen that the Site data roughly follow the linear pattern and the p-value for the Shapiro Wilk test is 0.14. Thus it can be concluded that the site Nickel concentrations are roughly normally distributed. From Figure D.11-4 it can be seen that the Background Nickel concentrations roughly follow a linear pattern and the p-value for the Shapiro Wilks test is 0.23. Thus it is concluded that the Nickel background concentrations are normally distributed.

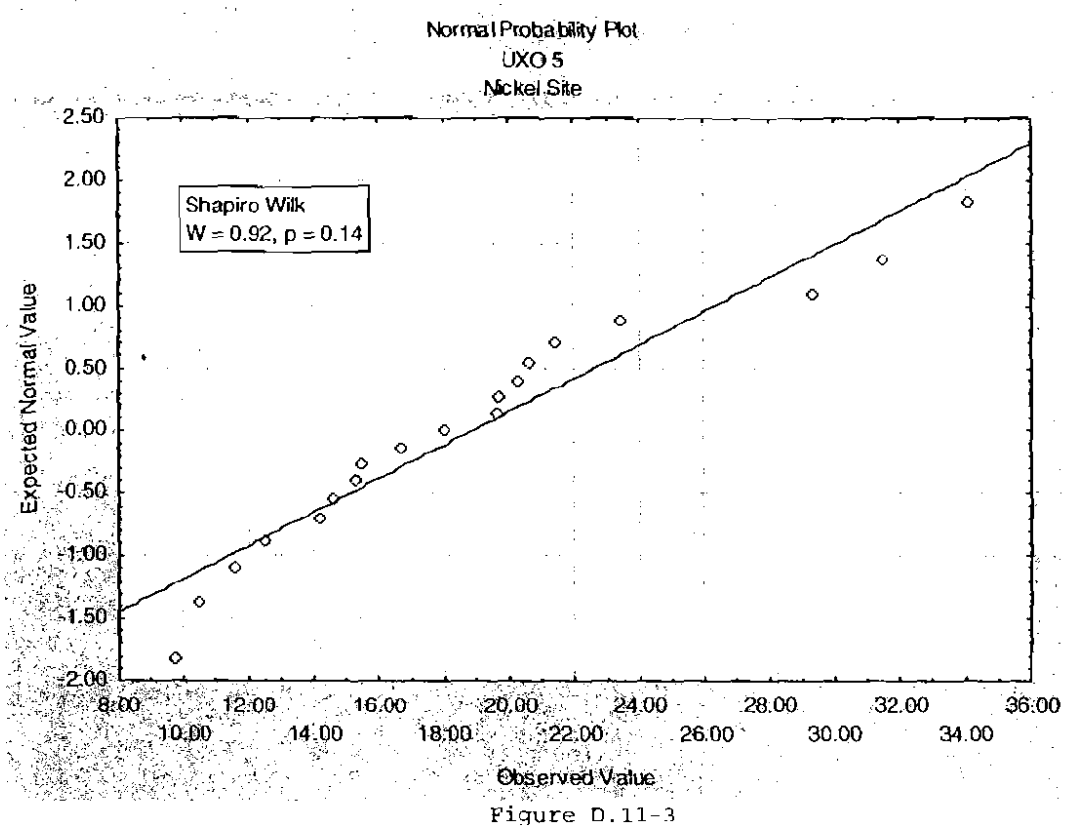


Figure D.11-3

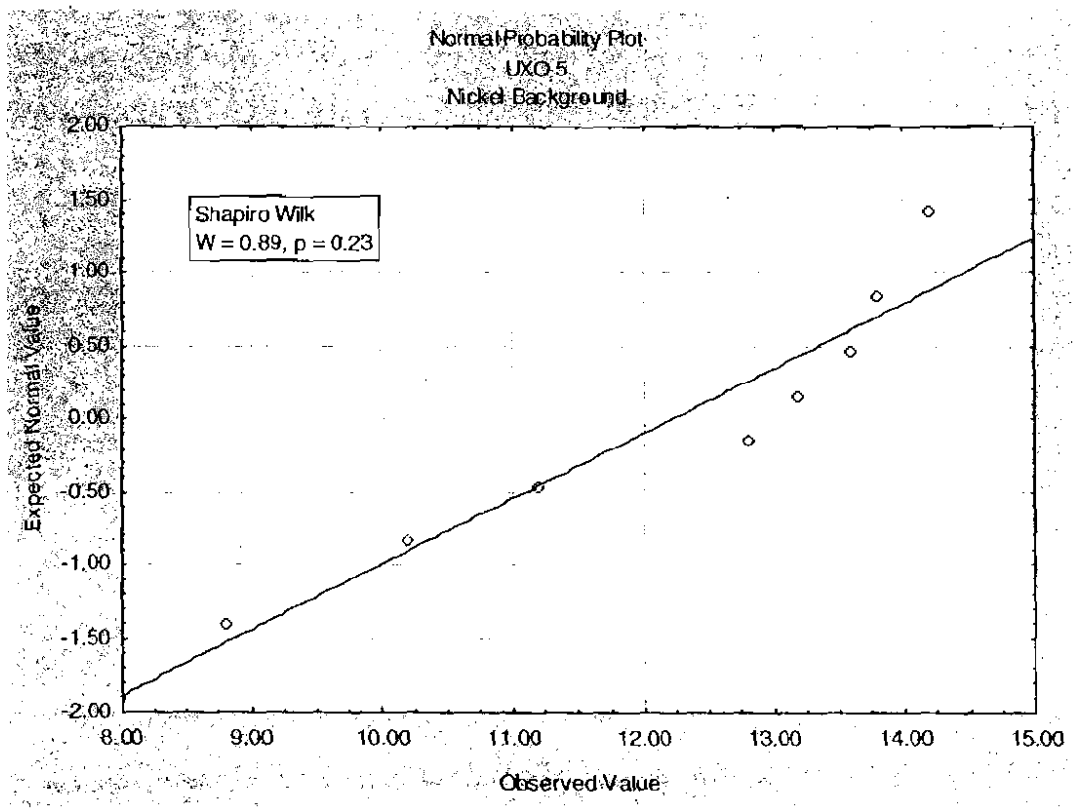


Figure D.11-4

Because the Site concentrations are Background concentrations do not have roughly the same standard deviation the Nonparametric Wilcoxon Rank Sum test will be used to see if the median site concentrations for Nickel are larger than the median background concentrations. The hypothesis is that there is no difference between median values for the site and background Nickel concentrations. The hypothesis will be rejected if the Test Statistic is great than the critical value. Table D.11-2 Contains the Test Statistic and the Critical Value for the comparison between the site and background Selenium concentrations. From Table D.11-2 it can be seen that the Test Statistic is larger than the Critical value. Therefore, we reject the null hypothesis that there is no difference between the site and background Nickel concentrations. This test was conducted with a significance level (alpha) of 0.01.

	Rank Sum
Site	319
Background	59

Test Statistic	Critical Value $_{0.01}$
129	120

Table D.11-2

APPENDIX D.12

SELENIUM

Table D.12-1 contains the Descriptive Statistics for site and background Selenium concentrations. From Table D.12-1 it can be seen that the mean and median site concentration are lower than the mean and median background concentrations.

Variable	Descriptive Statistics UXO 5					
	Valid N	Mean	Median	Minimum	Maximum	Std.Dev.
Selenium Background	8	0.46	0.48	0.32	0.65	0.11
Selenium Site	19	0.39	0.41	0.03	0.91	0.18

Table D.12-1

Figure D.12-1 contains the side by side Box Plots for the site and background Selenium concentrations. From these plots it can be seen that the median concentrations for the site are lower than the median concentrations for background.

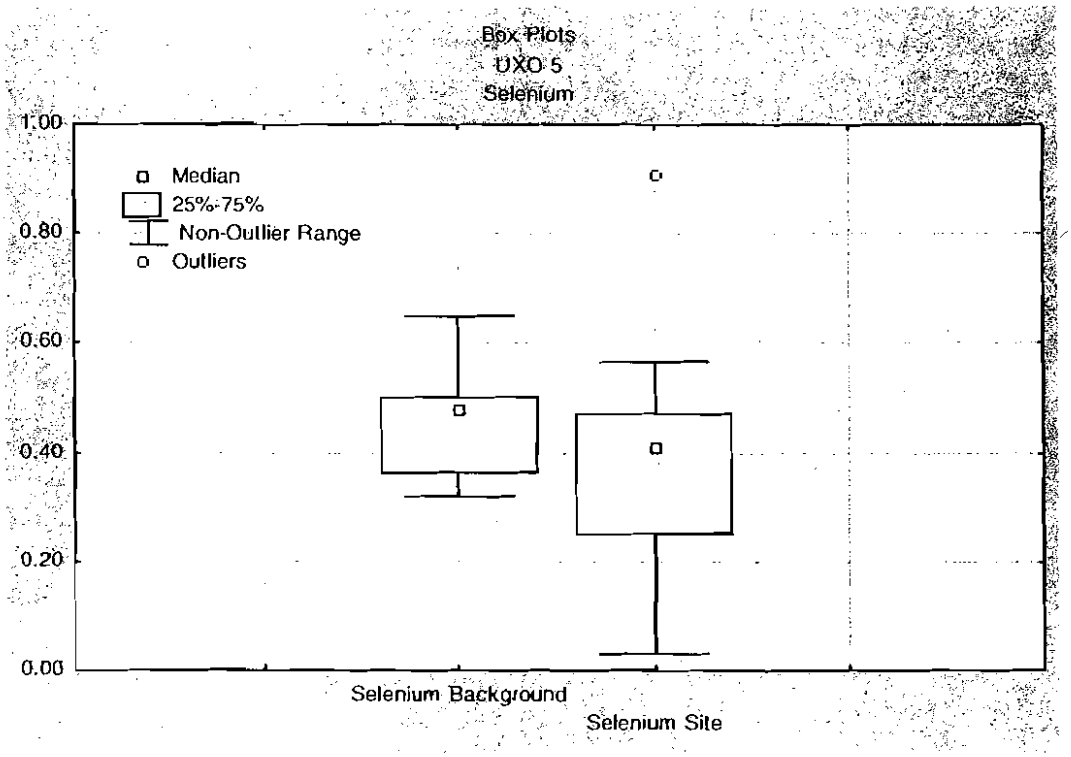


Figure D.12-1

Figure D.12-2 contains the 95% Confidence Intervals for the site and background Selenium concentrations. From this figure it can be seen that the mean background concentration is greater than the mean site concentration.

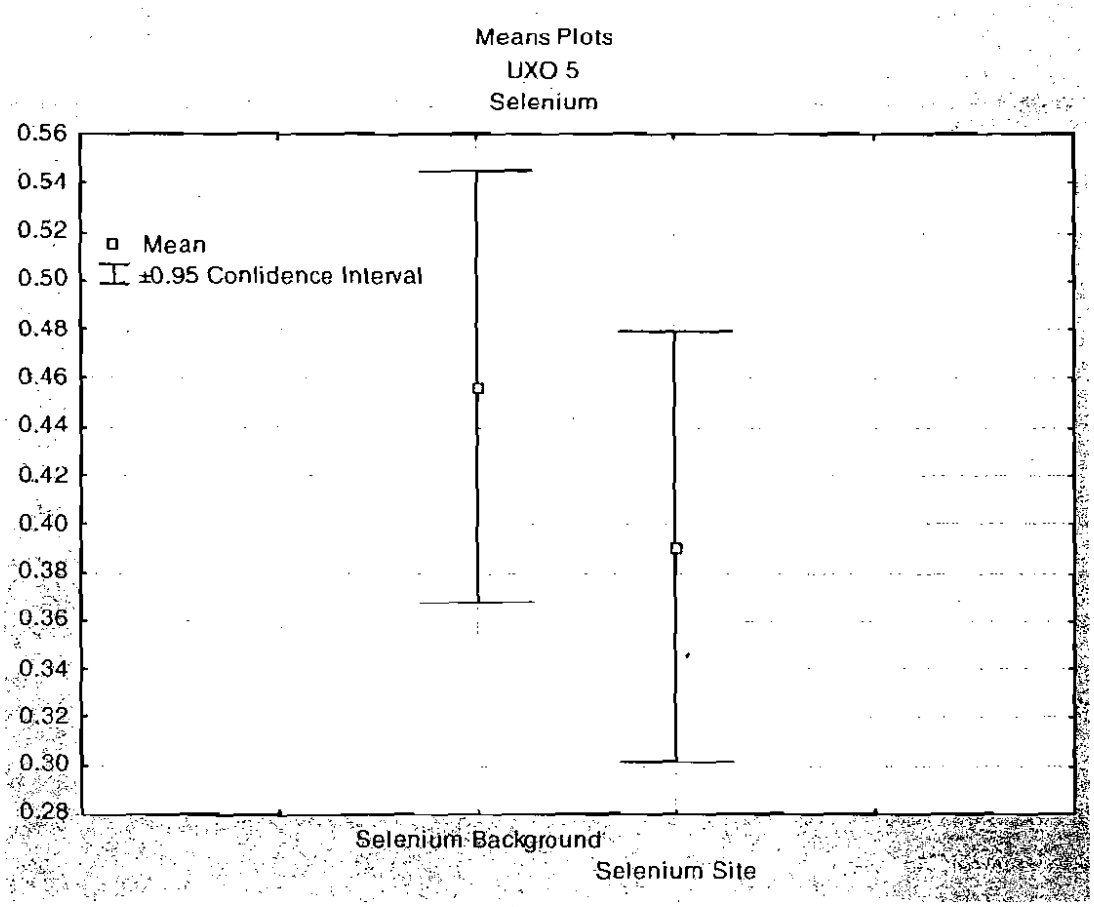


Figure D.12-2

Figures D.12-3 and D.12-4 show the normal probability plots and corresponding Shapiro Wilks test for normality. If the data is normal then the data points will roughly follow a linear pattern. The Shapiro Wilks test is a formal Statistical test of normality. The hypothesis being that the data is normally distributed. If the p-value for the test is less than 0.10 then the data is considered to be not normally distributed. From Figure D.12-3 it can be seen that the Site data do not roughly follow the linear pattern and the p-value for the Shapiro Wilk test is 0.08. Thus it can be concluded that the site Selenium concentrations are not normally distributed. From Figure D.12-4 it can be seen that the Background Selenium concentrations roughly follow a linear pattern and the p-value for the Shapiro Wilks test is 0.40. Thus it is concluded that the Selenium background concentrations are normally distributed.

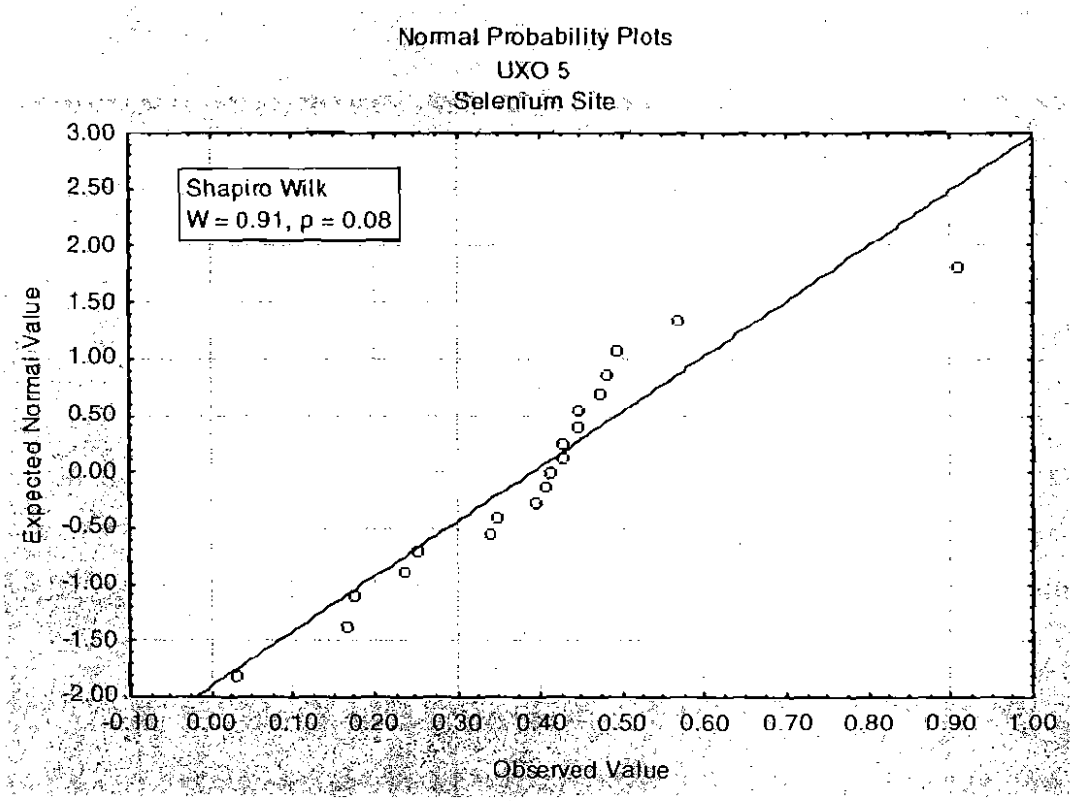


Figure D.12-3

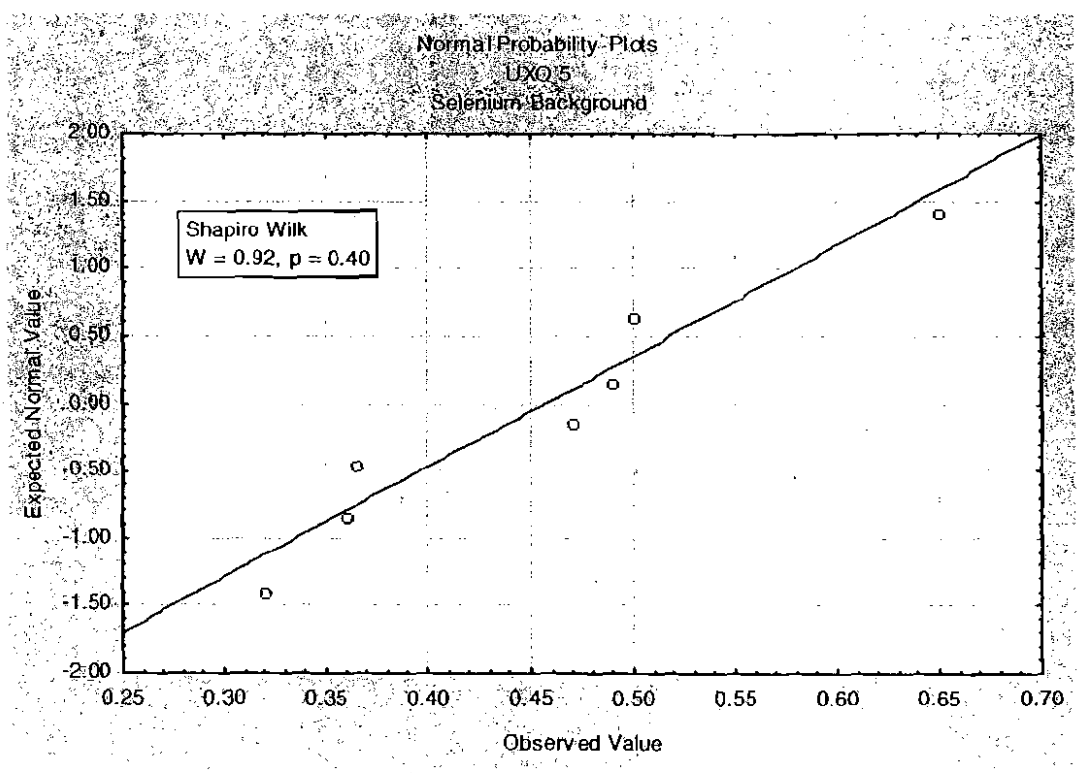


Figure D.12-4

Because the Site concentrations are not normally distributed the Nonparametric Wilcoxon Rank Sum test will be used to see if the median site concentrations for Selenium are

larger than the median background concentrations. The hypothesis is that there is no difference between median values for the site and background Selenium concentrations. The hypothesis will be rejected if the Test Statistic is great than the critical value. Table D.12-2 contains the Test Statistic and the Critical Value for the comparison between the site and background Selenium concentrations. From Table D.12-2 it can be seen that the Test Statistic is smaller than the Critical value. Therefore, we fail to reject the null hypothesis that there is no difference between the site and background Selenium concentrations. This test was conducted with a significance level (alpha) of 0.01.

	Rank Sum
Site	241
Background	137

Test Statistic	Critical Value $_{0.01}$
51	120

Table D.12-2

APPENDIX D.13

THALLIUM

Table D.13-1 contains the Descriptive Statistics for Site and Background Thallium concentrations for UXO 5. From Table D.13-1 it can be seen that the mean for the site Thallium concentration is less than the mean background Thallium concentration. Also the median site Thallium concentration is smaller than the background Thallium concentration.

Variable	Descriptive Statistics UXO 5					
	Valid N	Mean	Median	Minimum	Maximum	Std. Dev.
Thallium Background	8	0.19	0.18	0.15	0.22	0.03
Thallium Site	19	0.13	0.09	0.05	0.26	0.07

Table D.13-1

Figure D.13-1 contains the side by side Box Plots for the site and background Thallium concentrations. From these figures it can be seen that the median site Thallium concentration is smaller than the Thallium background concentration. It can also be seen that the lower quartile of the background is more than the median for the site concentration. The upper quartile of the background concentrations is slightly higher than the upper quartile for the site concentrations.

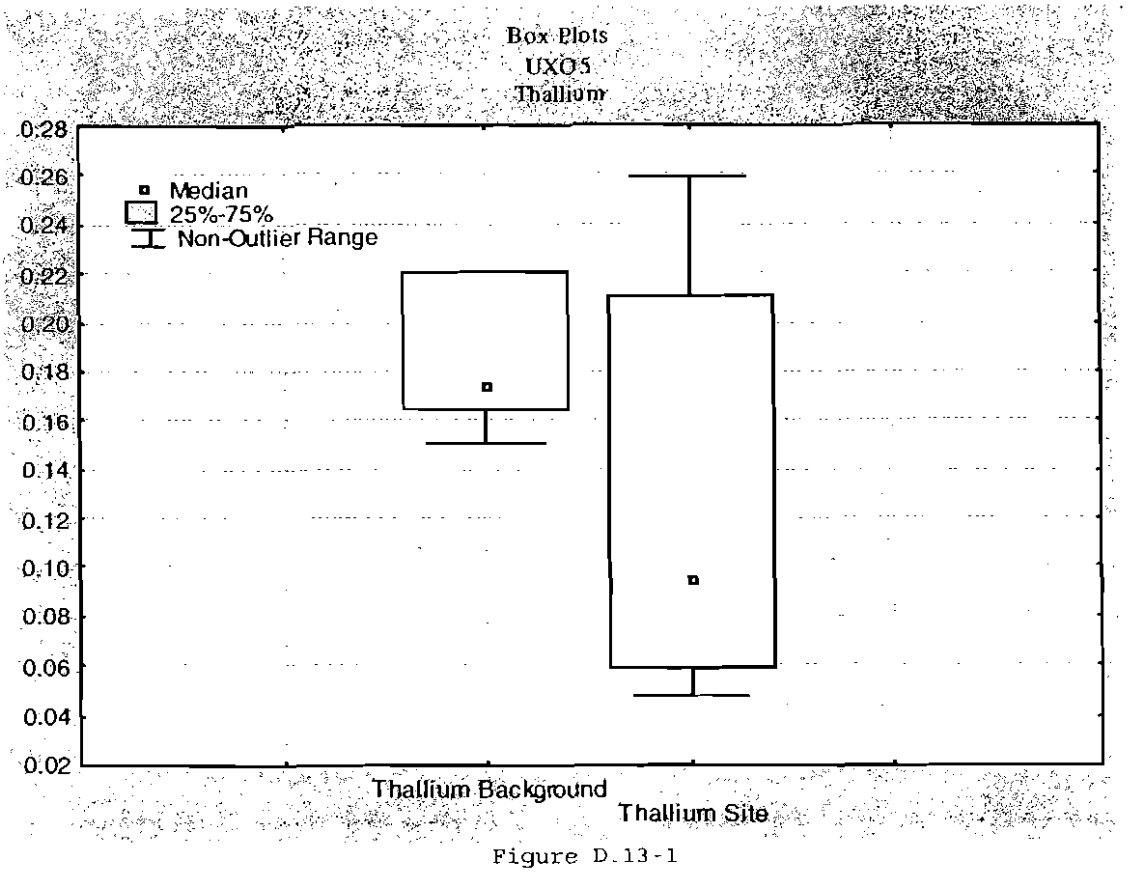


Figure D.13-1

Figure D.13-2 contains the 95% confidence intervals for site and background Thallium concentrations for UXO 5. From this figure it can be seen that the mean of the site is smaller than the background mean. Also, the UCL for the site mean is slightly higher than the background LCL.

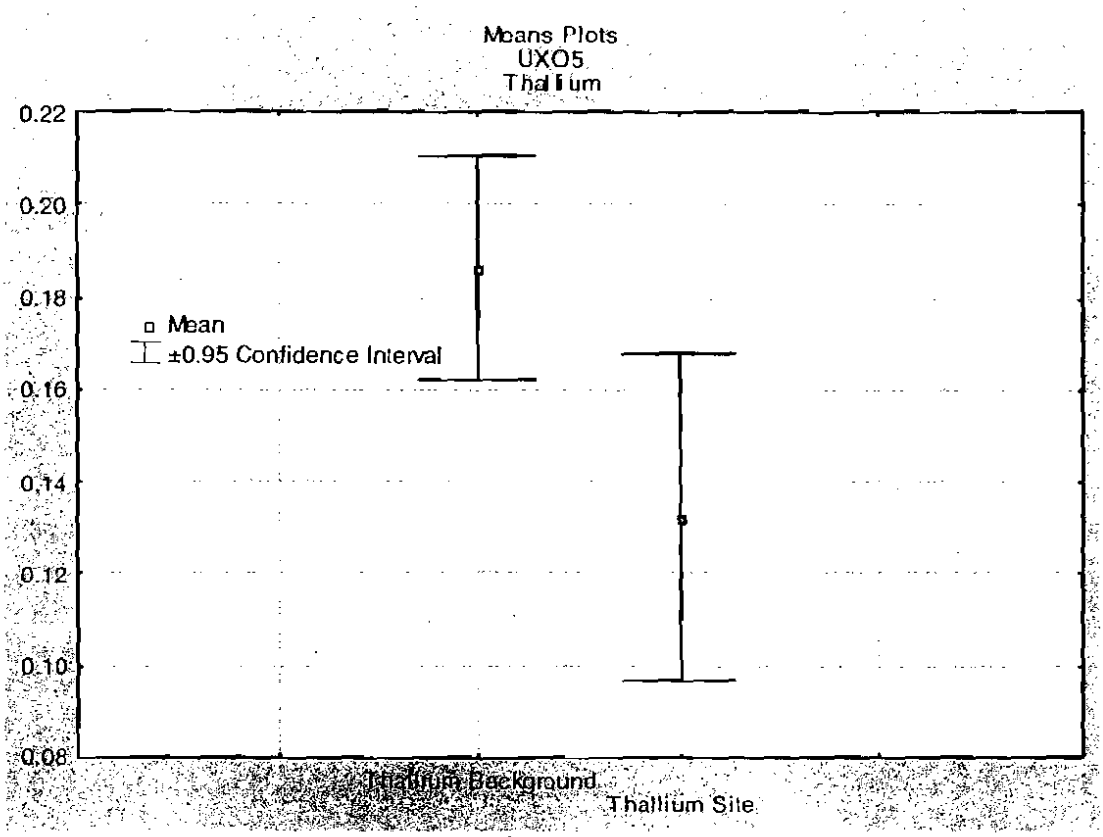


Figure D.13-2

Figures D.13-3 and D.13-4 show the normal probability plots and corresponding Shapiro Wilks test for normality. If the data is normal then the data points will roughly follow a linear pattern. The Shapiro Wilks test is a formal Statistical test of normality. The hypothesis being that the data is normally distributed. If the p-value for the test is less than 0.10 then the data is considered to be not normally distributed. From Figure D.13-3 it can be seen that the site Thallium concentrations do not roughly follow the linear pattern and the p-value for the Shapiro Wilk test is 0.02. Thus it is concluded that the site Thallium concentrations are not normally distributed. From Figure D.13-4 it can be seen that the background Thallium concentrations follow a curvature pattern and the p-value for the Shapiro Wilk Test is 0.06. Therefore, it is concluded that the background Thallium concentrations do not follow a normal distribution.

concentrations for Thallium are larger than the median background concentrations. The hypothesis is that there is no difference between median values for the site Thallium concentrations and background concentrations. The hypothesis of no difference will be rejected if the Test Statistic is greater than the Critical Value. Table D.13-2 contains the Test Statistic and Critical value for this comparison. From Table D.13-2 it can be seen that the Test Statistic is less than the Critical value. Therefore, we cannot reject the null hypothesis that there is no difference between site and background Thallium concentrations. It is concluded that the site Thallium concentrations are not larger than the background concentrations. This test was conducted with a significance level of 0.01 (alpha).

	Rank Sum
Site	207
Background	171

Test Statistic	Critical Value $_{0.01}$
44	120

Table D.13-2

APPENDIX D.14

VANADIUM

Table D.14-1 contains the descriptive Statistics for Vanadium for the Site and Background Concentrations for UXO 5. From Table D.14-1 it can be seen that the Mean and Median concentrations for Background and Site are relatively close with a difference of 0.43 and 0.7 respectively.

Variable	Descriptive Statistics UXO 5					
	Valid N	Mean	Median	Minimum	Maximum	Std Dev.
Vanadium Background	8	23.89	22.70	16.90	37.40	6.20
Vanadium Site	19	24.32	23.40	11.60	38.90	9.30

Table D.14-1

Figure D.14-1 contains the Side by Side Box Plots for Vanadium for UXO 5. From Figure D.14-1 it can be seen that the median values are relatively similar and that the range of the Site Concentrations is larger than that of the Background Concentrations. This difference in ranges is expected due to the larger sampling size of the Site Concentrations.

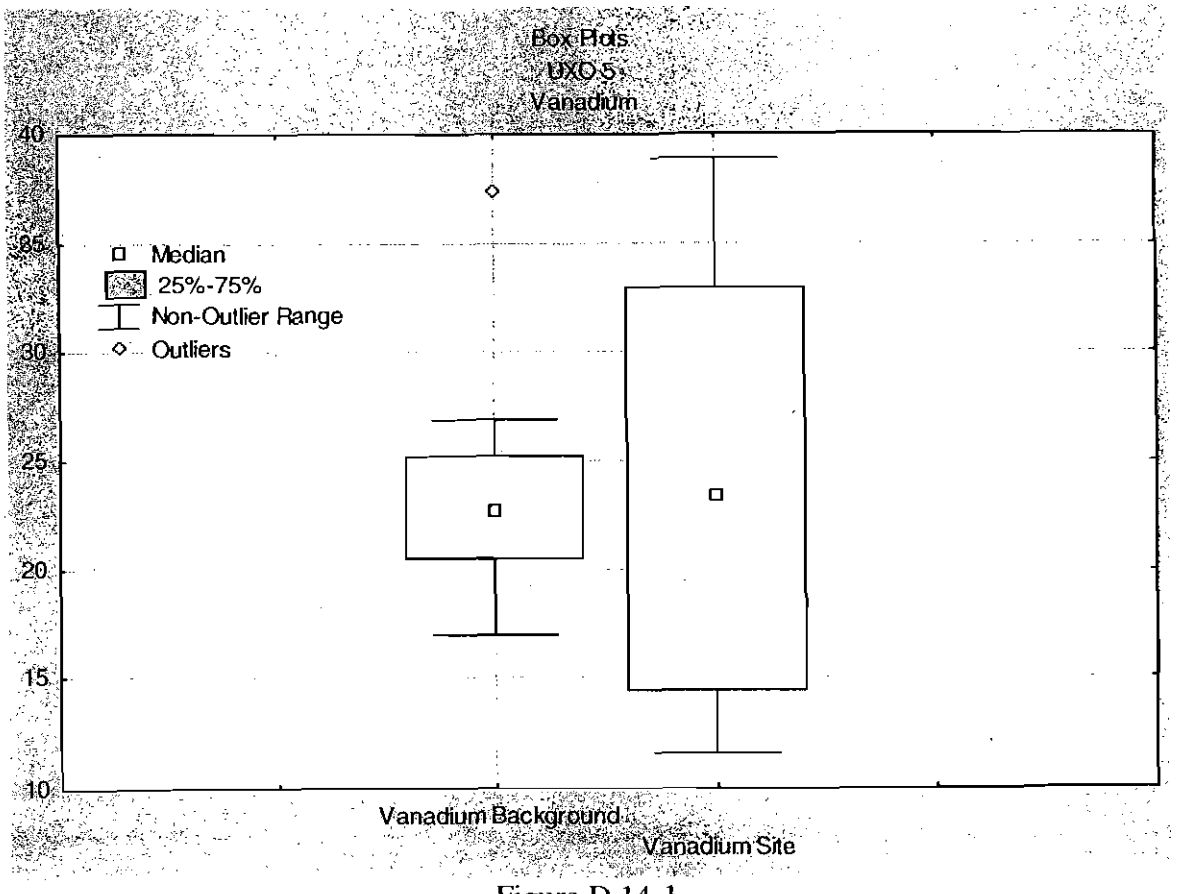


Figure D.14-1

Figure D.14-2 contains side by side Confidence Intervals for the Vanadium Concentrations. It can be seen that the site UCL is slightly smaller than the Background UCL. Also it can be seen that the mean concentration for the Site Concentrations is slightly higher than the Background Concentrations.

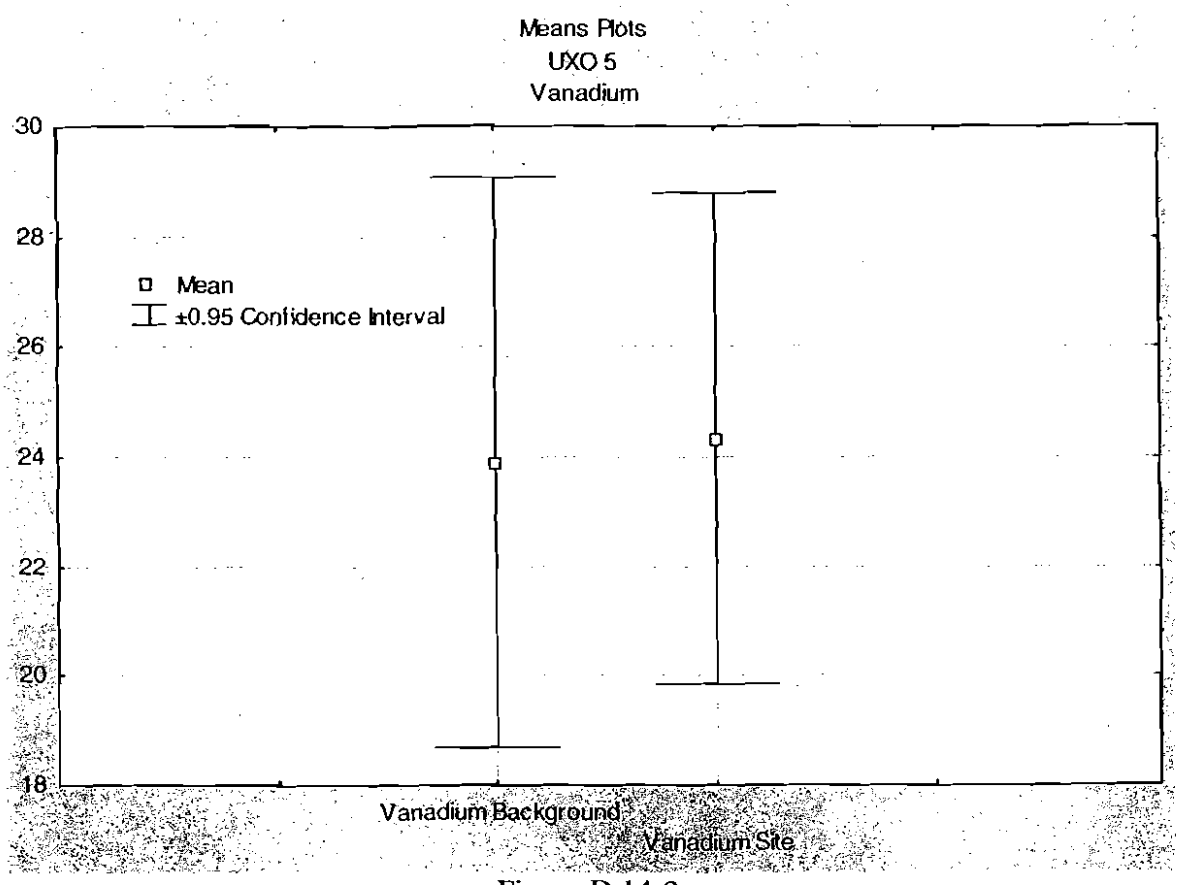


Figure D.14-2

Figures D.14-3 and D.14-4 show the normal probability plots and corresponding Shapiro Wilks test for normality. If the data is normal then the data points will roughly follow a linear pattern. The Shapiro Wilk test is a formal statistical test of normality. The hypothesis being that the data is normally distributed. If the p-value for the test is less than .10 then the data is considered to be not normally distributed. From Figure D.14-3 it can be seen that the data do roughly follow the linear line on the probability plot and that the p-value for the Shapiro Wilk test is 0.12. Therefore the Site Vanadium concentrations are normally distributed. From Figure D.14-4 it can be seen that the data deviate from the linear line and the p-value for the Shapiro Wilk Test is 0.10. Therefore the Background Vanadium Concentrations are considered not normally distributed.

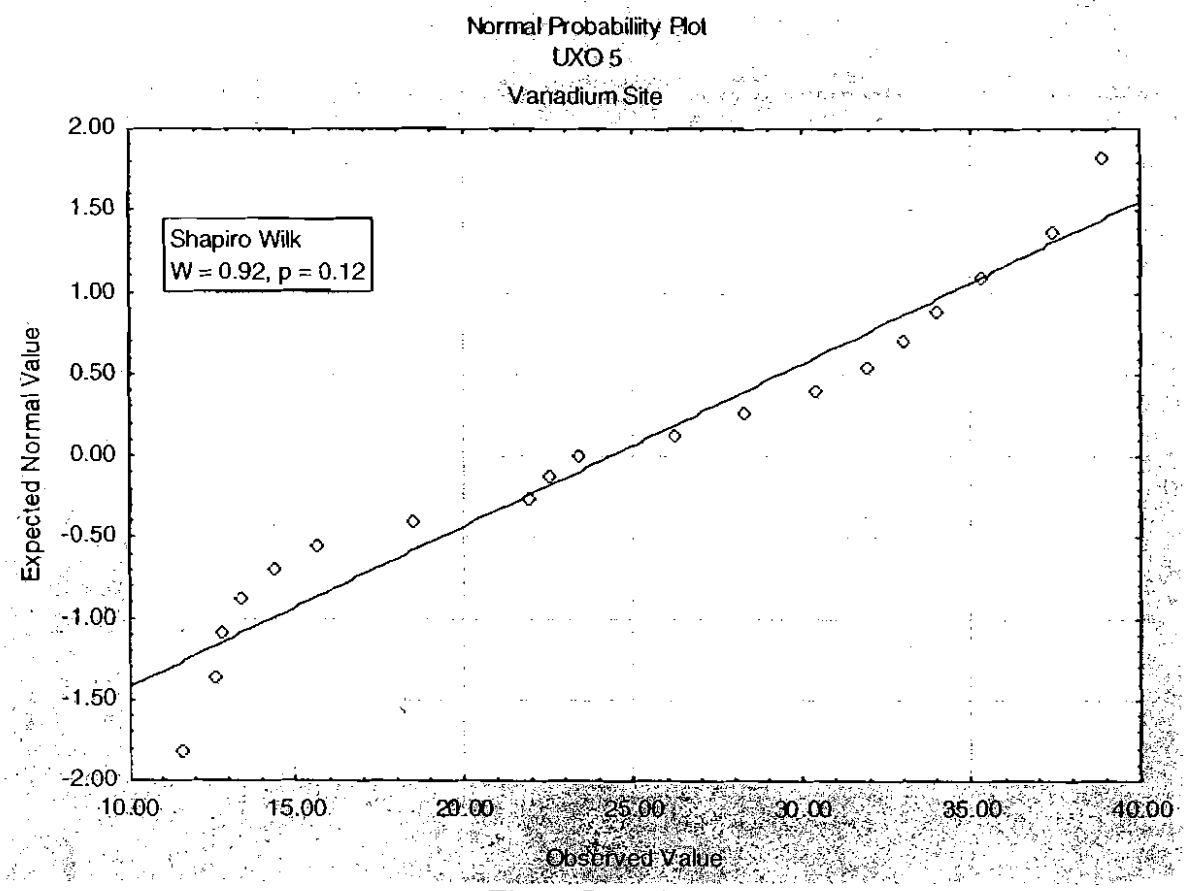

Normal Probability Plot
UXO 5
Vanadium Site
Shapiro Wilk
W = 0.92, p = 0.12
Expected Normal Value
Observed Value
2.00
1.50
1.00
0.50
0.00
-0.50
-1.00
-1.50
-2.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00

Figure D.14-3

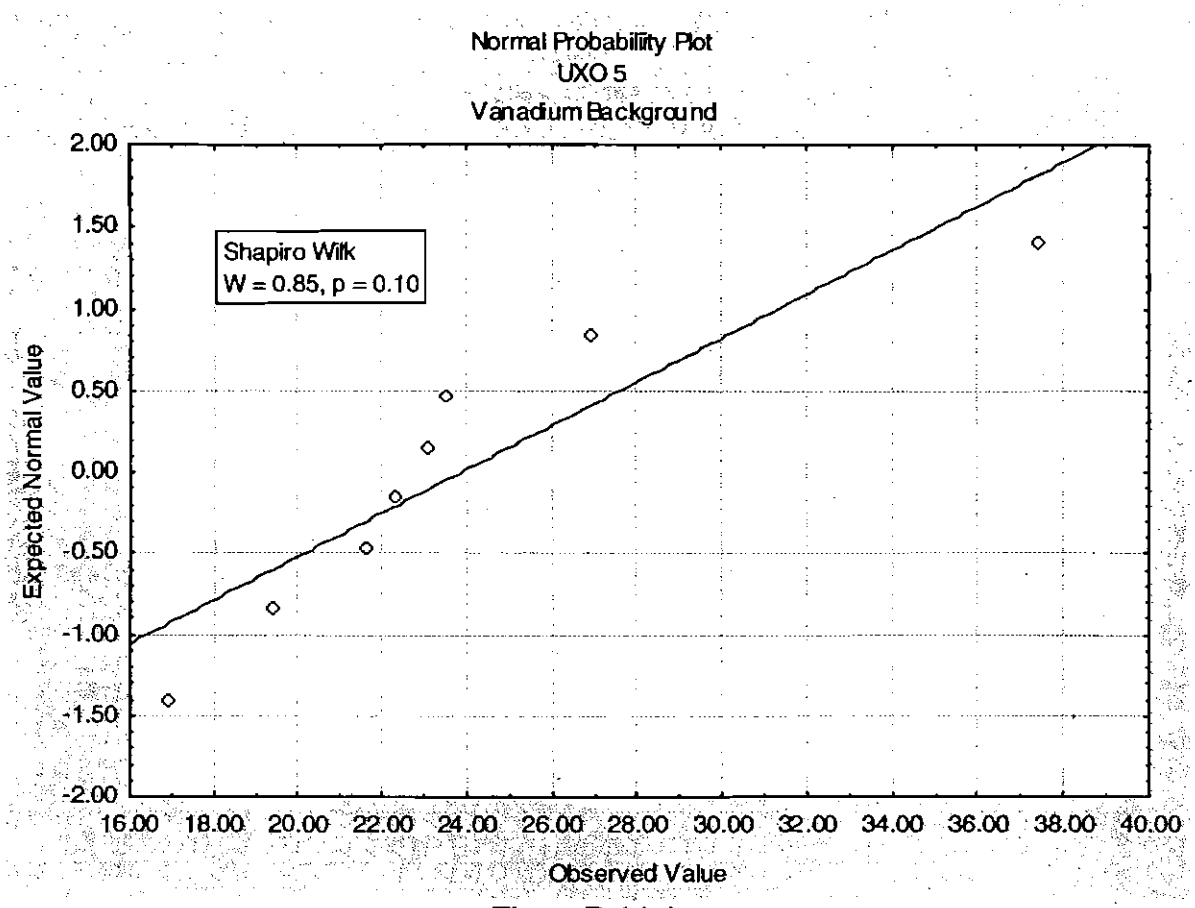


Figure D.14-4

Since the Background Concentrations are not normally distributed the Nonparameteric Wilcoxon Rank Sum test will be used to see if the median Site Concentrations for Vanadium are larger than the median background Concentrations. The hypothesis is that there is no difference between median values for the Site Vanadium Concentrations and the Background Vanadium Concentrations. Table D.14-2 contains the rank sums for the Site and Background Vanadium Concentrations and the corresponding Test Statistic and Critical Value. The Hypothesis that there is no difference between median Vanadium Concentration is rejected if the Test Statistic is greater than the Critical value. From Table D.14-2 it can be seen that the Test Statistic is not greater than the Critical Value so it is concluded that the Site Vanadium Concentrations are not greater than the Background Vanadium Concentrations. This test was conducted with a significance level (alpha) of 0.01.

	Rank Sum
Site	266.5
Background	111.5

Test Statistic	Critical Value $_{0.01}$
76.5	120

Table D.14-2

APPENDIX D.15

ZINC

Table D.15-1 contains the Descriptive Statistics for the site and background Zinc concentrations for UXO 5. From Table D.15-1 it can be seen that the mean and median site concentration are greater than the mean and median background concentration.

Variable	Descriptive Statistics UXO 5					
	Valid N	Mean	Median	Minimum	Maximum	Std. Dev.
Zinc Background	8	35.96	36.15	15.10	60.20	12.60
Zinc Site	19	523.19	59.30	31.00	8750.00	1992.40

Table D.15-1

Figures D.15-1 and D.15-2 contain the side by side Box Plots for the site and background Zinc concentrations. From these plots it can be seen that the site median concentrations is slightly higher than the background concentrations. Also it becomes apparent that there is an extreme value for the site concentrations.

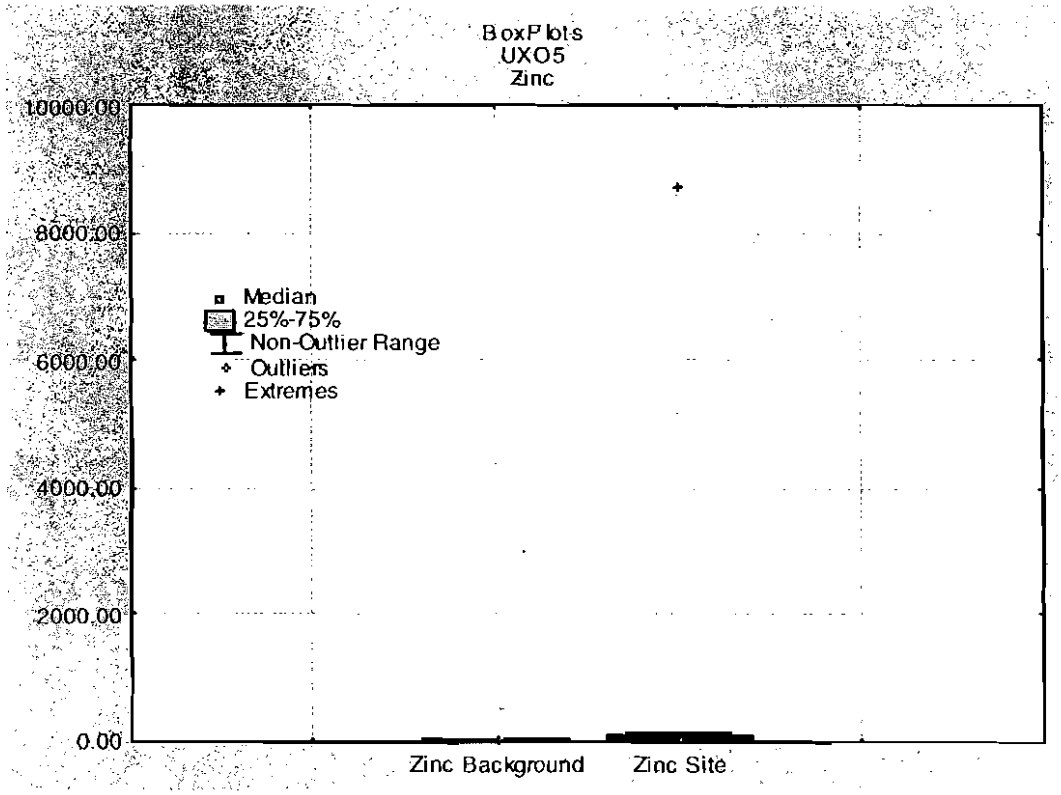


Figure D.15-1

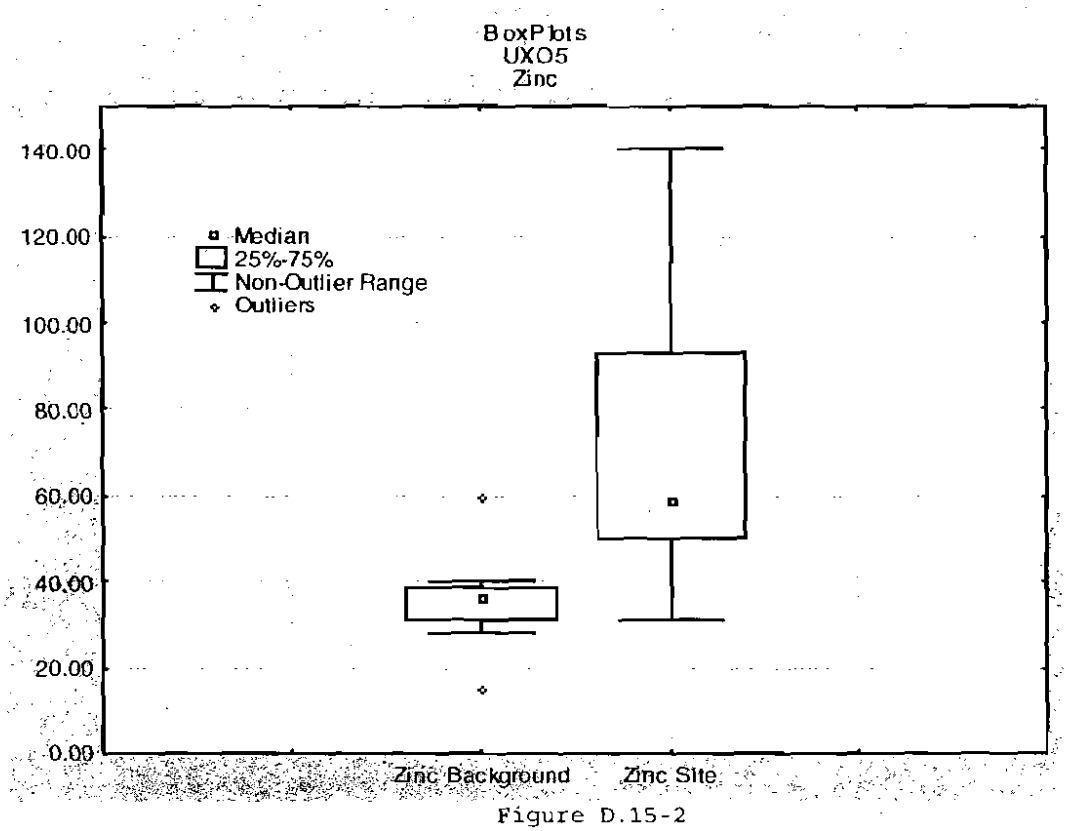


Figure D.15-2

Figure D.15-3 contains the 95% Confidence Intervals for the Site and Background Zinc concentrations. From this figure it can be seen that the mean site concentration is greater than the mean background concentration. Also the UCL for the Background concentrations is less than the mean site concentration.

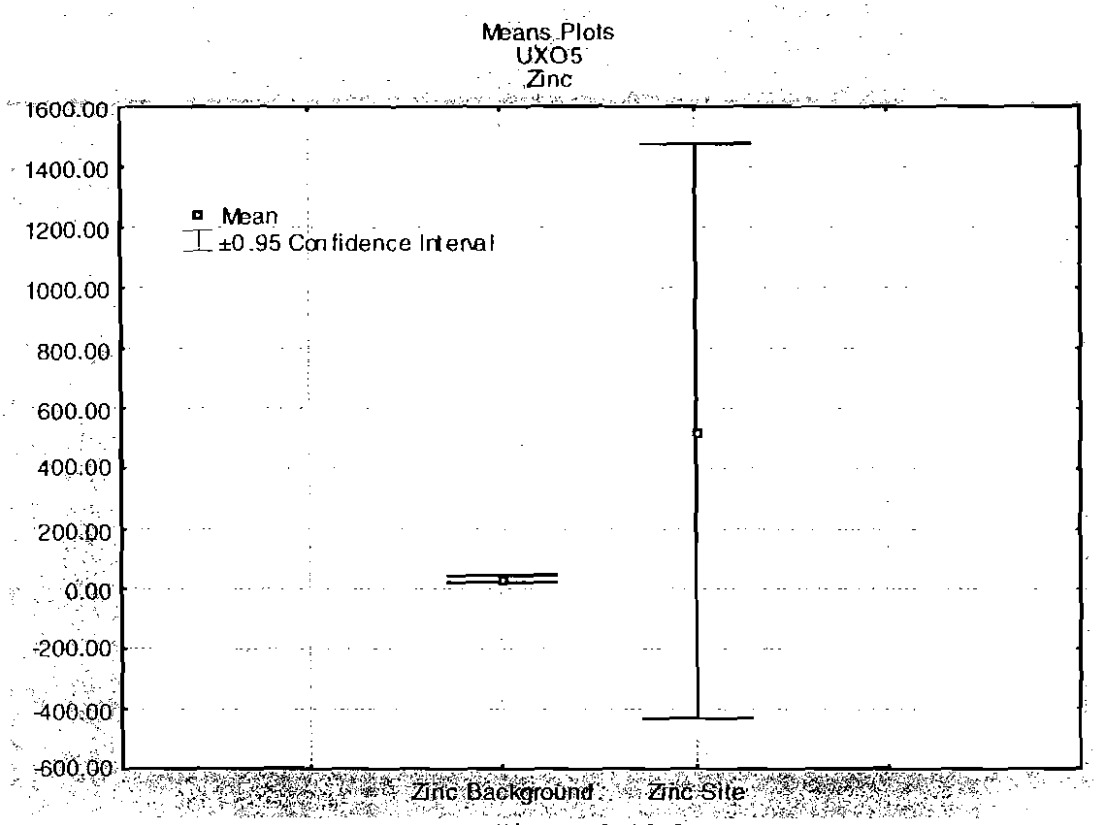


Figure D.15-3

Figures D.15-4 and D.15-5 show the normal probability plots and corresponding Shapiro Wilks test for normality. If the data is normal then the data points will roughly follow a linear pattern. The Shapiro Wilk test is a formal Statistical test of normality. The hypothesis being that the data is normally distributed. If the p-value for the test is less than 0.10 then the data is considered to be not normally distributed. From Figure D.15-4 it can be seen that the background data do not depart from the linear pattern and the p-value for the Shapiro Wilk test is 0.36. Thus it is concluded that the background data is normally distributed. From Figure D.15-5 it can be seen that the site data does not follow a linear pattern and the Shapiro Wilk p-value is 0.00. Thus the site data is not normally distributed.

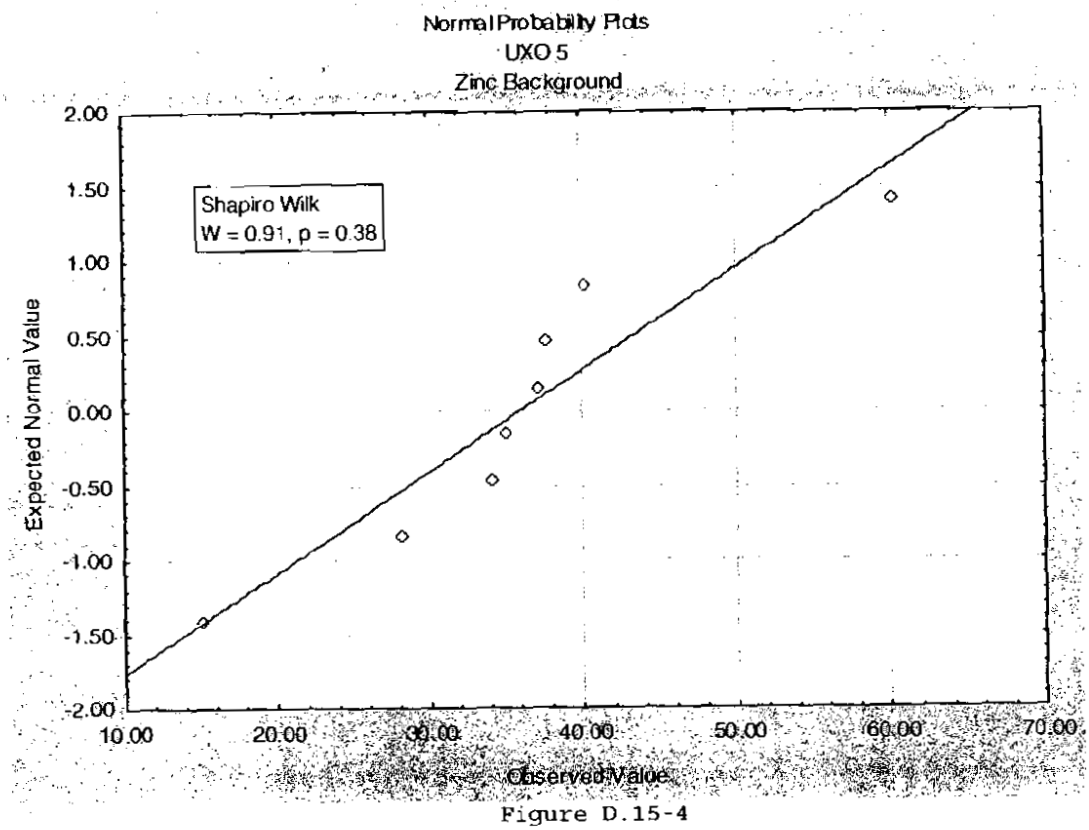


Figure D.15-4

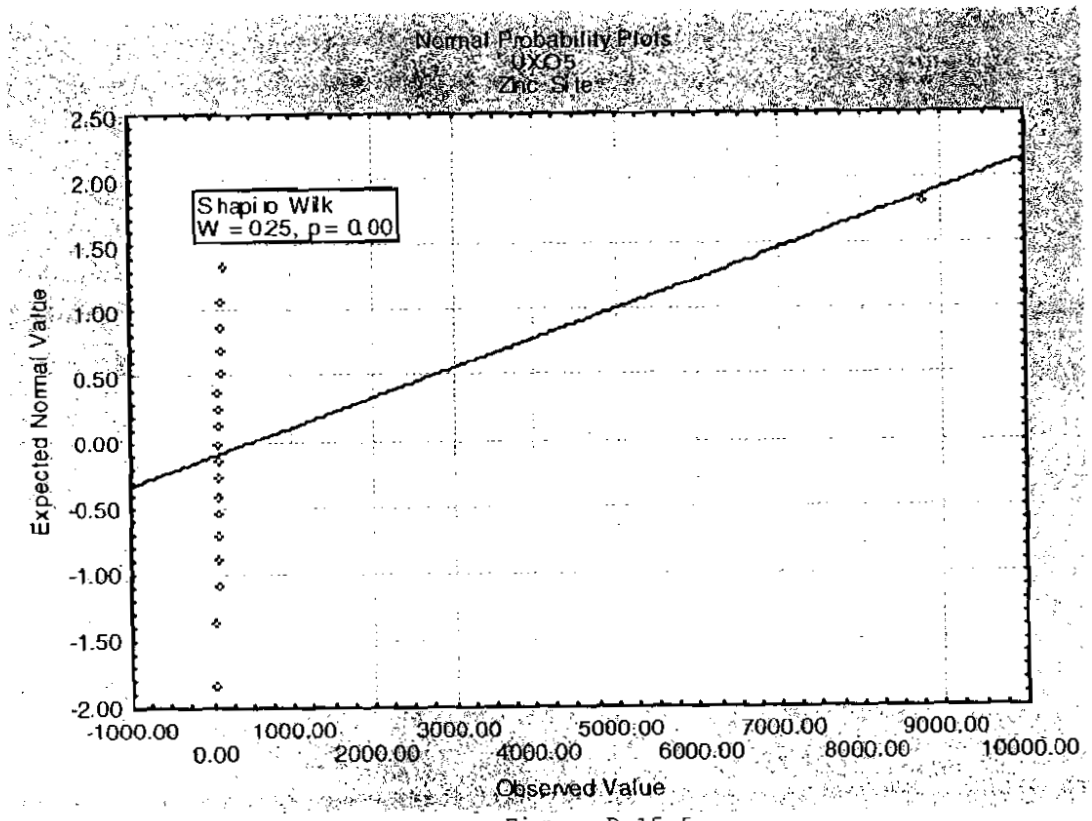


Figure D.15-5

Because the Site concentrations are not normally distributed the Nonparametric Wilcoxon Rank Sum test will be used to see if the median concentrations for Zinc are larger than the median background concentrations. The hypothesis is that there is no difference between median values for the site and background data. If the Test Statistic is greater than the Critical Value then this hypothesis is rejected and it is concluded that the site concentrations are greater than the background concentrations. Table D.15-2 contains the Test Statistic and Critical Value for the Zinc comparison. From Table D.15-2 it can be seen that the Test Statistic is greater than the critical value. Thus it is concluded that the Site Zinc Concentrations are greater than the Background Zinc Concentrations. This test was conducted with a significance level (alpha) of 0.01.

	Rank Sum
Site	321
Background	57

Test Statistic	Critical Value $_{0.01}$
131	120

Table D.15-2

APPENDIX E

ECOLOGICAL RISK SUPPORTING DOCUMENTATION

APPENDIX E

FOOD-CHAIN MODELING EQUATIONS AND METHODOLOGY
UXO 5 - BUILDING 2044 DROP TOWER AND TEST RAIL SITE
NSWC CRANE, CRANE, INDIANA

COPC intake for wildlife exposed to the COPCs in surface soil and sediment was estimated as daily dose (mg/kg-day) using exposure equations. The contaminant concentrations in surface soil and sediment were used to calculate CDI doses. The following equations present the CDI equations that were used in calculating a total daily dose for the surrogate species selected for modeling:

The following equation will be used to calculate the CDI for wildlife receptors:

$$CDI = \frac{[(Cf * If) + (Cs * Is) + (Cw * Iw)] * H}{BW}$$

Where:

CDI	=	Chronic daily intake (mg/kg-day)
Cf	=	Chemical concentration in food – (see discussion below)
Cs	=	Chemical concentration in surface soil (mg/kg) or sediment (mg/kg)
Cw	=	Chemical concentration in surface water (mg/L)
If	=	Food ingestion rate (kg/day)
Is	=	Incidental surface soil or sediment ingestion rate (kg/day)
Iw	=	Water ingestion rate (L/day)
H	=	Portion of food intake from the contaminated area (unitless)
BW	=	Body weight (kg)

Chemical concentrations in food items for soil invertivorous and herbivorous receptors will be calculated using soil-to-invertebrate or soil-to-plant bioaccumulation factors (BAFs) and regression equations from the USEPA Eco SSL Guidance Document (USEPA, 2007) or other published sources. The sources of the BAFs are documented elsewhere in this Appendix. The following equation will be used to calculate the chemical concentration in plants or invertebrates when BAFs are used:

$$Cf = Cs * BAF$$

Where:

Cf	=	Contaminant concentration in food (mg/kg)

Cs	=	Contaminant concentration in surface soil (mg/kg)
BAF	=	Biota-soil bioaccumulation factor (unitless)

Chemical concentrations in food items for piscivorous receptors will be calculated using sediment-to-fish BSAFs. The sources of the BSAFs are documented elsewhere in this Appendix. Contaminant concentrations in food items for piscivorous mammals and birds will be calculated as follows:

$$Cf \text{ (for metals)} = Csd * BSAF$$

Where:

Cf	=	Contaminant concentration in food (mg/kg)
Csd	=	Contaminant concentration in sediment (mg/kg)
BSAF	=	Biota-sediment bioaccumulation factor (unitless)

$$Cf \text{ (for organics)} = Csd * \left(BSAF * \frac{\%L}{\%TOC} \right)$$

Where:

Cf	=	Contaminant concentration in food (mg/kg)
Csd	=	Contaminant concentration in sediment (mg/kg)
BSAF	=	Biota-sediment bioaccumulation factor (for organics) (unitless)
%L	=	Percent lipids [14.4% (dry weight) for invertebrates]
%TOC	=	Percent total organic carbon (TOC) (average TOC for the site)

The exposure assumptions (e.g., ingestion rates and body weight) were obtained from the Wildlife Exposure Factors Handbook (EPA, 1993) or other literature sources, as necessary. The exposure parameters from EPA (1993) are wet weight values; however, the BAFs estimate the tissue concentrations in dry weight. Therefore, the exposure parameters from EPA (1993) were converted to dry weight values for the food chain model calculations. The exposure parameters that were used in this ERA, the values that were used to calculate the exposure parameters, and a discussion of how they were calculated are presented elsewhere in this Appendix.

An ecological effects quotient (EEQ) approach was used to characterize the risk to terrestrial receptors. This approach characterizes the potential effects by comparing the exposure concentration with the effects data. An EEQ of greater than 1.0 is considered indicative of a potential risk. The EEQ is not an expression of probability, and the meaning of values greater than 1.0 must be interpreted in light of uncertainties in risk management.

The EEQ for the terrestrial wildlife model was calculated as follows:

$$EEQ = \frac{\text{Total CDI}}{\text{TRV}}$$

Where:	EEQ	= Ecological effects quotient (unitless)
	Total CDI	= Total daily intake dose (mg/kg-day)
	TRV	= Toxicity reference value (NOAEL or LOAEL) (mg/kg-day)

APPENDIX E

CHEMICAL CONCENTRATIONS IN SURFACE SOIL AND TISSUE FOR FOOD-CHAIN MODEL CALCULATIONS
UXO 5 - BUILDING 2044 DROP TOWER TEST RAIL SITE
NSWC CRANE, CRANE, INDIANA

Chemical	Surface Soil Concentrations (mg/kg)				Surface Water Concentrations (mg/L)		Earthworm Bioaccumulation Factors		Earthworm Concentrations (mg/kg)		Plant Bioaccumulation Factors		Plant Concentrations (mg/kg)	
	Maximum Detection	Average All	Average of Positive Detections	Average [1]	Maximum Detection	Average Concentration[1]	Conservative	Average	Maximum Detection	Average	Conservative	Average	Maximum Detection	Averag
Explosives														
2,4-DINITROTOLUENE	1.50E+00	1.32E-01	1.20E+00	1.32E-01	0.00E+00	0.00E+00	1.00E+00	1.00E+00	1.50E+00	1.32E-01	2.60E+00	2.60E+00	3.90E+00	3.44E-0
Inorganics														
ANTIMONY	2.10E+00	5.89E-01	1.44E+00	5.89E-01	0.00E+00	0.00E+00	1.00E+00	1.00E+00	2.10E+00	5.89E-01	1.14E-02	1.02E-02	2.39E-02	6.00E-0
BARIUM	1.17E+03	1.38E+02	1.38E+02	1.38E+02	0.00E+00	0.00E+00	Regression or BAF from Eco SSL		1.06E+02	1.25E+01	Regression or BAF from Eco SSL		1.83E+02	2.15E+0
CADMIUM	3.84E+01	4.12E+00	4.12E+00	4.12E+00	0.00E+00	0.00E+00	Regression or BAF from Eco SSL		1.51E+02	2.55E+01	Regression or BAF from Eco SSL		4.56E+00	1.35E+0
CHROMIUM	8.56E+01	2.13E+01	2.13E+01	2.13E+01	0.00E+00	0.00E+00	Regression or BAF from Eco SSL		2.62E+01	6.53E+00	Regression or BAF from Eco SSL		3.51E+00	8.75E-0
COBALT	1.88E+01	7.90E+00	7.90E+00	7.90E+00	0.00E+00	0.00E+00	Regression or BAF from Eco SSL		2.03E+00	9.64E-01	Regression or BAF from Eco SSL		1.25E-01	5.93E-0
COPPER	1.56E+02	2.12E+01	2.12E+01	2.12E+01	0.00E+00	0.00E+00	Regression or BAF from Eco SSL		8.03E+01	1.09E+01	Regression or BAF from Eco SSL		1.43E+01	6.49E+0
LEAD	5.97E+02	4.62E+01	4.62E+01	4.62E+01	0.00E+00	0.00E+00	Regression or BAF from Eco SSL		1.40E+02	1.77E+01	Regression or BAF from Eco SSL		9.56E+00	2.27E+0
MANGANESE	1.12E+03	4.27E+02	4.27E+02	4.27E+02	0.00E+00	0.00E+00	Regression or BAF from Eco SSL		5.35E+01	2.77E+01	Regression or BAF from Eco SSL		8.85E+01	3.37E+0
SELENIUM	9.09E-01	3.91E-01	4.12E-01	3.91E-01	0.00E+00	0.00E+00	Regression or BAF from Eco SSL		4.30E+00	4.15E-01	Regression or BAF from Eco SSL		1.01E-01	5.37E-0
THALLIUM	2.59E-01	1.33E-01	1.33E-01	1.33E-01	0.00E+00	0.00E+00	Regression or BAF from Eco SSL		1.23E+00	1.41E-01	1.00E+00	1.00E+00	3.94E-02	2.40E-0
VANADIUM	3.89E+01	2.43E+01	2.43E+01	2.43E+01	0.00E+00	0.00E+00	Regression or BAF from Eco SSL		1.63E+00	1.02E+00	Regression or BAF from Eco SSL		1.89E-01	1.18E-0
ZINC	8.75E+03	5.23E+02	5.23E+02	5.23E+02	0.00E+00	0.00E+00	Regression or BAF from Eco SSL		1.68E+03	6.67E+02	Regression or BAF from Eco SSL		7.38E+02	1.55E+0

1 - If the average of all value is the greater than the maximum detection, the average of the positive detections was used as the average value.

BOBWH[illegible]L - AVERAGE INPUTS
TERRESTRIAL WILDLIFE MODEL ECOLOGICAL EFFECTS QUOTIENT CALCULATION
UXO 5 - BUILDING 2044 DROP TOWER AND TEST RAIL SITE
NSWC CRANE, INDIANA

Parameter	Avg Soil Concentration (mg/kg)	Vegetation Concentration (mg/kg)	Dose (mg/kg/day) from: Surface Soil	Vegetation	Total Dose (mg/kg/day)	NOAEL (mg/kg/day)	LOAEL (mg/kg/day)	NOAEL EEQ	LOAEL EEQ
Explosives									
2,4-DINITROTOLUENE	1.32E-01	3.44E-01	9.836E-05	4.192E-03	4.29E-03	NV	NV	NV	NV
Inorganics									
ANTIMONY	5.89E-01	6.00E-03	4.382E-04	7.328E-05	5.11E-04	NV	NV	NV	NV
BARIUM	1.38E+02	2.15E+01	1.026E-01	2.624E-01	3.65E-01	NV	NV	NV	NV
CADMIUM	4.12E+00	1.35E+00	3.070E-03	1.645E-02	1.95E-02	1.47E+00	6.35E+00	1.33E-02	3.07E-03
CHROMIUM	2.13E+01	8.75E-01	1.588E-02	1.067E-02	2.66E-02	2.66E+00	1.56E+01	9.99E-03	1.70E-03
COBALT	7.90E+00	5.93E-02	5.881E-03	7.231E-04	6.60E-03	7.61E+00	1.83E+01	8.68E-04	3.60E-04
COPPER	2.12E+01	6.49E+00	1.576E-02	7.923E-02	9.50E-02	4.05E+00	3.49E+01	2.35E-02	2.72E-03
LEAD	4.62E+01	2.27E+00	3.436E-02	2.776E-02	6.21E-02	1.63E+00	4.46E+01	3.81E-02	1.39E-03
MANGANESE	4.27E+02	3.37E+01	3.178E-01	4.116E-01	7.29E-01	1.79E+02	3.77E+02	4.07E-03	1.93E-03
SELENIUM	3.91E-01	5.37E-02	2.914E-04	6.552E-04	9.47E-04	2.90E-01	8.20E-01	3.26E-03	1.15E-03
THALLIUM	1.33E-01	2.40E-02	9.927E-05	2.928E-04	3.92E-04	NV	NV	NV	NV
VANADIUM	2.43E+01	1.18E-01	1.810E-02	1.439E-03	1.95E-02	3.44E-01	1.70E+00	5.68E-02	1.15E-02
ZINC	5.23E+02	1.55E+02	3.896E-01	1.891E+00	2.28E+00	6.61E+01	1.71E+02	3.45E-02	1.33E-02

Cells are shaded if the EEQ is greater than 1.0.
Data from Mine Fill A Proper samples were used for surface soil concentrations.
Data from Gully samples were used for surface water concentrations.
Energetics, cadmium, mercury, selenium, and silver were COPCs in surface water only.
A biotransfer factor of 1.0 was used for the energetics where a biotransfer factor was not available.

Body Weight = (BW)	1.770E-01
Food Ingestion Rate = (If)	2.160E-03
Water Ingestion Rate = (Iw)	1.840E-02
Soil Ingestion Rate = (Is)	1.318E-04
Home Range = (HR)	2.860E+01
Contaminated Area = (CA)	Assume equal to home range

H=HR/CA (Assume = to 1 for maximum exposure)

Dose (surface soil) = (Cs * Is)(H)/BW
Dose (surface water) = (Cw * Iw)(H)/BW
Dose (vegetation) = (Cv * If)(H)/BW
Total Dose = Dose (surface soil) + Dose (surface water) + Dose (vegetation)

Definitions:
EEQ - Ecological Effects Quotient
NOAEL - No Observed Adverse Effects Level
LOAEL - Lowest Observed Adverse Effects Level
Cs = Contaminant concentration in soil
Cw = Contaminant concentration in water
Cv = Contaminant conc. in vegetation (=soil conc. * Biotransfer Factor)
NV = No Value is available

SHORT-TAILED SHREW - AVERAGE INPUTS
TERRESTRIAL WILDLIFE MODEL ECOLOGICAL EFFECTS QUOTIENT CALCULATION
UXO 5 - BUILDING 2044 DROP TOWER AND TEST RAIL SITE
NSWC CRANE, INDIANA

Parameter	Avg Soil Concentration (mg/kg)	Invertebrate Concentration (mg/kg)	Dose (mg/kg/day) from: Surface Soil	Dose (mg/kg/day) from: Inverts.	Total Dose (mg/kg/day)	NOAEL (mg/kg/day)	LOAEL (mg/kg/day)	NOAEL EEQ	LOAEL EEQ
Explosives									
2,4-DINITROTOLUENE	1.32E-01	1.32E-01	1.16E-04	1.29E-02	1.30E-02	2.00E-01	1.50E+00	6.51E-02	8.68E-03
Inorganics									
ANTIMONY	5.89E-01	5.89E-01	5.18E-04	5.75E-02	5.80E-02	5.90E-02	2.76E+00	9.83E-01	2.10E-02
BARIUM	1.38E+02	1.25E+01	1.21E-01	1.23E+00	1.35E+00	5.18E+01	8.27E+01	2.60E-02	1.63E-02
CADMIUM	4.12E+00	2.55E+01	3.63E-03	2.50E+00	2.50E+00	7.70E-01	6.90E+00	3.25E+00	3.62E-01
CHROMIUM	2.13E+01	6.53E+00	1.88E-02	6.38E-01	6.56E-01	2.40E+00	5.82E+01	2.73E-01	1.13E-02
COBALT	7.90E+00	9.64E-01	6.95E-03	9.42E-02	1.01E-01	7.33E+00	1.89E+01	1.38E-02	5.35E-03
COPPER	2.12E+01	1.09E+01	1.86E-02	1.06E+00	1.08E+00	5.60E+00	8.27E+01	1.93E-01	1.31E-02
LEAD	4.62E+01	1.77E+01	4.06E-02	1.73E+00	1.77E+00	4.70E+00	1.86E+02	3.77E-01	9.50E-03
MANGANESE	4.27E+02	2.77E+01	3.75E-01	2.71E+00	3.08E+00	5.15E+01	1.46E+02	5.98E-02	2.11E-02
SELENIUM	3.91E-01	4.15E-01	3.44E-04	4.05E-02	4.08E-02	1.43E-01	6.60E-01	2.86E-01	6.19E-02
THALLIUM	1.33E-01	1.41E-01	1.17E-04	1.38E-02	1.39E-02	7.40E-03	7.40E-02	1.88E+00	1.88E-01
VANADIUM	2.43E+01	1.02E+00	2.14E-02	9.98E-02	1.21E-01	4.16E+00	9.44E+00	2.91E-02	1.28E-02
ZINC	5.23E+02	6.67E+02	4.60E-01	6.51E+01	6.56E+01	7.54E+01	2.98E+02	8.70E-01	2.20E-01

Cells are shaded if the EEQ is greater than 1.0.
Data from Mine Fill A Proper samples were used for surface soil concentrations.
Data from Gully samples were used for surface water concentrations.
Energetics, cadmium, mercury, selenium, and silver were COPCs in surface water only.
A biotransfer factor of 1.0 was used for the energetics where a biotransfer factor was not available.

Body Weight = (BW)	1.687E-02
Food Ingestion Rate = (If)	1.648E-03
Water Ingestion Rate = (Iw)	3.800E-03
Soil Ingestion Rate = (Is)	1.483E-05
Home Range = (HR)	9.700E-01
Contaminated Area = (CA)	Assume equal to home range

H=HR/CA (Assume = to 1 for maximum exposure)

Dose (surface soil) = (Cs * Is)(H)/BW
Dose (surface water) = (Cw * Iw)(H)/BW
Dose (invertebrates) = (Ci * If)(H)/BW
Total Dose = Dose (surface soil) + Dose (surface water) + Dose (invertebrates)

Definitions:
EEQ - Ecological Effects Quotient
NOAEL - No Observed Adverse Effects Level
LOAEL - Lowest Observed Adverse Effects Level
Cs = Contaminant concentration in soil
Cw = Contaminant concentration in water
Ci = Contaminant conc. in soil invertebrates (=soil conc. * Biotransfer Factor)
NV = No Value is available

MEADOW VOLE - AVERAGE INPUTS
TERRESTRIAL WILDLIFE MODEL ECOLOGICAL EFFECTS QUOTIENT CALCULATION
UXO 5 - BUILDING 2044 DROP TOWER AND TEST RAIL SITE
NSWC CRANE, INDIANA

Parameter	Avg Soil Concentration (mg/kg)	Vegetation Concentration (mg/kg)	Dose (mg/kg/day) from: Surface Soil	Dose (mg/kg/day) from: Vegetation	Total Dose (mg/kg/day)	NOAEL (mg/kg/day)	LOAEL (mg/kg/day)	NOAEL EEQ	LOAEL EEQ
Explosives									
2,4-DINITROTOLUENE	1.32E-01	3.44E-01	7.727E-05	1.674E-02	1.68E-02	2.00E-01	1.50E+00	8.41E-02	1.12E-02
Inorganics									
ANTIMONY	5.89E-01	6.00E-03	3.442E-04	2.926E-04	6.37E-04	5.90E-02	2.76E+00	1.08E-02	2.31E-04
BARIUM	1.38E+02	2.15E+01	8.061E-02	1.048E+00	1.13E+00	5.18E+01	8.27E+01	2.18E-02	1.36E-02
CADMIUM	4.12E+00	1.35E+00	2.411E-03	6.568E-02	6.81E-02	7.70E-01	6.90E+00	8.84E-02	9.87E-03
CHROMIUM	2.13E+01	8.75E-01	1.248E-02	4.262E-02	5.51E-02	2.40E+00	5.82E+01	2.29E-02	9.47E-04
COBALT	7.90E+00	5.93E-02	4.620E-03	2.887E-03	7.51E-03	7.33E+00	1.89E+01	1.02E-03	3.97E-04
COPPER	2.12E+01	6.49E+00	1.238E-02	3.164E-01	3.29E-01	5.60E+00	8.27E+01	5.87E-02	3.98E-03
LEAD	4.62E+01	2.27E+00	2.699E-02	1.108E-01	1.38E-01	4.70E+00	1.86E+02	2.93E-02	7.39E-04
MANGANESE	4.27E+02	3.37E+01	2.496E-01	1.643E+00	1.89E+00	5.15E+01	1.46E+02	3.68E-02	1.30E-02
SELENIUM	3.91E-01	5.37E-02	2.289E-04	2.616E-03	2.85E-03	1.43E-01	6.60E-01	1.99E-02	4.31E-03
THALLIUM	1.33E-01	2.40E-02	7.798E-05	1.169E-03	1.25E-03	7.40E-03	7.40E-02	1.69E-01	1.69E-02
VANADIUM	2.43E+01	1.18E-01	1.422E-02	5.748E-03	2.00E-02	4.16E+00	9.44E+00	4.80E-03	2.12E-03
ZINC	5.23E+02	1.55E+02	3.060E-01	7.551E+00	7.86E+00	7.54E+01	2.98E+02	1.04E-01	2.64E-02

Cells are shaded if the EEO is greater than 1.0.
Data from Mine Fill A Proper samples were used for surface soil concentrations.
Data from Gully samples were used for surface water concentrations.
Energetics, cadmium, mercury, selenium, and silver were COPCs in surface water only.
A biotransfer factor of 1.0 was used for the energetics where a biotransfer factor was not available.

Body Weight = (BW)	3.663E-02
Food Ingestion Rate = (If)	1.785E-03
Water Ingestion Rate = (Iw)	6.400E-03
Soil Ingestion Rate = (Is)	2.142E-05
Home Range = (HR)	1.640E-01
Contaminated Area = (CA)	Assume equal to home range

H=HR/CA (Assume = to 1 for maximum exposure)

Dose (surface soil) = (Cs * Is)(H)/BW
Dose (surface water) = (Cw * Iw)(H)/BW
Dose (vegetation) = (Cv * If)(H)/BW
Total Dose = Dose (surface soil) + Dose (surface water) + Dose (vegetation)

Definitions:
EEQ - Ecological Effects Quotient
NOAEL - No Observed Adverse Effects Level
LOAEL - Lowest Observed Adverse Effects Level
Cs = Contaminant concentration in soil
Cw = Contaminant concentration in water
Cv = Contaminant conc. in vegetation (=soil conc. * Biotransfer Factor)
NV = No Value is available

AMERICAN WOODCOCK - AVERAGE INPUTS
TERRESTRIAL WILDLIFE MODEL ECOLOGICAL EFFECTS QUOTIENT CALCULATION
UXO 5 - BUILDING 2044 DROP TOWER AND TEST RAIL SITE
NSWC CRANE, INDIANA

Parameter	Avg Soil Concentration (mg/kg)	Invertebrate Concentration (mg/kg)	Dose (mg/kg/day) from: Surface Soil	Dose (mg/kg/day) from: Inverts.	Total Dose (mg/kg/day)	NOAEL (mg/kg/day)	LOAEL (mg/kg/day)	NOAEL EEQ	LOAEL EEQ
Explosives									
2,4-DINITROTOLUENE	1.32E-01	1.32E-01	1.13E-03	1.76E-02	1.87E-02	NV	NV	NV	NV
Inorganics									
ANTIMONY	5.89E-01	5.89E-01	5.02E-03	7.85E-02	8.35E-02	NV	NV	NV	NV
BARIUM	1.38E+02	1.25E+01	1.18E+00	1.67E+00	2.85E+00	NV	NV	NV	NV
CADMIUM	4.12E+00	2.55E+01	3.52E-02	3.41E+00	3.44E+00	1.47E+00	6.35E+00	2.35E+00	5.42E-01
CHROMIUM	2.13E+01	6.53E+00	1.82E-01	8.70E-01	1.05E+00	2.66E+00	1.56E+01	3.96E-01	6.73E-02
COBALT	7.90E+00	9.64E-01	6.74E-02	1.29E-01	1.96E-01	7.61E+00	1.83E+01	2.57E-02	1.07E-02
COPPER	2.12E+01	1.09E+01	1.81E-01	1.45E+00	1.63E+00	4.05E+00	3.49E+01	4.03E-01	4.69E-02
LEAD	4.62E+01	1.77E+01	3.94E-01	2.36E+00	2.76E+00	1.63E+00	4.46E+01	1.69E+00	6.18E-02
MANGANESE	4.27E+02	2.77E+01	3.64E+00	3.69E+00	7.34E+00	1.79E+02	3.77E+02	4.10E-02	1.95E-02
SELENIUM	3.91E-01	4.15E-01	3.34E-03	5.53E-02	5.86E-02	2.90E-01	8.20E-01	2.02E-01	7.15E-02
THALLIUM	1.33E-01	1.41E-01	1.14E-03	1.88E-02	2.00E-02	NV	NV	NV	NV
VANADIUM	2.43E+01	1.02E+00	2.08E-01	1.36E-01	3.44E-01	3.44E-01	1.70E+00	9.99E-01	2.02E-01
ZINC	5.23E+02	6.67E+02	4.47E+00	8.89E+01	9.33E+01	6.61E+01	1.71E+02	1.41E+00	5.46E-01

Cells are shaded if the EEQ is greater than 1.0.
Data from Mine Fill A Proper samples were used for surface soil concentrations.
Data from Gully samples were used for surface water concentrations.
Energetics, cadmium, mercury, selenium, and silver were COPCs in surface water only.
A biotransfer factor of 1.0 was used for the energetics where a biotransfer factor was not available.

Body Weight = (BW)	1.895E-01
Food Ingestion Rate = (If)	2.526E-02
Water Ingestion Rate = (Iw)	1.900E-02
Soil Ingestion Rate = (Is)	1.617E-03
Home Range = (HR)	6.133E+01
Contaminated Area = (CA)	Assume equal to home range
H=HR/CA (Assume = to 1 for maximum exposure)	

Definitions:
EEQ - Ecological Effects Quotient
NOAEL - No Observed Adverse Effects Level
LOAEL - Lowest Observed Adverse Effects Level
Cs = Contaminant concentration in soil
Cw = Contaminant concentration in water
Ci = Contaminant conc. in soil invertebrates (=soil conc. * Biotransfer Factor)
NV = No Value is available

Dose (surface soil) = (Cs * Is)(H)/BW
Dose (surface water) = (Cw * Iw)(H)/BW
Dose (invertebrates) = (Ci * If)(H)/BW
Total Dose = Dose (surface soil) + Dose (surface water) + Dose (invertebrates)

APPENDIX F

DATA VALIDATION REPORTS

Tetra Tech NUS

INTERNAL CORRESPONDENCE

TO:	R. BASINSKI	DATE:	JANUARY 18, 2008
FROM:	EDWARD SEDLMYER	COPIES:	DV FILE
SUBJECT:	ORGANIC DATA VALIDATION – EXP CTO 0034, NSWC CRANE SDG TT03401		
SAMPLES:	19 / Soil		

X5SS-001C0002	X5SS-002C0002	X5SS-003C0002
X5SS-004C0002	X5SS-005C0002	X5SS-006C0002
X5SS-007C0002	X5SS-008C0002	X5SS-009C0002
X5SS-010C0002	X5SS-011C0002	X5SS-012C0002
X5SS-013C0002	X5SS-014C0002	X5SS-015C0002
X5SS-016C0002	X5SS-017C0002	X5SS-018C0002
X5SS-019C0002		

OVERVIEW

The sample set for CTO 0034, NSWC CRANE, SDG TT03401 consists of nineteen (19) soil environmental samples. All samples were analyzed for explosives (EXP).

The samples were collected by TetraTech NUS on October 8, 2007 and analyzed by Laucks Testing Laboratories, Seattle, WA. All analyses were conducted in accordance with USEPA SW 846 Method 8330. The data contained in this SDG were validated with regard to the following parameters:

- * Data completeness
- * Holding times
- * Initial and continuing calibration
- * Blank results
- * Surrogate spike recoveries
- * Blank Spike/Blank Spike Duplicate Results
- * Matrix Spike/Matrix Spike Duplicate Results
- * Detection Limits
- * Field Duplicate Results
- * Compound Quantitation
- * Compound Identification

The symbol (*) indicates that all quality control criteria were met for this parameter. Problems affecting data quality are discussed below; documentation supporting these findings is presented in Appendix C. Qualified Analytical results are presented in Appendix A. Results as reported by the laboratory are presented in Appendix B.

EXP

The laboratory reported the surrogate percent recoveries from one column only. No qualifications were made on this basis.

EXECUTIVE SUMMARY

Laboratory Performance Issues: None.

Other Factors Affecting Data Quality: None.

The data for these analyses were reviewed with reference to the EPA Functional Guidelines for Organic Data Validation (October 1999) and the Department of Defense (DoD) document entitled "Quality Systems Manual (QSM) for Environmental Laboratories" (January 2006). The text of this report has been formulated to address only those problem areas affecting data quality.

"I attest that the data referenced herein were validated according to the agreed upon validation criteria as specified in the DoD QSM."

Tetra Tech NUS

Edward Sedlmyer
Chemist/Data Validator

TetraTech NUS

Joseph A. Samchuck
Data Validation Quality Assurance Officer

Attachments:

1. Appendix A - Qualified Analytical Results
2. Appendix B - Results as Reported by the Laboratory
3. Appendix C - Support Documentation

APPENDIX A

QUALIFIED ANALYTICAL RESULTS

Data Validation Qualifier Codes:

A = Lab Blank Contamination
B = Field Blank Contamination
C = Calibration Noncompliance (e.g. % RSDs, %Ds, ICVs, CCVs, RRFs, etc.)
C01 = GC/MS Tuning Noncompliance
D = MS/MSD Recovery Noncompliance
E = LCS/LCSD Recovery Noncompliance
F = Lab Duplicate Imprecision
G = Field Duplicate Imprecision
H = Holding Time Exceedance
I = ICP Serial Dilution Noncompliance
J = GFAA PDS - GFAA MSA's $r < 0.995$ / ICP PDS Recovery Noncompliance
K = ICP Interference - includes ICS % R Noncompliance
L = Instrument Calibration Range Exceedance
M = Sample Preservation Noncompliance
N = Internal Standard Noncompliance
N01 = Internal Standard Recovery Noncompliance Dioxins
N02 = Recovery Standard Noncompliance Dioxins
N03 = Clean-up Standard Noncompliance Dioxins
O = Poor Instrument Performance (e.g. base-line drifting)
P = Uncertainty near detection limit (< 2 x IDL for inorganics and <CRQL for organics)
Q = Other problems (can encompass a number of issues; e.g. chromatography,interferences, etc.)
R = Surrogates Recovery Noncompliance
S = Pesticide/PCB Resolution
T = % Breakdown Noncompliance for DDT and Endrin
U = % Difference between columns/detectors >25% for positive results determined via GC/HPLC
V = Non-linear calibrations; correlation coefficient $r < 0.995$
W = EMPC result
X = Signal to noise response drop
Y = Percent solids <30%
Z = Uncertainty at 2 sigma deviation is greater than sample activity

PROJ_NO: 00447

SDG: TT03401 MEDIA: SOIL DATA FRACTION: EXP

nsample	X5SS-001C0002	nsample	X5SS-002C0002	nsample	X5SS-003C0002
samp_date	10/8/2007 8:15:00 AM	samp_date	10/8/2007 8:30:00 AM	samp_date	10/8/2007 8:50:00 AM
lab_id	TT03401-001C	lab_id	TT03401-002C	lab_id	TT03401-003C
qc_type	NM	qc_type	NM	qc_type	NM
units	MG/KG	units	MG/KG	units	MG/KG
Pct_Solids	100.0	Pct_Solids	100.0	Pct_Solids	100.0
DUP_OF:		DUP_OF:		DUP_OF:	

Parameter	Result	Val Qual	Qual Code
1,3,5-TRINITROBENZENE	0.029	U	
1,3-DINITROBENZENE	0.0081	U	
2,4,6-TRINITROTOLUENE	0.016	U	
2,4-DINITROTOLUENE	0.013	U	
2,6-DINITROTOLUENE	0.040	U	
2-AMINO-4,6-DINITROTOLUENE	0.025	U	
2-NITROTOLUENE	0.021	U	
3-NITROTOLUENE	0.012	U	
4-AMINO-2,6-DINITROTOLUENE	0.024	U	
4-NITROTOLUENE	0.016	U	
HMX	0.037	U	
NITROBENZENE	0.0067	U	
RDX	0.041	U	
TETRYL	0.029	U	

Parameter	Result	Val Qual	Qual Code
1,3,5-TRINITROBENZENE	0.029	U	
1,3-DINITROBENZENE	0.0081	U	
2,4,6-TRINITROTOLUENE	0.016	U	
2,4-DINITROTOLUENE	0.013	U	
2,6-DINITROTOLUENE	0.040	U	
2-AMINO-4,6-DINITROTOLUENE	0.025	U	
2-NITROTOLUENE	0.021	U	
3-NITROTOLUENE	0.012	U	
4-AMINO-2,6-DINITROTOLUENE	0.024	U	
4-NITROTOLUENE	0.016	U	
HMX	0.037	U	
NITROBENZENE	0.0067	U	
RDX	0.041	U	
TETRYL	0.029	U	

Parameter	Result	Val Qual	Qual Code
1,3,5-TRINITROBENZENE	0.029	U	
1,3-DINITROBENZENE	0.0081	U	
2,4,6-TRINITROTOLUENE	0.016	U	
2,4-DINITROTOLUENE	0.013	U	
2,6-DINITROTOLUENE	0.040	U	
2-AMINO-4,6-DINITROTOLUENE	0.025	U	
2-NITROTOLUENE	0.021	U	
3-NITROTOLUENE	0.012	U	
4-AMINO-2,6-DINITROTOLUENE	0.024	U	
4-NITROTOLUENE	0.016	U	
HMX	0.037	U	
NITROBENZENE	0.0067	U	
RDX	0.041	U	
TETRYL	0.029	U	

PROJ_NO: 00447

SDG: TT03401 MEDIA: SOIL DATA FRACTION: EXP

nsample	X5SS-004C0002	nsample	X5SS-005C0002	nsample	X5SS-006C0002
samp_date	10/8/2007 9:10:00 AM	samp_date	10/8/2007 9:25:00 AM	samp_date	10/8/2007 9:45:00 AM
lab_id	TT03401-004C	lab_id	TT03401-005C	lab_id	TT03401-006C
qc_type	NM	qc_type	NM	qc_type	NM
units	MG/KG	units	MG/KG	units	MG/KG
Pct_Solids	100.0	Pct_Solids	100.0	Pct_Solids	100.0
DUP_OF:		DUP_OF:		DUP_OF:	

Parameter	Result	Val Qual	Qual Code
1,3,5-TRINITROBENZENE	0.029	U	
1,3-DINITROBENZENE	0.0081	U	
2,4,6-TRINITROTOLUENE	0.016	U	
2,4-DINITROTOLUENE	0.013	U	
2,6-DINITROTOLUENE	0.040	U	
2-AMINO-4,6-DINITROTOLUENE	0.025	U	
2-NITROTOLUENE	0.021	U	
3-NITROTOLUENE	0.012	U	
4-AMINO-2,6-DINITROTOLUENE	0.024	U	
4-NITROTOLUENE	0.016	U	
HMX	0.037	U	
NITROBENZENE	0.0067	U	
RDX	0.041	U	
TETRYL	0.029	U	

Parameter	Result	Val Qual	Qual Code
1,3,5-TRINITROBENZENE	0.029	U	
1,3-DINITROBENZENE	0.0081	U	
2,4,6-TRINITROTOLUENE	0.016	U	
2,4-DINITROTOLUENE	0.013	U	
2,6-DINITROTOLUENE	0.040	U	
2-AMINO-4,6-DINITROTOLUENE	0.025	U	
2-NITROTOLUENE	0.021	U	
3-NITROTOLUENE	0.012	U	
4-AMINO-2,6-DINITROTOLUENE	0.024	U	
4-NITROTOLUENE	0.016	U	
HMX	0.037	U	
NITROBENZENE	0.0067	U	
RDX	0.041	U	
TETRYL	0.029	U	

Parameter	Result	Val Qual	Qual Code
1,3,5-TRINITROBENZENE	0.029	U	
1,3-DINITROBENZENE	0.0081	U	
2,4,6-TRINITROTOLUENE	0.016	U	
2,4-DINITROTOLUENE	0.013	U	
2,6-DINITROTOLUENE	0.040	U	
2-AMINO-4,6-DINITROTOLUENE	0.025	U	
2-NITROTOLUENE	0.021	U	
3-NITROTOLUENE	0.012	U	
4-AMINO-2,6-DINITROTOLUENE	0.024	U	
4-NITROTOLUENE	0.016	U	
HMX	0.037	U	
NITROBENZENE	0.0067	U	
RDX	0.041	U	
TETRYL	0.029	U	

PROJ_NO: 00447

SDG: TT03401 MEDIA: SOIL DATA FRACTION: EXP

nsample	X5SS-007C0002	nsample	X5SS-008C0002	nsample	X5SS-009C0002
samp_date	10/8/2007 10:20:00 AM	samp_date	10/8/2007 2:38:00 PM	samp_date	10/8/2007 12:30:00 PM
lab_id	TT03401-007C	lab_id	TT03401-008C	lab_id	TT03401-009C
qc_type	NM	qc_type	NM	qc_type	NM
units	MG/KG	units	MG/KG	units	MG/KG
Pct_Solids	100.0	Pct_Solids	100.0	Pct_Solids	100.0
DUP_OF:		DUP_OF:		DUP_OF:	

Parameter	Result	Val Qual	Qual Code
1,3,5-TRINITROBENZENE	0.029	U	
1,3-DINITROBENZENE	0.0081	U	
2,4,6-TRINITROTOLUENE	0.016	U	
2,4-DINITROTOLUENE	0.013	U	
2,6-DINITROTOLUENE	0.040	U	
2-AMINO-4,6-DINITROTOLUENE	0.025	U	
2-NITROTOLUENE	0.021	U	
3-NITROTOLUENE	0.012	U	
4-AMINO-2,6-DINITROTOLUENE	0.024	U	
4-NITROTOLUENE	0.016	U	
HMX	0.037	U	
NITROBENZENE	0.0067	U	
RDX	0.041	U	
TETRYL	0.029	U	

Parameter	Result	Val Qual	Qual Code
1,3,5-TRINITROBENZENE	0.029	U	
1,3-DINITROBENZENE	0.0081	U	
2,4,6-TRINITROTOLUENE	0.016	U	
2,4-DINITROTOLUENE	0.013	U	
2,6-DINITROTOLUENE	0.040	U	
2-AMINO-4,6-DINITROTOLUENE	0.025	U	
2-NITROTOLUENE	0.021	U	
3-NITROTOLUENE	0.012	U	
4-AMINO-2,6-DINITROTOLUENE	0.024	U	
4-NITROTOLUENE	0.016	U	
HMX	0.037	U	
NITROBENZENE	0.0067	U	
RDX	0.041	U	
TETRYL	0.029	U	

Parameter	Result	Val Qual	Qual Code
1,3,5-TRINITROBENZENE	0.029	U	
1,3-DINITROBENZENE	0.0081	U	
2,4,6-TRINITROTOLUENE	0.016	U	
2,4-DINITROTOLUENE	0.013	U	
2,6-DINITROTOLUENE	0.040	U	
2-AMINO-4,6-DINITROTOLUENE	0.025	U	
2-NITROTOLUENE	0.021	U	
3-NITROTOLUENE	0.012	U	
4-AMINO-2,6-DINITROTOLUENE	0.024	U	
4-NITROTOLUENE	0.016	U	
HMX	0.037	U	
NITROBENZENE	0.0067	U	
RDX	0.041	U	
TETRYL	0.029	U	

PROJ_NO: 00447

SDG: TT03401 MEDIA: SOIL DATA FRACTION: EXP

nsample	X5SS-010C0002	nsample	X5SS-011C0002	nsample	X5SS-012C0002
samp_date	10/8/2007 12:50:00 PM	samp_date	10/8/2007 1:00:00 PM	samp_date	10/8/2007 10:45:00 AM
lab_id	TT03401-010C	lab_id	TT03401-011C	lab_id	TT03401-012C
qc_type	NM	qc_type	NM	qc_type	NM
units	MG/KG	units	MG/KG	units	MG/KG
Pct_Solids	100.0	Pct_Solids	100.0	Pct_Solids	100.0
DUP_OF:		DUP_OF:		DUP_OF:	

Parameter	Result	Val Qual	Qual Code
1,3,5-TRINITROBENZENE	0.029	U	
1,3-DINITROBENZENE	0.0081	U	
2,4,6-TRINITROTOLUENE	0.016	U	
2,4-DINITROTOLUENE	0.013	U	
2,6-DINITROTOLUENE	0.040	U	
2-AMINO-4,6-DINITROTOLUENE	0.025	U	
2-NITROTOLUENE	0.021	U	
3-NITROTOLUENE	0.012	U	
4-AMINO-2,6-DINITROTOLUENE	0.024	U	
4-NITROTOLUENE	0.016	U	
HMX	0.037	U	
NITROBENZENE	0.0067	U	
RDX	0.041	U	
TETRYL	0.029	U	

Parameter	Result	Val Qual	Qual Code
1,3,5-TRINITROBENZENE	0.029	U	
1,3-DINITROBENZENE	0.0081	U	
2,4,6-TRINITROTOLUENE	0.016	U	
2,4-DINITROTOLUENE	0.013	U	
2,6-DINITROTOLUENE	0.040	U	
2-AMINO-4,6-DINITROTOLUENE	0.025	U	
2-NITROTOLUENE	0.021	U	
3-NITROTOLUENE	0.012	U	
4-AMINO-2,6-DINITROTOLUENE	0.024	U	
4-NITROTOLUENE	0.016	U	
HMX	0.037	U	
NITROBENZENE	0.0067	U	
RDX	0.041	U	
TETRYL	0.029	U	

Parameter	Result	Val Qual	Qual Code
1,3,5-TRINITROBENZENE	0.029	U	
1,3-DINITROBENZENE	0.0081	U	
2,4,6-TRINITROTOLUENE	0.016	U	
2,4-DINITROTOLUENE	0.013	U	
2,6-DINITROTOLUENE	0.040	U	
2-AMINO-4,6-DINITROTOLUENE	0.025	U	
2-NITROTOLUENE	0.021	U	
3-NITROTOLUENE	0.012	U	
4-AMINO-2,6-DINITROTOLUENE	0.024	U	
4-NITROTOLUENE	0.016	U	
HMX	0.037	U	
NITROBENZENE	0.0067	U	
RDX	0.041	U	
TETRYL	0.029	U	

PROJ_NO: 00447

SDG: TT03401 MEDIA: SOIL DATA FRACTION: EXP

nsample	X5SS-013C0002	nsample	X5SS-014C0002	nsample	X5SS-015C0002
samp_date	10/8/2007 11:05:00 AM	samp_date	10/8/2007 11:25:00 AM	samp_date	10/8/2007 2:25:00 PM
lab_id	TT03401-013C	lab_id	TT03401-014C	lab_id	TT03401-015C
qc_type	NM	qc_type	NM	qc_type	NM
units	MG/KG	units	MG/KG	units	MG/KG
Pct_Solids	100.0	Pct_Solids	100.0	Pct_Solids	100.0
DUP_OF:		DUP_OF:		DUP_OF:	

Parameter	Result	Val Qual	Qual Code
1,3,5-TRINITROBENZENE	0.029	U	
1,3-DINITROBENZENE	0.0081	U	
2,4,6-TRINITROTOLUENE	0.016	U	
2,4-DINITROTOLUENE	0.90		
2,6-DINITROTOLUENE	0.040	U	
2-AMINO-4,6-DINITROTOLUENE	0.025	U	
2-NITROTOLUENE	0.021	U	
3-NITROTOLUENE	0.012	U	
4-AMINO-2,6-DINITROTOLUENE	0.024	U	
4-NITROTOLUENE	0.016	U	
HMX	0.037	U	
NITROBENZENE	0.0067	U	
RDX	0.041	U	
TETRYL	0.029	U	

Parameter	Result	Val Qual	Qual Code
1,3,5-TRINITROBENZENE	0.029	U	
1,3-DINITROBENZENE	0.0081	U	
2,4,6-TRINITROTOLUENE	0.016	U	
2,4-DINITROTOLUENE	1.5		
2,6-DINITROTOLUENE	0.040	U	
2-AMINO-4,6-DINITROTOLUENE	0.025	U	
2-NITROTOLUENE	0.021	U	
3-NITROTOLUENE	0.012	U	
4-AMINO-2,6-DINITROTOLUENE	0.024	U	
4-NITROTOLUENE	0.016	U	
HMX	0.037	U	
NITROBENZENE	0.0067	U	
RDX	0.041	U	
TETRYL	0.029	U	

Parameter	Result	Val Qual	Qual Code
1,3,5-TRINITROBENZENE	0.029	U	
1,3-DINITROBENZENE	0.0081	U	
2,4,6-TRINITROTOLUENE	0.016	U	
2,4-DINITROTOLUENE	0.013	U	
2,6-DINITROTOLUENE	0.040	U	
2-AMINO-4,6-DINITROTOLUENE	0.025	U	
2-NITROTOLUENE	0.021	U	
3-NITROTOLUENE	0.012	U	
4-AMINO-2,6-DINITROTOLUENE	0.024	U	
4-NITROTOLUENE	0.016	U	
HMX	0.037	U	
NITROBENZENE	0.0067	U	
RDX	0.041	U	
TETRYL	0.029	U	

PROJ_NO: 00447

SDG: TT03401 MEDIA: SOIL DATA FRACTION: EXP

nsample	X5SS-016C0002	nsample	X5SS-017C0002	nsample	X5SS-018C0002
samp_date	10/8/2007 2:08:00 PM	samp_date	10/8/2007 1:55:00 PM	samp_date	10/8/2007 1:45:00 PM
lab_id	TT03401-016C	lab_id	TT03401-017C	lab_id	TT03401-018C
qc_type	NM	qc_type	NM	qc_type	NM
units	MG/KG	units	MG/KG	units	MG/KG
Pct_Solids	100.0	Pct_Solids	100.0	Pct_Solids	100.0
DUP_OF:		DUP_OF:		DUP_OF:	

Parameter	Result	Val Qual	Qual Code
1,3,5-TRINITROBENZENE	0.029	U	
1,3-DINITROBENZENE	0.0081	U	
2,4,6-TRINITROTOLUENE	0.016	U	
2,4-DINITROTOLUENE	0.013	U	
2,6-DINITROTOLUENE	0.040	U	
2-AMINO-4,6-DINITROTOLUENE	0.025	U	
2-NITROTOLUENE	0.021	U	
3-NITROTOLUENE	0.012	U	
4-AMINO-2,6-DINITROTOLUENE	0.024	U	
4-NITROTOLUENE	0.016	U	
HMX	0.037	U	
NITROBENZENE	0.0067	U	
RDX	0.041	U	
TETRYL	0.029	U	

Parameter	Result	Val Qual	Qual Code
1,3,5-TRINITROBENZENE	0.029	U	
1,3-DINITROBENZENE	0.0081	U	
2,4,6-TRINITROTOLUENE	0.016	U	
2,4-DINITROTOLUENE	0.013	U	
2,6-DINITROTOLUENE	0.040	U	
2-AMINO-4,6-DINITROTOLUENE	0.025	U	
2-NITROTOLUENE	0.021	U	
3-NITROTOLUENE	0.012	U	
4-AMINO-2,6-DINITROTOLUENE	0.024	U	
4-NITROTOLUENE	0.016	U	
HMX	0.037	U	
NITROBENZENE	0.0067	U	
RDX	0.041	U	
TETRYL	0.029	U	

Parameter	Result	Val Qual	Qual Code
1,3,5-TRINITROBENZENE	0.029	U	
1,3-DINITROBENZENE	0.0081	U	
2,4,6-TRINITROTOLUENE	0.016	U	
2,4-DINITROTOLUENE	0.013	U	
2,6-DINITROTOLUENE	0.040	U	
2-AMINO-4,6-DINITROTOLUENE	0.025	U	
2-NITROTOLUENE	0.021	U	
3-NITROTOLUENE	0.012	U	
4-AMINO-2,6-DINITROTOLUENE	0.024	U	
4-NITROTOLUENE	0.016	U	
HMX	0.037	U	
NITROBENZENE	0.0067	U	
RDX	0.041	U	
TETRYL	0.029	U	

PROJ_NO: 00447

SDG: TT03401 MEDIA: SOIL DATA FRACTION: EXP

nsample	X5SS-019C0002
samp_date	10/8/2007 1:12:00 PM
lab_id	TT03401-019C
qc_type	NM
units	MG/KG
Pct_Solids	100.0
DUP_QF:	

Parameter	Result	Val Qual	Qual Code
1,3,5-TRINITROBENZENE	0.029	U	
1,3-DINITROBENZENE	0.0081	U	
2,4,6-TRINITROTOLUENE	0.016	U	
2,4-DINITROTOLUENE	0.013	U	
2,6-DINITROTOLUENE	0.040	U	
2-AMINO-4,6-DINITROTOLUENE	0.025	U	
2-NITROTOLUENE	0.021	U	
3-NITROTOLUENE	0.012	U	
4-AMINO-2,6-DINITROTOLUENE	0.024	U	
4-NITROTOLUENE	0.016	U	
HMX	0.037	U	
NITROBENZENE	0.0067	U	
RDX	0.041	U	
TETRYL	0.029	U	

Tetra Tech NUS **INTERNAL CORRESPONDENCE**

TO:	**R. BASINSKI**	**DATE:**	**JANUARY 7, 2008**
FROM:	**TERRI L. SOLOMON**	**COPIES:**	**DV FILE**

SUBJECT: **INORGANIC DATA VALIDATION –TAL METALS**
CTO 0034 NSWC CRANE
SAMPLE DELIVERY GROUP (SDG) – TT03401

SAMPLES: 19/Soils/

X5SS-001G0002	X5SS-002G0002	X5SS-003G0002
X5SS-004G0002	X5SS-005G0002	X5SS-006G0002
X5SS-007G0002	X5SS-008G0002	X5SS-009G0002
X5SS-010G0002	X5SS-011G0002	X5SS-012G0002
X5SS-013G0002	X5SS-014G0002	X5SS-015G0002
X5SS-016G0002	X5SS-017G0002	X5SS-018G0002
X5SS-019G0002		

Overview

The sample set for NSWC Crane, CTO 0034, SDG TT03401, consists of nineteen (19) soil environmental samples. No field duplicate pairs are included within this SDG.

All samples were analyzed for target analyte list (TAL) metals except mercury. The samples were collected on October 8, 2007 and analyzed by Laucks Testing Laboratories under Naval Facilities Engineering Service Center (NFESC) Quality Assurance / Quality Control (QA/QC) criteria. Metals analyses were conducted using SW-846 method 6020.

These data were evaluated based on the following parameters:

* • Data Completeness
* • Holding Times
• Calibration Verification Results
• Laboratory Method / Preparation Quality Control Blank Analyses
* • Detection Limits

* - All quality control criteria were met for this parameter.

Calibration Verification Results

The continuing calibration percent recovery for beryllium was < 90% quality control limit affecting samples X5SS-016G0002 and X5SS-018G0002. The positive results reported for beryllium in the affected samples were qualified as estimated, "J".

Laboratory Blank Analyses

The following contaminants were detected in the laboratory method/preparation blanks at the following maximum concentrations:

Analyte	Maximum Concentration	Action Level
Antimony[1]	0.16 mg/kg	0.80 mg/kg
Chromium[1]	0.0369 mg/kg	0.1845 mg/kg
Copper[1]	0.0489 mg/kg	0.2445 mg/kg
Iron[1]	6.34 mg/kg	31.7 mg/kg
Lead	0.0656 ug/L	0.0328 mg/kg
Nickel[1]	0.0226 mg/kg	0.113 mg/kg
Potassium[1]	5.56 mg/kg	27.8 mg/kg
Sodium[1]	3.80 mg/kg	19.0 mg/kg
Vanadium	0.0729 ug/L	0.03645 mg/kg

[1] Maximum concentration present in a soil preparation blank.

An action level of 5X the maximum contaminant level has been used to evaluate sample data for blank contamination. Sample aliquot, percent solids and dilution factors, if applicable, were taken into consideration when evaluating for blank contamination. The positive results less than the blank action level for antimony and sodium were qualified "U" as a result of laboratory blank contamination.

Notes

The antimony results for the original analyses were incorrectly prepped. The laboratory re-prepped and reanalyzed the samples. The resubmitted antimony results were used for validation.

Executive Summary

Laboratory Performance: The continuing calibration percent recovery for beryllium was < 90% quality control limit affecting samples X5SS-016G0002 and X5SS-018G0002. Several analytes were present in the laboratory / preparation blanks.

Other Factors Affecting Data Quality: None.

The data for these analyses were reviewed with reference to the "National Functional Guidelines for Inorganic Data Validation", October 2004, and the Department of Defense (DoD) document entitled "Quality Systems Manual (QSM) for Environmental Laboratories", January 2006.

The text of this report has been formulated to address only those problem areas affecting data quality.

"I attest that the data referenced herein were validated according to the agreed upon validation criteria as specified in the DoD QSM."

Tetra Tech NUS
Terri L. Solomon
Environmental Scientist

Tetra Tech NUS
Joseph A. Samchuck
Quality Assurance Officer

Attachments:

1. Appendix A - Qualified Analytical Results
2. Appendix B - Results as reported by the Laboratory
3. Appendix C - Support Documentation

APPENDIX A
QUALIFIED ANALYTICAL RESULTS

Data Validation Qualifier Codes:

A = Lab Blank Contamination
B = Field Blank Contamination
C = Calibration Noncompliance (e.g. % RSDs, %Ds, ICVs, CCVs, RRFs, etc.)
C01 = GC/MS Tuning Noncompliance
D = MS/MSD Recovery Noncompliance
E = LCS/LCSD Recovery Noncompliance
F = Lab Duplicate Imprecision
G = Field Duplicate Imprecision
H = Holding Time Exceedance
I = ICP Serial Dilution Noncompliance
J = GFAA PDS-GFAA MSA's r < 0.995 / ICP PDS Recovery Noncompliance
K = ICP Interference.- includes ICS % R Noncompliance
L = Instrument Calibration Range Exceedance
M = Sample Preservation Noncompliance
N = Internal Standard Noncompliance
N01 = Internal Standard Recovery Noncompliance Dioxins
N02 = Recovery Standard Noncompliance Dioxins
N03 = Clean-up Standard Noncompliance Dioxins
O - Poor Instrument Performance (e.g. base-line drifting)
P = Uncertainty near detection limit (< 2 x IDL for inorganics and <CRQL for organics)
Q = Other problems (can encompass a number of issues; e.g. chromatography,interferences, etc.)
R = Surrogates Recovery Noncompliance
S = Pesticide/PCB Resolution
T = % Breakdown Noncompliance for DOT and Endrin
U = % Difference between columns/detectors >25% for positive results determined via GC/HPLC
V = Non-linear calibrations; correlation coefficient r < 0.995
W = EMPC result
X = Signal to noise response drop
Y = Percent solids <30%
Z = Uncertainty at 2 sigma deviation is greater than sample activity

PROJ_NO: 00447

SDG: TT03401 MEDIA: SOIL DATA FRACTION: M

nsample	X5SS-001G0002	nsample	X5SS-002G0002	nsample	X5SS-003G0002
samp_date	10/8/2007 8:15:00 AM	samp_date	10/8/2007 8:30:00 AM	samp_date	10/8/2007 8:50:00 AM
lab_id	TT03401-001G	lab_id	TT03401-002G	lab_id	TT03401-003G
qc_type	NM	qc_type	NM	qc_type	NM
units	MG/KG	units	MG/KG	units	MG/KG
Pct_Solids	89.7	Pct_Solids	85.9	Pct_Solids	90.0
DUP_OF:		DUP_OF:		DUP_OF:	

Parameter	Result	Val Qual	Qual Code
ALUMINUM	12300		
ANTIMONY	0.25	U	A
ARSENIC	5.72		
BARIUM	68.5		
BERYLLIUM	0.466		
CADMIUM	2.04		
CALCIUM	56400		
CHROMIUM	23.2		
COBALT	5.75		
COPPER	10.5		
IRON	24500		
LEAD	13.4		
MAGNESIUM	9450		
MANGANESE	238		
NICKEL	15.5		
POTASSIUM	792		
SELENIUM	0.173		
SILVER	0.0698		
SODIUM	152		
THALLIUM	0.162		
VANADIUM	31.9		
ZINC	97.4		

Parameter	Result	Val Qual	Qual Code
ALUMINUM	15500		
ANTIMONY	0.38	U	A
ARSENIC	5.79		
BARIUM	78.6		
BERYLLIUM	0.470		
CADMIUM	2.40		
CALCIUM	93900		
CHROMIUM	19.6		
COBALT	5.98		
COPPER	12.7		
IRON	18100		
LEAD	12.4		
MAGNESIUM	9960		
MANGANESE	205		
NICKEL	20.6		
POTASSIUM	1150		
SELENIUM	0.0626	U	
SILVER	0.0814		
SODIUM	123		
THALLIUM	0.214		
VANADIUM	35.3		
ZINC	103		

Parameter	Result	Val Qual	Qual Code
ALUMINUM	5700		
ANTIMONY	0.51	U	A
ARSENIC	4.29		
BARIUM	1170		
BERYLLIUM	0.188		
CADMIUM	38.4		
CALCIUM	177000		
CHROMIUM	85.6		
COBALT	11.7		
COPPER	64.8		
IRON	18100		
LEAD	597		
MAGNESIUM	20000		
MANGANESE	395		
NICKEL	34.1		
POTASSIUM	732		
SELENIUM	0.909		
SILVER	0.422		
SODIUM	158		
THALLIUM	0.0949		
VANADIUM	22.5		
ZINC	8750		

SDG: TT03401 MEDIA: SOIL DATA FRACTION: M

nsample	X5SS-004G0002	nsample	X5SS-005G0002	nsample	X5SS-006G0002
samp_date	10/8/2007 9:10:00 AM	samp_date	10/8/2007 9:25:00 AM	samp_date	10/8/2007 9:45:00 AM
lab_id	TT03401-004G	lab_id	TT03401-005G	lab_id	TT03401-006G
qc_type	NM	qc_type	NM	qc_type	NM
units	MG/KG	units	MG/KG	units	MG/KG
Pct_Solids	95.3	Pct_Solids	94.3	Pct_Solids	96.4
DUP_OF:		DUP_OF:		DUP_OF:	

Parameter	Result	Val Qual	Qual Code
ALUMINUM	3760		
ANTIMONY	0.19	U	A
ARSENIC	1.99		
BARIUM	55.1		
BERYLLIUM	0.108		
CADMIUM	1.82		
CALCIUM	142000		
CHROMIUM	8.40		
COBALT	1.75		
COPPER	4.37		
IRON	7020		
LEAD	5.50		
MAGNESIUM	4630		
MANGANESE	98.1		
NICKEL	9.75		
POTASSIUM	380		
SELENIUM	0.235		
SILVER	0.0444		
SODIUM	57.8		
THALLIUM	0.0588		
VANADIUM	11.6		
ZINC	31.0		

Parameter	Result	Val Qual	Qual Code
ALUMINUM	4350		
ANTIMONY	0.69	U	A
ARSENIC	6.60		
BARIUM	378		
BERYLLIUM	0.448		
CADMIUM	2.23		
CALCIUM	199000		
CHROMIUM	17.9		
COBALT	15.1		
COPPER	156		
IRON	24000		
LEAD	23.3		
MAGNESIUM	23100		
MANGANESE	1120		
NICKEL	31.5		
POTASSIUM	589		
SELENIUM	0.412		
SILVER	0.0611		
SODIUM	196		
THALLIUM	0.0923		
VANADIUM	18.5		
ZINC	140		

Parameter	Result	Val Qual	Qual Code
ALUMINUM	3340		
ANTIMONY	0.13	U	A
ARSENIC	7.87		
BARIUM	73.2		
BERYLLIUM	0.344		
CADMIUM	2.12		
CALCIUM	198000		
CHROMIUM	24.5		
COBALT	7.23		
COPPER	5.57		
IRON	24300		
LEAD	7.77		
MAGNESIUM	24200		
MANGANESE	516		
NICKEL	23.4		
POTASSIUM	489		
SELENIUM	0.349		
SILVER	0.110		
SODIUM	205		
THALLIUM	0.0476		
VANADIUM	21.9		
ZINC	50.6		

PROJ_NO: 00447

SDG: TT03401 MEDIA: SOIL DATA FRACTION: M

nsample	X5SS-007G0002	nsample	X5SS-008G0002	nsample	X5SS-009G0002
samp_date	10/8/2007 10:20:00 AM	samp_date	10/8/2007 2:38:00 PM	samp_date	10/8/2007 12:30:00 PM
lab_id	TT03401-007G	lab_id	TT03401-008G	lab_id	TT03401-009G
qc_type	NM	qc_type	NM	qc_type	NM
units	MG/KG	units	MG/KG	units	MG/KG
Pct_Solids	90.0	Pct_Solids	82.2	Pct_Solids	76.5
DUP_OF:		DUP_OF:		DUP_OF:	

Parameter	Result	Val Qual	Qual Code
ALUMINUM	7110		
ANTIMONY	0.29	U	A
ARSENIC	5.08		
BARIUM	115		
BERYLLIUM	0.382		
CADMIUM	2.85		
CALCIUM	191000		
CHROMIUM	14.7		
COBALT	10.9		
COPPER	12.6		
IRON	19500		
LEAD	8.25		
MAGNESIUM	33300		
MANGANESE	567		
NICKEL	29.3		
POTASSIUM	699		
SELENIUM	0.425		
SILVER	0.105		
SODIUM	229		
THALLIUM	0.0926		
VANADIUM	23.4		
ZINC	59.8		

Parameter	Result	Val Qual	Qual Code
ALUMINUM	10400		
ANTIMONY	1.6		
ARSENIC	11.8		
BARIUM	78.0		
BERYLLIUM	0.763		
CADMIUM	2.68		
CALCIUM	3020		
CHROMIUM	34.4		
COBALT	11.1		
COPPER	17.4		
IRON	41100		
LEAD	24.2		
MAGNESIUM	1720		
MANGANESE	620		
NICKEL	19.7		
POTASSIUM	685		
SELENIUM	0.492		
SILVER	0.190		
SODIUM	29.5	U	A
THALLIUM	0.171		
VANADIUM	37.4		
ZINC	91.1		

Parameter	Result	Val Qual	Qual Code
ALUMINUM	13800		
ANTIMONY	0.57	U	A
ARSENIC	5.28		
BARIUM	88.1		
BERYLLIUM	0.574		
CADMIUM	2.78		
CALCIUM	2310		
CHROMIUM	18.5		
COBALT	10.6		
COPPER	12.7		
IRON	15300		
LEAD	21.3		
MAGNESIUM	1910		
MANGANESE	570		
NICKEL	14.6		
POTASSIUM	902		
SELENIUM	0.426		
SILVER	0.133		
SODIUM	61.3	U	A
THALLIUM	0.259		
VANADIUM	30.4		
ZINC	61.5		

nsample	X5SS-010G0002	nsample	X5SS-011G0002	nsample	X5SS-012G0002
samp_date	10/8/2007 12:50:00 PM	samp_date	10/8/2007 1:00:00 PM	samp_date	10/8/2007 10:45:00 AM
lab_id	TT03401-010G	lab_id	TT03401-011G	lab_id	TT03401-012G
qc_type	NM	qc_type	NM	qc_type	NM
units	MG/KG	units	MG/KG	units	MG/KG
Pct_Solids	83.0	Pct_Solids	80.1	Pct_Solids	85.6
DUP_OF:		DUP_OF:		DUP_OF:	

Parameter	Result	Val Qual	Qual Code
ALUMINUM	14000		
ANTIMONY	0.30	U	A
ARSENIC	5.50		
BARIUM	51.3		
BERYLLIUM	0.349		
CADMIUM	1.86		
CALCIUM	550		
CHROMIUM	19.8		
COBALT	4.12		
COPPER	12.6		
IRON	20000		
LEAD	12.6		
MAGNESIUM	1850		
MANGANESE	120		
NICKEL	11.1		
POTASSIUM	810		
SELENIUM	0.270		
SILVER	0.0789		
SODIUM	43.6	U	A
THALLIUM	0.207		
VANADIUM	33.0		
ZINC	36.4		

Parameter	Result	Val Qual	Qual Code
ALUMINUM	11500		
ANTIMONY	1.4		
ARSENIC	6.26		
BARIUM	78.9		
BERYLLIUM	0.467		
CADMIUM	2.46		
CALCIUM	1310		
CHROMIUM	17.1		
COBALT	16.6		
COPPER	11.3		
IRON	17900		
LEAD	19.9		
MAGNESIUM	1510		
MANGANESE	793		
NICKEL	14.2		
POTASSIUM	664		
SELENIUM	0.406		
SILVER	0.0964		
SODIUM	28.8	U	A
THALLIUM	0.210		
VANADIUM	28.3		
ZINC	54.1		

Parameter	Result	Val Qual	Qual Code
ALUMINUM	11300		
ANTIMONY	0.50	U	A
ARSENIC	5.96		
BARIUM	85.0		
BERYLLIUM	0.633		
CADMIUM	1.89		
CALCIUM	24200		
CHROMIUM	17.7		
COBALT	10.7		
COPPER	12.6		
IRON	22100		
LEAD	15.5		
MAGNESIUM	2110		
MANGANESE	549		
NICKEL	15.3		
POTASSIUM	615		
SELENIUM	0.473		
SILVER	0.0872		
SODIUM	28.0	U	A
THALLIUM	0.169		
VANADIUM	26.2		
ZINC	50.9		

PROJ_NO: 00447

SDG: TT03401 MEDIA: SOIL DATA FRACTION: M

nsample	X5SS-013G0002	nsample	X5SS-014G0002	nsample	X5SS-015G0002
samp_date	10/8/2007 11:05:00 AM	samp_date	10/8/2007 11:25:00 AM	samp_date	10/8/2007 2:25:00 PM
lab_id	TT03401-013G	lab_id	TT03401-014G	lab_id	TT03401-015G
qc_type	NM	qc_type	NM	qc_type	NM
units	MG/KG	units	MG/KG	units	MG/KG
Pct_Solids	88.0	Pct_Solids	93.3	Pct_Solids	90.3
DUP_OF:		DUP_OF:		DUP_OF:	

Parameter	Result	Val Qual	Qual Code
ALUMINUM	3830		
ANTIMONY	0.62	U	A
ARSENIC	1.01		
BARIUM	17.6		
BERYLLIUM	0.117		
CADMIUM	1.96		
CALCIUM	225000		
CHROMIUM	12.7		
COBALT	2.10		
COPPER	3.99		
IRON	4850		
LEAD	6.49		
MAGNESIUM	102000		
MANGANESE	140		
NICKEL	20.3		
POTASSIUM	1220		
SELENIUM	0.340		
SILVER	0.0648		
SODIUM	636		
THALLIUM	0.0530		
VANADIUM	14.4		
ZINC	44.0		

Parameter	Result	Val Qual	Qual Code
ALUMINUM	3250		
ANTIMONY	1.2		
ARSENIC	2.62		
BARIUM	25.6		
BERYLLIUM	0.141		
CADMIUM	2.12		
CALCIUM	241000		
CHROMIUM	10.4		
COBALT	3.09		
COPPER	9.53		
IRON	9460		
LEAD	16.4		
MAGNESIUM	21700		
MANGANESE	175		
NICKEL	18.0		
POTASSIUM	397		
SELENIUM	0.480		
SILVER	0.920		
SODIUM	190		
THALLIUM	0.0527		
VANADIUM	12.6		
ZINC	49.8		

Parameter	Result	Val Qual	Qual Code
ALUMINUM	3640		
ANTIMONY	2.1		
ARSENIC	1.94		
BARIUM	25.5		
BERYLLIUM	0.139		
CADMIUM	2.18		
CALCIUM	234000		
CHROMIUM	12.2		
COBALT	2.68		
COPPER	9.25		
IRON	6150		
LEAD	21.3		
MAGNESIUM	35400		
MANGANESE	189		
NICKEL	19.6		
POTASSIUM	617		
SELENIUM	0.445		
SILVER	0.554		
SODIUM	322		
THALLIUM	0.0590		
VANADIUM	12.8		
ZINC	69.4		

nsample	X5SS-016G0002	nsample	X5SS-017G0002	nsample	X5SS-018G0002
samp_date	10/8/2007 2:08:00 PM	samp_date	10/8/2007 1:55:00 PM	samp_date	10/8/2007 1:45:00 PM
lab_id	TT03401-016G	lab_id	TT03401-017G	lab_id	TT03401-018G
qc_type	NM	qc_type	NM	qc_type	NM
units	MG/KG	units	MG/KG	units	MG/KG
Pct_Solids	92.6	Pct_Solids	84.3	Pct_Solids	92.2
DUP_OF:		DUP_OF:		DUP_OF:	

Parameter	Result	Val Qual	Qual Code
ALUMINUM	4430		
ANTIMONY	0.24	U	A
ARSENIC	3.67		
BARIUM	25.4		
BERYLLIUM	0.162	J	C
CADMIUM	2.28		
CALCIUM	99900		
CHROMIUM	9.08		
COBALT	4.10		
COPPER	6.94		
IRON	10100		
LEAD	8.44		
MAGNESIUM	21700		
MANGANESE	366		
NICKEL	12.5		
POTASSIUM	516		
SELENIUM	0.165		
SILVER	0.505		
SODIUM	188		
THALLIUM	0.0803		
VANADIUM	15.6		
ZINC	43.9		

Parameter	Result	Val Qual	Qual Code
ALUMINUM	14000		
ANTIMONY	0.96		
ARSENIC	6.32		
BARIUM	88.1		
BERYLLIUM	0.642		
CADMIUM	1.61		
CALCIUM	3910		
CHROMIUM	20.2		
COBALT	11.1		
COPPER	15.2		
IRON	21800		
LEAD	19.3		
MAGNESIUM	2730		
MANGANESE	527		
NICKEL	16.7		
POTASSIUM	905		
SELENIUM	0.447		
SILVER	0.215		
SODIUM	34.4	U	A
THALLIUM	0.233		
VANADIUM	34.0		
ZINC	58.1		

Parameter	Result	Val Qual	Qual Code
ALUMINUM	2980		
ANTIMONY	0.38	U	A
ARSENIC	2.64		
BARIUM	31.3		
BERYLLIUM	0.150	J	C
CADMIUM	1.90		
CALCIUM	121000		
CHROMIUM	9.57		
COBALT	2.61		
COPPER	8.64		
IRON	7550		
LEAD	21.7		
MAGNESIUM	26000		
MANGANESE	219		
NICKEL	11.6		
POTASSIUM	365		
SELENIUM	0.394		
SILVER	0.171		
SODIUM	182		
THALLIUM	0.0595		
VANADIUM	13.4		
ZINC	59.3		

PROJ_NO: 00447

SDG: TT03401 MEDIA: SOIL DATA FRACTION: M

nsample	X5SS-019G0002
samp_date	10/8/2007 1:12:00 PM
lab_id	TT03401-019G
qc_type	NM
units	MG/KG
Pct_Solids	86.6
DUP_OF:	

Parameter	Result	Val Qual	Qual Code
ALUMINUM	12900		
ANTIMONY	1.4		
ARSENIC	13.6		
BARIUM	86.0		
BERYLLIUM	0.935		
CADMIUM	2.77		
CALCIUM	9210		
CHROMIUM	29.8		
COBALT	12.9		
COPPER	15.5		
IRON	47200		
LEAD	22.3		
MAGNESIUM	3250		
MANGANESE	704		
NICKEL	21.4		
POTASSIUM	863		
SELENIUM	0.566		
SILVER	0.130		
SODIUM	31.8	U	A
THALLIUM	0.218		
VANADIUM	38.9		
ZINC	92.9		

Tetra Tech NUS **INTERNAL CORRESPONDENCE**

TO:	**R. BASINSKI**	**DATE:**	**JANUARY 18, 2008**
FROM:	**EDWARD SEDLMYER**	**COPIES:**	**DV FILE**

SUBJECT: **ORGANIC DATA VALIDATION – EXP/PAH**
CTO 0034, NSWC CRANE
SDG TT03402

SAMPLES: 1 / Aqueous / PAH / EXP

RB10090701

1 / Soil / EXP

X5FD10080701

OVERVIEW

The sample set for CTO 0034, NSWC CRANE, SDG TT03402 consists of one (1) rinse blank and one (1) soil environmental sample. One field duplicate was associated with this SDG: X5SS-010C0002 / X5FD10080701. The data for sample X5SS-010C0002 is located in SDG TT03401. Sample RB10090701 was analyzed for polynuclear aromatic hydrocarbons (PAHS) and explosives (EXP). Sample X5FD10080701 was analyzed for EXP.

The samples were collected by TetraTech NUS on October 8 and 9, 2007 and analyzed by Laucks Testing Laboratories, Seattle, WA. All analyses were conducted in accordance with USEPA SW 846 Method 8330 and 8270C. The data contained in this SDG were validated with regard to the following parameters:

* • Data completeness
* • Holding times
* • GC/MS Tuning
* • Initial and continuing calibration
* • Blank results
* • Surrogate spike recoveries
* • Internal standard recoveries
* • Blank Spike/Blank Spike Duplicate Results
* • Matrix Spike/Matrix Spike Duplicate Results
* • Detection Limits
* • Field Duplicate Results
* • Compound Quantitation
* • Compound Identification

The symbol (*) indicates that all quality control criteria were met for this parameter. Problems affecting data quality are discussed below; documentation supporting these findings is presented in Appendix C. Qualified Analytical results are presented in Appendix A. Results as reported by the laboratory are presented in Appendix B.

PAH

No qualification of the data was necessary.

EXP

The laboratory reported the surrogate percent recoveries from one column only. No qualifications were made on this basis.

EXECUTIVE SUMMARY

Laboratory Performance Issues: None.

Other Factors Affecting Data Quality: None.

The data for these analyses were reviewed with reference to the EPA Functional Guidelines for Organic Data Validation (October 1999) and the Department of Defense (DoD) document entitled "Quality Systems Manual (QSM) for Environmental Laboratories" (January 2006). The text of this report has been formulated to address only those problem areas affecting data quality.

"I attest that the data referenced herein were validated according to the agreed upon validation criteria as specified in the DoD QSM."

Tetra Tech NUS

Edward Sedlmyer
Chemist/Data Validator

Tetra Tech NUS

Joseph A. Samchuck
Data Validation Quality Assurance Officer

Attachments:

1. Appendix A - Qualified Analytical Results
2. Appendix B - Results as Reported by the Laboratory
3. Appendix C - Support Documentation

APPENDIX A

QUALIFIED ANALYTICAL RESULTS

Data Validation Qualifier Codes:

A = Lab Blank Contamination
B = Field Blank Contamination
C = Calibration Noncompliance (e.g. % RSDs, %Ds, ICVs, CCVs, RRFs, etc.)
C01 = GC/MS Tuning Noncompliance
D = MS/MSD Recovery Noncompliance
E = LCS/LCSD Recovery Noncompliance
F = Lab Duplicate Imprecision
G = Field Duplicate Imprecision
H = Holding Time Exceedance
I = ICP Serial Dilution Noncompliance
J = GFAA PDS - GFAA MSA's $r < 0.995$ / ICP PDS Recovery Noncompliance
K = ICP Interference - includes ICS % R Noncompliance
L = Instrument Calibration Range Exceedance
M = Sample Preservation Noncompliance
N = Internal Standard Noncompliance
N01 = Internal Standard Recovery Noncompliance Dioxins
N02 = Recovery Standard Noncompliance Dioxins
N03 = Clean-up Standard Noncompliance Dioxins
O = Poor Instrument Performance (e.g. base-line drifting)
P = Uncertainty near detection limit (< 2 x IDL for inorganics and <CRQL for organics)
Q = Other problems (can encompass a number of issues; e.g. chromatography,interferences, etc.)
R = Surrogates Recovery Noncompliance
S = Pesticide/PCB Resolution
T = % Breakdown Noncompliance for DDT and Endrin
U = % Difference between columns/detectors >25% for positive results determined via GC/HPLC
V = Non-linear calibrations; correlation coefficient $r < 0.995$
W = EMPC result
X = Signal to noise response drop
Y = Percent solids <30%
Z = Uncertainty at 2 sigma deviation is greater than sample activity

PROJ_NO: 00447

SDG: TT03402 MEDIA: WATER DATA FRACTION: OS

nsample	RB10090701
samp_date	10/9/2007 4:30:00 PM
lab_id	TT03402-020
qc_type	NM
units	UG/L
Pct_Solids	
DUP_OF:	

Parameter	Result	Val Qual	Qual Code
2-METHYLNAPHTHALENE	0.014	U	
ACENAPHTHENE	0.011	U	
ACENAPHTHYLENE	0.014	U	
ANTHRACENE	0.012	U	
BENZO(A)ANTHRACENE	0.017	U	
BENZO(A)PYRENE	0.019	U	
BENZO(B)FLUORANTHENE	0.019	U	
BENZO(G,H,I)PERYLENE	0.026	U	
BENZO(K)FLUORANTHENE	0.012	U	
CHRYSENE	0.020	U	
DIBENZO(A,H)ANTHRACENE	0.013	U	
FLUORANTHENE	0.014	U	
FLUORENE	0.014	U	
INDENO(1,2,3-CD)PYRENE	0.030	U	
NAPHTHALENE	0.013	U	
PHENANTHRENE	0.026	U	
PYRENE	0.015	U	

PR(: 00447

SDG: TT03402 MEDIA: WATER DATA FRACTION: EXP

nsample	RB10090701
samp_date	10/9/2007 4:30:00 PM
lab_id	TT03402-020
qc_type	NM
units	UG/L
Pct_Solids	
DUP_OF:	

Parameter	Result	Val Qual	Qual Code
1,3,5-TRINITROBENZENE	0.066	U	
1,3-DINITROBENZENE	0.050	U	
2,4,6-TRINITROTOLUENE	0.087	U	
2,4-DINITROTOLUENE	0.021	U	
2,6-DINITROTOLUENE	0.056	U	
2-AMINO-4,6-DINITROTOLUENE	0.10	U	
2-NITROTOLUENE	0.068	U	
3-NITROTOLUENE	0.10	U	
4-AMINO-2,6-DINITROTOLUENE	0.061	U	
4-NITROTOLUENE	0.058	U	
HMX	0.77		
NITROBENZENE	0.058	U	
RDX	0.10	U	
TETRYL	0.075	U	

PROJ_NO: 00447

SDG: TT03402 MEDIA: SOIL DATA FRACTION: EXP

nsample	X5FD10080701
samp_date	10/6/2007
lab_id	TT03402-001
qc_type	NM
units	MG/KG
Pct_Solids	100.0
DUP_OF:	X5SS-010C0002

Parameter	Result	Val Qual	Qual Code
1,3,5-TRINITROBENZENE	0.029	U	
1,3-DINITROBENZENE	0.0081	U	
2,4,6-TRINITROTOLUENE	0.016	U	
2,4-DINITROTOLUENE	0.013	U	
2,6-DINITROTOLUENE	0.040	U	
2-AMINO-4,6-DINITROTOLUENE	0.025	U	
2-NITROTOLUENE	0.021	U	
3-NITROTOLUENE	0.012	U	
4-AMINO-2,6-DINITROTOLUENE	0.024	U	
4-NITROTOLUENE	0.016	U	
HMX	0.037	U	
NITROBENZENE	0.0067	U	
RDX	0.041	U	
TETRYL	0.029	U	

Tetra Tech NUS **INTERNAL CORRESPONDENCE**

TO:	**R. BASINSKI**	**DATE:**	**JANUARY 18, 2008**
FROM:	**TERRI L. SOLOMON**	**COPIES:**	**DV FILE**

SUBJECT: **INORGANIC DATA VALIDATION –TAL METALS**
CTO 0034 NSWC CRANE
SAMPLE DELIVERY GROUP (SDG) – TT03402

SAMPLES: 18/Soils/

X5FD10080701	X7FD10020701	X7SS0020002
X7SS0030002	X7SS0040002	X7SS0120002
X7SS0190002	X7SS0390002	X7SS0440002
X7SS0450002	X7SS0460002	X7SS1790002
X7SS1800002	X7SS1810002	X7SS1820002
X7SS1830002	X7SS1840002	X7SS1890002

1/Aqueous/

RB10090701

Overview

The sample set for NSWC Crane, CTO 0034, SDG TT03402, consists of eighteen (18) soil environmental samples and one (1) rinsate blank (RB10090701). One (1) field duplicate pair (X7SS0120002 / X7FD10020701) was included within this SDG. Field duplicate sample X5FD10080701 was included in this SDG. The corresponding original sample (X5SS-010G0002) was included in SDG TT03401. The original sample X7SS0450002 was included in this SDG, The corresponding field duplicate X7FD10030701 was included in SDG TT03403.

All samples were analyzed for target analyte list (TAL) metals except mercury. The samples were collected on October 2, 3, 7, 8 and 9, 2007 and analyzed by Laucks Testing Laboratories under Naval Facilities Engineering Service Center (NFESC) Quality Assurance / Quality Control (QA/QC) criteria. Metals analyses were conducted using SW-846 method 6020.

These data were evaluated based on the following parameters:

* • Data Completeness
* • Holding Times
• Calibration Verification Results
• Laboratory Method / Preparation Quality Control Blank Analyses
• Field Duplicate Results
* • Detection Limits

* - All quality control criteria were met for this parameter.

Calibration Verification Results

The continuing calibration percent recovery for beryllium was < 90% quality control limit affecting samples X7SS1800002, X7SS1820002, X7SS1830002 and X7SS1840002. The positive results reported for beryllium in the affected samples were qualified as estimated, "J".

Laboratory Blank Analyses

The following contaminants were detected in the laboratory method/preparation blanks at the following maximum concentrations:

Analyte	Maximum Concentration	Action Level
Antimony[1]	0.17 mg/kg	0.85 mg/kg
Cadmium[1]	0.0437 mg/kg	0.2365 mg/kg
Chromium[1]	0.133 mg/kg	0.665 mg/kg
Iron[1]	11.1 mg/kg	55.5 mg/kg
Lead[2]	0.0676 ug/L	0.0338 mg/kg
Nickel[1]	0.0324 mg/kg	0.162 mg/kg
Potassium[1]	8.6 mg/kg	43.0 mg/kg
Sodium[1]	7.13 mg/kg	35.65 mg/kg
Thallium[3]	0.0880 ug/L	0.044 mg/kg
Vanadium[1]	0.0330 mg/kg	0.165 mg/kg

[1] Maximum concentration present in a soil preparation blank.
[2] Maximum concentration present in a laboratory blank affecting all samples except X7SS0190002, X7SS0390002 and X7SS1890002.
[3] Maximum concentration present in a laboratory blank affecting sample X7SS1890002 only.

An action level of 5X the maximum contaminant level has been used to evaluate sample data for blank contamination. Sample aliquot, percent solids and dilution factors, if applicable, were taken into consideration when evaluating for blank contamination. The positive results less than the blank action level for antimony, sodium and thallium were qualified "U" as a result of laboratory blank contamination.

Field Duplicate Results

Field duplicate imprecision (>50%) for results > 5X contract required detection limit (CRDL) for antimony was noted for sample pair X7SS0450002 / X7FD10030701. The positive results reported for antimony were qualified as estimated, "J".

Notes

The antimony results for the original analyses were incorrectly prepped. The laboratory re-prepped and reanalyzed the samples. The resubmitted antimony results were used for validation.

Executive Summary

Laboratory Performance: The continuing calibration percent recovery for beryllium was < 90% quality control limit affecting samples X7SS1800002, X7SS1820002, X7SS1830002 and X7SS1840002. Several analytes were present in the laboratory / preparation blanks.

Other Factors Affecting Data Quality: field duplicate imprecision was noted for sample pair X7SS0450002 / X7FD10030701.

The data for these analyses were reviewed with reference to the "National Functional Guidelines for Inorganic Data Validation", October 2004, and the Department of Defense (DoD) document entitled "Quality Systems Manual (QSM) for Environmental Laboratories", January 2006.

The text of this report has been formulated to address only those problem areas affecting data quality.

"I attest that the data referenced herein were validated according to the agreed upon validation criteria as specified in the DoD QSM."

Terri L. Solomon

Tetra Tech NUS
Terri L. Solomon
Environmental Scientist

Tetra Tech NUS
Joseph A. Samchuck
Quality Assurance Officer

Attachments:

1. Appendix A - Qualified Analytical Results
2. Appendix B - Results as reported by the Laboratory
3. Appendix C - Support Documentation

APPENDIX A
QUALIFIED ANALYTICAL RESULTS

Data Validation Qualifier Codes:

A = Lab Blank Contamination
B = Field Blank Contamination
C = Calibration Noncompliance (e.g. % RSDs, %Ds, ICVs, CCVs, RRFs, etc.)
C01 = GC/MS Tuning Noncompliance
D = MS/MSD Recovery Noncompliance
E = LCS/LCSD Recovery Noncompliance
F = Lab Duplicate Imprecision
G = Field Duplicate Imprecision
H = Holding Time Exceedance
I = ICP Serial Dilution Noncompliance
J = GFAA PDS-GFAA MSA's $r < 0.995$ / ICP PDS Recovery Noncompliance
K = ICP Interference - includes ICS % R Noncompliance
L = Instrument Calibration Range Exceedance
M = Sample Preservation Noncompliance
N = Internal Standard Noncompliance
N01 = Internal Standard Recovery Noncompliance Dioxins
N02 = Recovery Standard Noncompliance Dioxins
N03 = Clean-up Standard Noncompliance Dioxins
O = Poor Instrument Performance (e.g. base-line drifting)
P = Uncertainty near detection limit (< 2 x IDL for inorganics and <CRQL for organics)
Q = Other problems (can encompass a number of issues; e.g. chromatography,interferences, etc.)
R = Surrogates Recovery Noncompliance
S = Pesticide/PCB Resolution
T = % Breakdown Noncompliance for DOT and Endrin
U = % Difference between columns/detectors >25% for positive results determined via GC/HPLC
V = Non-linear calibrations; correlation coefficient $r < 0.995$
W = EMPC result
X = Signal to noise response drop
Y = Percent solids <30%
Z = Uncertainty at 2 sigma deviation is greater than sample activity

PROJ_NO: 00447

SDG: TT03402 MEDIA: WATER DATA FRACTION: M

nsample	RB10090701
samp_date	10/9/2007 4:30:00 PM
lab_id	TT03402-020
qc_type	NM
units	UG/L
Pct_Solids	
DUP_OF:	

Parameter	Result	Val Qual	Qual Code
ALUMINUM	32.0	U	
ANTIMONY	0.310		
ARSENIC	0.100	U	
BARIUM	4.78		
BERYLLIUM	0.0430	U	
CADMIUM	2.52		
CALCIUM	36.0	U	
CHROMIUM	0.334		
COBALT	0.0280	U	
COPPER	0.520	U	
IRON	20.0	U	
LEAD	0.0750	U	
MAGNESIUM	4.40	U	
MANGANESE	0.440	U	
NICKEL	0.110	U	
POTASSIUM	11.0	U	
SELENIUM	0.147		
SILVER	0.0850	U	
SODIUM	61.2		
THALLIUM	0.0440	U	
VANADIUM	0.0823		
ZINC	1.80	U	

PROJ_NO: 00447

SDG: TT03402 MEDIA: SOIL DATA FRACTION: M

nsample	X5FD10080701	nsample	X7FD10020701	nsample	X7SS0020002
samp_date	10/8/2007	samp_date	10/2/2007	samp_date	10/2/2007 10:45:00 AM
lab_id	TT03402-001	lab_id	TT03402-006	lab_id	TT03402-002
qc_type	NM	qc_type	NM	qc_type	NM
units	MG/KG	units	MG/KG	units	MG/KG
Pct_Solids	84.1	Pct_Solids	83.4	Pct_Solids	83.1
DUP_OF:	X5SS-010G0002	DUP_OF:	X7SS0120002	DUP_OF:	

Parameter	Result	Val Qual	Qual Code
ALUMINUM	13500		
ANTIMONY	0.38	U	A
ARSENIC	4.89		
BARIUM	46.0		
BERYLLIUM	0.345		
CADMIUM	0.366		
CALCIUM	600		
CHROMIUM	19.1		
COBALT	3.50		
COPPER	11.4		
IRON	17100		
LEAD	10.8		
MAGNESIUM	1740		
MANGANESE	89.0		
NICKEL	9.85		
POTASSIUM	860		
SELENIUM	0.234		
SILVER	0.0642		
SODIUM	17.7	U	A
THALLIUM	0.170		
VANADIUM	29.4		
ZINC	31.3		

Parameter	Result	Val Qual	Qual Code
ALUMINUM	16500		
ANTIMONY	0.86	U	A
ARSENIC	8.09		
BARIUM	103		
BERYLLIUM	0.820		
CADMIUM	0.689		
CALCIUM	11200		
CHROMIUM	21.1		
COBALT	12.7		
COPPER	22.3		
IRON	23200		
LEAD	26.6		
MAGNESIUM	2350		
MANGANESE	1210		
NICKEL	17.5		
POTASSIUM	1100		
SELENIUM	0.602		
SILVER	0.103		
SODIUM	38.6	U	A
THALLIUM	0.226		
VANADIUM	35.6		
ZINC	59.5		

Parameter	Result	Val Qual	Qual Code
ALUMINUM	12800		
ANTIMONY	0.71	U	A
ARSENIC	12.9		
BARIUM	110		
BERYLLIUM	0.820		
CADMIUM	0.683		
CALCIUM	2500		
CHROMIUM	24.6		
COBALT	21.9		
COPPER	20.5		
IRON	40200		
LEAD	22.8		
MAGNESIUM	2340		
MANGANESE	694		
NICKEL	28.7		
POTASSIUM	1790		
SELENIUM	0.650		
SILVER	0.102		
SODIUM	75.7	U	A
THALLIUM	0.250		
VANADIUM	29.6		
ZINC	59.3		

PROJ_NO: 00447

SDG: TT03402 MEDIA: SOIL DATA FRACTION: M

nsample	X7SS0030002	nsample	X7SS0040002	nsample	X7SS0120002
samp_date	10/2/2007 10:25:00 AM	samp_date	10/2/2007 11:00:00 AM	samp_date	10/2/2007 3:04:00 PM
lab_id	TT03402-003	lab_id	TT03402-004	lab_id	TT03402-005
qc_type	NM	qc_type	NM	qc_type	NM
units	MG/KG	units	MG/KG	units	MG/KG
Pct_Solids	86.7	Pct_Solids	85.9	Pct_Solids	73.4
DUP_OF:		DUP_OF:		DUP_OF:	

Parameter	Result	Val Qual	Qual Code
ALUMINUM	7910		
ANTIMONY	5.8	J	G
ARSENIC	16.4		
BARIUM	907		
BERYLLIUM	1.35		
CADMIUM	1.09		
CALCIUM	4430		
CHROMIUM	66.6		
COBALT	14.3		
COPPER	21.7		
IRON	90700		
LEAD	140		
MAGNESIUM	923		
MANGANESE	974		
NICKEL	50.2		
POTASSIUM	626		
SELENIUM	0.559		
SILVER	0.117		
SODIUM	22.7	U	A
THALLIUM	0.0808		
VANADIUM	46.3		
ZINC	110		

Parameter	Result	Val Qual	Qual Code
ALUMINUM	8600		
ANTIMONY	11.1	J	G
ARSENIC	9.34		
BARIUM	949		
BERYLLIUM	0.670		
CADMIUM	0.923		
CALCIUM	1810		
CHROMIUM	25.0		
COBALT	13.5		
COPPER	33.8		
IRON	37600		
LEAD	125		
MAGNESIUM	999		
MANGANESE	749		
NICKEL	16.8		
POTASSIUM	1040		
SELENIUM	0.460		
SILVER	0.113		
SODIUM	21.1	U	A
THALLIUM	0.138		
VANADIUM	23.7		
ZINC	111		

Parameter	Result	Val Qual	Qual Code
ALUMINUM	14000		
ANTIMONY	1.6	J	G
ARSENIC	7.93		
BARIUM	95.6		
BERYLLIUM	0.909		
CADMIUM	0.959		
CALCIUM	13400		
CHROMIUM	22.3		
COBALT	11.4		
COPPER	30.9		
IRON	37200		
LEAD	43.9		
MAGNESIUM	2130		
MANGANESE	1370		
NICKEL	17.8		
POTASSIUM	1190		
SELENIUM	0.618		
SILVER	0.110		
SODIUM	36.8	U	A
THALLIUM	0.204		
VANADIUM	34.9		
ZINC	68.1		

PROJ_NO: 00447

SDG: TT03402 MEDIA: SOIL DATA FRACTION: M

nsample	X7SS0190002	nsample	X7SS0390002	nsample	X7SS0440002
samp_date	10/2/2007 3:40:00 PM	samp_date	10/3/2007 11:50:00 AM	samp_date	10/3/2007 1:20:00 PM
lab_id	TT03402-007	lab_id	TT03402-009	lab_id	TT03402-010
qc_type	NM	qc_type	NM	qc_type	NM
units	MG/KG	units	MG/KG	units	MG/KG
Pct_Solids	92.2	Pct_Solids	88.4	Pct_Solids	87.4
DUP_OF:		DUP_OF:		DUP_OF:	

Parameter	Result	Val Qual	Qual Code
ALUMINUM	13300		
ANTIMONY	3.7	J	G
ARSENIC	5.69		
BARIUM	118		
BERYLLIUM	0.873		
CADMIUM	0.712		
CALCIUM	4700		
CHROMIUM	21.0		
COBALT	12.4		
COPPER	427		
IRON	29200		
LEAD	537		
MAGNESIUM	1950		
MANGANESE	950		
NICKEL	24.8		
POTASSIUM	1780		
SELENIUM	0.553		
SILVER	0.105		
SODIUM	57.8	U	A
THALLIUM	0.157		
VANADIUM	27.1		
ZINC	148		

Parameter	Result	Val Qual	Qual Code
ALUMINUM	15300		
ANTIMONY	96.2	J	G
ARSENIC	7.20		
BARIUM	91.2		
BERYLLIUM	0.637		
CADMIUM	0.895		
CALCIUM	26700		
CHROMIUM	20.4		
COBALT	9.72		
COPPER	94.6		
IRON	26600		
LEAD	495		
MAGNESIUM	7000		
MANGANESE	737		
NICKEL	14.5		
POTASSIUM	1100		
SELENIUM	0.406		
SILVER	0.109		
SODIUM	65.3	U	A
THALLIUM	0.197		
VANADIUM	32.1		
ZINC	89.8		

Parameter	Result	Val Qual	Qual Code
ALUMINUM	14900		
ANTIMONY	4.5	J	G
ARSENIC	6.34		
BARIUM	61.0		
BERYLLIUM	0.553		
CADMIUM	0.462		
CALCIUM	735		
CHROMIUM	24.1		
COBALT	12.1		
COPPER	96.1		
IRON	32100		
LEAD	199		
MAGNESIUM	1680		
MANGANESE	709		
NICKEL	11.7		
POTASSIUM	852		
SELENIUM	0.249		
SILVER	0.0640		
SODIUM	59.2	U	A
THALLIUM	0.170		
VANADIUM	32.5		
ZINC	50.3		

PROJ_NO: 00447

SDG: TT03402 MEDIA: SOIL DATA FRACTION: M

nsample	X7SS0450002	nsample	X7SS0460002	nsample	X7SS1790002
samp_date	10/3/2007 12:38:00 PM	samp_date	10/3/2007 12:44:00 PM	samp_date	10/7/2007 10:30:00 AM
lab_id	TT03402-011	lab_id	TT03402-012	lab_id	TT03402-013
qc_type	NM	qc_type	NM	qc_type	NM
units	MG/KG	units	MG/KG	units	MG/KG
Pct_Solids	85.7	Pct_Solids	84.5	Pct_Solids	74.3
DUP_OF:		DUP_OF:		DUP_OF:	

Parameter	Result	Val Qual	Qual Code
ALUMINUM	13400		
ANTIMONY	3.9	J	G
ARSENIC	7.72		
BARIUM	69.4		
BERYLLIUM	0.601		
CADMIUM	0.387		
CALCIUM	917		
CHROMIUM	27.4		
COBALT	13.7		
COPPER	128		
IRON	38600		
LEAD	286		
MAGNESIUM	1610		
MANGANESE	919		
NICKEL	14.0		
POTASSIUM	788		
SELENIUM	0.273		
SILVER	0.0695		
SODIUM	16.1	U	
THALLIUM	0.181		
VANADIUM	34.7		
ZINC	52.3		

Parameter	Result	Val Qual	Qual Code
ALUMINUM	16300		
ANTIMONY	24.5	J	G
ARSENIC	7.38		
BARIUM	85.3		
BERYLLIUM	0.776		
CADMIUM	0.594		
CALCIUM	3670		
CHROMIUM	23.4		
COBALT	12.0		
COPPER	283		
IRON	22900		
LEAD	1100		
MAGNESIUM	2760		
MANGANESE	1060		
NICKEL	15.7		
POTASSIUM	1100		
SELENIUM	0.368		
SILVER	0.115		
SODIUM	34.1	U	A
THALLIUM	0.223		
VANADIUM	35.9		
ZINC	79.4		

Parameter	Result	Val Qual	Qual Code
ALUMINUM	11500		
ANTIMONY	2.0	J	G
ARSENIC	11.0		
BARIUM	56.2		
BERYLLIUM	0.769		
CADMIUM	0.439		
CALCIUM	1110		
CHROMIUM	39.2		
COBALT	14.4		
COPPER	29.2		
IRON	38400		
LEAD	83.6		
MAGNESIUM	1190		
MANGANESE	637		
NICKEL	13.6		
POTASSIUM	592		
SELENIUM	0.322		
SILVER	0.0593		
SODIUM	23.8	U	A
THALLIUM	0.147		
VANADIUM	35.9		
ZINC	42.2		

PROJ_NO: 00447

SDG: TT03402 MEDIA: SOIL DATA FRACTION: M

nsample	X7SS1800002	nsample	X7SS1810002	nsample	X7SS1820002
samp_date	10/7/2007 10:55:00 AM	samp_date	10/7/2007 11:03:00 AM	samp_date	10/7/2007 11:12:00 AM
lab_id	TT03402-014	lab_id	TT03402-015	lab_id	TT03402-016
qc_type	NM	qc_type	NM	qc_type	NM
units	MG/KG	units	MG/KG	units	MG/KG
Pct_Solids	85.6	Pct_Solids	83.6	Pct_Solids	86.1
DUP_OF:		DUP_OF:		DUP_OF:	

Parameter	Result	Val Qual	Qual Code
ALUMINUM	16200		
ANTIMONY	2.1	J	G
ARSENIC	15.0		
BARIUM	81.8		
BERYLLIUM	0.827	J	C
CADMIUM	1.32		
CALCIUM	1020		
CHROMIUM	32.2		
COBALT	19.2		
COPPER	51.9		
IRON	31500		
LEAD	89.0		
MAGNESIUM	2280		
MANGANESE	544		
NICKEL	27.0		
POTASSIUM	1210		
SELENIUM	0.604		
SILVER	0.186		
SODIUM	138		
THALLIUM	0.390		
VANADIUM	78.0		
ZINC	74.8		

Parameter	Result	Val Qual	Qual Code
ALUMINUM	14800		
ANTIMONY	5.3	J	G
ARSENIC	8.77		
BARIUM	118		
BERYLLIUM	1.20		
CADMIUM	0.572		
CALCIUM	1080		
CHROMIUM	45.9		
COBALT	11.2		
COPPER	63.8		
IRON	35800		
LEAD	212		
MAGNESIUM	1810		
MANGANESE	571		
NICKEL	32.4		
POTASSIUM	715		
SELENIUM	0.279		
SILVER	0.0620		
SODIUM	19.1	U	A
THALLIUM	0.133		
VANADIUM	73.2		
ZINC	96.5		

Parameter	Result	Val Qual	Qual Code
ALUMINUM	11700		
ANTIMONY	2.8	J	G
ARSENIC	15.1		
BARIUM	61.5		
BERYLLIUM	0.703	J	C
CADMIUM	0.823		
CALCIUM	1040		
CHROMIUM	35.2		
COBALT	22.6		
COPPER	44.2		
IRON	45700		
LEAD	95.1		
MAGNESIUM	1140		
MANGANESE	641		
NICKEL	22.1		
POTASSIUM	810		
SELENIUM	0.373		
SILVER	0.0985		
SODIUM	40.9		
THALLIUM	0.224		
VANADIUM	57.0		
ZINC	47.0		

PROJ_NO: 00447

SDG: TT03402 MEDIA: SOIL DATA FRACTION: M

nsample	X7SS1830002	nsample	X7SS1840002	nsample	X7SS1890002
samp_date	10/7/2007 11:30:00 AM	samp_date	10/7/2007 11:45:00 AM	samp_date	10/9/2007 3:27:00 PM
lab_id	TT03402-017	lab_id	TT03402-018	lab_id	TT03402-019
qc_type	NM	qc_type	NM	qc_type	NM
units	MG/KG	units	MG/KG	units	MG/KG
Pct_Solids	77.3	Pct_Solids	85.4	Pct_Solids	84.7
DUP_OF:		DUP_OF:		DUP_OF:	

Parameter	Result	Val Qual	Qual Code
ALUMINUM	19400		
ANTIMONY	0.59	U	A
ARSENIC	17.0		
BARIUM	92.9		
BERYLLIUM	0.718	J	C
CADMIUM	1.90		
CALCIUM	18700		
CHROMIUM	28.5		
COBALT	16.9		
COPPER	48.2		
IRON	29700		
LEAD	28.8		
MAGNESIUM	3910		
MANGANESE	334		
NICKEL	29.7		
POTASSIUM	1740		
SELENIUM	0.913		
SILVER	0.238		
SODIUM	138		
THALLIUM	0.525		
VANADIUM	85.9		
ZINC	74.3		

Parameter	Result	Val Qual	Qual Code
ALUMINUM	15600		
ANTIMONY	0.38	U	A
ARSENIC	12.5		
BARIUM	73.7		
BERYLLIUM	0.625	J	C
CADMIUM	1.32		
CALCIUM	1790		
CHROMIUM	21.1		
COBALT	18.8		
COPPER	33.8		
IRON	24700		
LEAD	25.3		
MAGNESIUM	2620		
MANGANESE	477		
NICKEL	24.3		
POTASSIUM	1180		
SELENIUM	0.367		
SILVER	0.152		
SODIUM	93.5		
THALLIUM	0.394		
VANADIUM	64.3		
ZINC	61.0		

Parameter	Result	Val Qual	Qual Code
ALUMINUM	10000		
ANTIMONY	2.6	J	G
ARSENIC	5.52		
BARIUM	82.8		
BERYLLIUM	0.860		
CADMIUM	0.815		
CALCIUM	1130		
CHROMIUM	16.7		
COBALT	13.3		
COPPER	46.3		
IRON	23200		
LEAD	151		
MAGNESIUM	1020		
MANGANESE	665		
NICKEL	19.6		
POTASSIUM	660		
SELENIUM	0.383		
SILVER	0.126		
SODIUM	64.7	U	A
THALLIUM	0.128	U	A
VANADIUM	25.6		
ZINC	61.8		