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Final

East Vieques Background Soil Inorganics Investigation Report

Former Vieques Naval Training Range,
Vieques, Puerto Rico



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Resumen Ejecutivo

Dentro del Antiguo Campo de Entrenamiento Naval de Vieques (VNTR), también mencionado en este reporte como el Este de Vieques, hay un número de sitios ambientales que están siendo evaluados. Estos sitios ambientales han sido designados en base a su conocimiento o historial potencial pasado como Unidades de Manejo de Desechos Sólidos (SWMUs), áreas de preocupación (AOCs), áreas potenciales de preocupación (PAOCs), y sitios foto-identificados (PI). El propósito de estas evaluaciones es determinar si ha habido escapes de materiales o constituyentes peligrosos al ambiente (en otras palabras, contaminación) resultado de prácticas anteriores en el sitio y, de ser confirmado, evaluar el posible riesgo de contaminación para los humanos, animales, y plantas. Los tipos de contaminantes potencialmente descargados en los sitios ambientales incluyen constituyentes inorgánicos, así como también contaminantes que caen dentro de otras categorías (por ejemplo, compuestos orgánicos volátiles [VOCs]). Tomar la determinación de si un inorgánico detectado en un sitio ambiental en particular se debe a un escape de prácticas pasadas en ese sitio es un desafío, ya que es un hecho de que inorgánicos ocurren naturalmente en el ambiente y también pueden estar presentes por fuentes antropogénicas (hechas por el hombre), (por ejemplo, automóviles, extractores,) en vez de provenir del sitio ambiental bajo investigación. La Isla de Vieques, así como otras islas y continentes en el mundo, está hecha de rocas. Estas rocas, y los suelos que se desarrollan de ellas y en ellas, están formadas principalmente de inorgánicos. En el Este de Vieques, los sitios ambientales bajo investigación se encuentran bajo cuatro zonas geológicas cuya litología y tipos de suelo varían debido a las diferencias de como se formaron las rocas.

Para poder determinar si los inorgánicos encontrados en el suelo de un sitio ambiental en particular están asociados a escapes pasados de ese sitio, es necesario poder distinguir entre concentraciones inorgánicas debido a escapes específicos del sitio y concentraciones inorgánicas que pueden haber estado allí aun en la ausencia del sitio ambiental. Para hacer esto, se debe obtener un conjunto de datos de trasfondo de concentraciones de suelo inorgánico. El conjunto de datos de trasfondo abarca un grupo de datos de suelos inorgánicos que es representativo de vastas concentraciones inorgánicas como resultado de condiciones ocurridas naturalmente y/o fuentes antropogénicas no relacionadas con los sitios ambientales.

A mediados del 2006, las Facilidades Navales del Comando de Ingeniería, División del Atlántico, (Marina) realizó un estudio para recolectar datos representativos de concentraciones inorgánicas de trasfondo en suelos de superficie y subsuelos dentro del Antiguo VNTR. Para hacer esto, la Marina primero estableció un objetivo de estudio de trasfondo y las condiciones sobre las cuales los objetivos serían alcanzados. El objetivo del estudio de trasfondo fue definido como:

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- Establecer concentraciones representativas de trasfondo de suelos inorgánicos que puedan ser comparadas a datos de suelos inorgánicos de un sitio en específico para determinar si cualquier concentración inorgánica detectada en un sitio ambiental en un sitio en particular es atribuible a escapes de estos sitios, o si es consistente con los niveles de trasfondo.

Para alcanzar los objetivos del estudio de trasfondo, las siguientes condiciones fueron definidas:

- No se coleccionarán muestras dentro o adyacentes a los sitios ambientales
- No se coleccionarán muestras dentro de las área de tiro de artillería
- No se coleccionarán muestras dentro de áreas de mantenimiento (por ejemplo, hierba recortada)
- No se coleccionarán muestras dentro de áreas de salidas de superficie obvias
- Todas las muestras serán coleccionadas al menos a 100 pies de las carreteras

El propósito de establecer estas condiciones fue el evitar recolectar muestras dentro de áreas donde las concentraciones de inorgánicos puedan haber sido influenciadas (en otras palabras, aumentadas) de tal manera que ya no sean representativas de niveles amplios de trasfondo.

Además de lo antes dicho, se determinó que 10 localizaciones por zona geológica, y dos profundidades (superficie y subsuelo) serían identificadas de manera que se pueda obtener estadísticamente un número suficiente de muestras de suelo de cada zona geológica, y de cada profundidad de esa zona, en el caso de que las concentraciones inorgánicas de diferentes zonas geológicas o profundidades no puedan ser combinadas.

Basado en las condiciones anteriores, 40 localizaciones propuestas fueron identificadas para las muestras de suelos de trasfondo (10 por zona geológica) marcándolas en un mapa del este de Vieques. Para verificar que las localizaciones propuestas cumplan con los criterios de selección, representantes de la Marina y de las agencias reguladoras realizaron una visita a las localizaciones propuestas para evaluar la aptitud de las condiciones circundantes. Basado en las observaciones hechas durante la visita, 12 localizaciones de muestreo fueron re-localizadas para asegurar la adherencia a los criterios de selección. Luego de la visita de las agencias, se acompañó a varios miembros del público a varias localizaciones de trasfondo propuestas que ellos seleccionaron para visitar. Basado en observaciones hechas durante esta visita, una localización adicional de muestreo fue re-localizada. Más aun, basado en un comentario público, la localización de muestreo 11 que fuera propuesta para incluir en el conjunto de datos de trasfondo fue eliminada porque no cumplía con todos los criterios de selección. Once localizaciones de reemplazo que no alcanzaban los criterios de selección fueron identificadas subsecuentemente. Además, se añadió el análisis de explosivos a los análisis de muestreo según fuera requerido por el público.

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Una vez aprobado el *Final Work Plan and Sampling and Analysis Plan, Soil Inorganics Background Investigation, Former Vieques Naval Training Range, Vieques, Puerto Rico* (CH2M HILL, 2006) por la Agencia de Protección Ambiental de los EE.UU. (EPA), el muestreo de suelos de trasfondo fue completado en junio y julio del 2006. En consulta y de acuerdo con la EPA, cuatro localizaciones de muestreo adicionales fueron re-localizadas durante el trabajo de campo. Además, no se recolectó una muestra de subsuelo debido a la baja profundidad del lecho rocoso en esa localización. Sin embargo, como se demuestra en la Sección 3 de este reporte, la evaluación estadística de los resultados del conjunto de datos indicó que muchos de los puntos (data points) a través de múltiples zonas geológicas y a ambas profundidades pueden ser combinados. Por lo tanto, la única muestra que no se colectó no fue necesaria para desarrollar un conjunto de datos estadísticamente fuerte que es representativo del trasfondo.

Todas las muestras de suelo fueron analizadas por un laboratorio independiente de acuerdo con el SW-846 y los métodos del Programa de Contratación de Laboratorios de la EPA (CLP) y validadas por un validador independiente (tercera-persona). Los resultados del estudio mostraron que con excepción del antimonio, todos los inorgánicos fueron detectados entre las 79 muestras de suelos de superficie y subsuelos a nombre de la Marina. No se detectaron explosivos en ninguna de las 79 muestras. Durante el estudio de trasfondo, la EPA proveyó supervisión y tomó muestras divididas (split samples) en un 20 por ciento (8 localizaciones; 16 muestras). Las muestras divididas son muestras tomadas de los aparatos de muestreo, mezcladas en un recipiente, y entonces divididas en muestras que son analizadas por diferentes laboratorios. El propósito del muestreo dividido es el proveer verificación independiente de los resultados proporcionados por el laboratorio contratado por la Marina. Los resultados de los datos colectados a nombre de la Marina y los datos colectados por la EPA, muestran resultados reportados para inorgánicos similares. Un explosivo fue detectado tentativamente a un nivel muy bajo (respecto al límite de reporte del instrumento) en una muestra de subsuelo analizada por EPA (ningún otro explosivo fue reportado en los datos validados de EPA). Es importante notar que la presencia actual y la concentración del explosivo detectado son cuestionables debido a los problemas de reproductividad del instrumento. Más aun, su presencia o ausencia no posee ningún efecto en el uso de las concentraciones inorgánicas para esa muestra; cuando se compara con otras superficies de subsuelo, las concentraciones de inorgánicos para esta muestra son más bajas. Por lo tanto, para retener los datos inorgánicos para esta muestra en el conjunto de datos de trasfondo es más conservador, (en otras palabras, removerlas del conjunto de datos tendrían potencialmente el efecto de aumentar la media de las concentraciones).

Además de comparar los datos inorgánicos recolectados a través de las localizaciones de trasfondo del este de Vieques con los datos divididos de muestras inorgánicas de la EPA, los datos del trasfondo del este de Vieques también fueron comparados con los datos de suelos inorgánicos de trasfondo recolectados de las mismas zonas geológicas en el oeste de Vieques. Este comparación mostró que los conjuntos de datos del este y el oeste de Vieques son muy similares en términos de inorgánicos detectados y las concentraciones asociadas.

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Esto provee evidencia adicional de que el conjunto de datos de trasfondo en el este y en el oeste de Vieques son representativos de amplias concentraciones de trasfondo.

Después de comparar los datos a los datos de las muestras divididas de la EPA y los datos de trasfondo del oeste de Vieques, se evaluaron los datos del este de Vieques utilizando métodos publicados y aceptados ampliamente, a la extensión posible y aplicable, de acuerdo con la EPA o otras guías estándares. Como parte de esta evaluación, la presencia de afloramientos en el conjunto de datos fue evaluado y, donde identificados, los afloramientos fueron eliminados del conjunto de datos. Los afloramientos son aquellas concentraciones inorgánicas que se encuentran estadísticamente sobre o juzgadas significativamente más altas que el resto de las concentraciones para un constituyente inorgánico dado. Al remover los afloramientos del conjunto de datos de trasfondo, las concentraciones que pudiesen haber aumentado potencialmente los valores calculados para ser usados como trasfondo fueron removidos. A pesar de que los afloramientos pueden ser actualmente representativos de condiciones de trasfondo reales, estos fueron eliminados como una medida adicional de conservación y para tener en cuenta cualquier influencia aislada en las concentraciones inorgánicas en una localización de trasfondo en particular. En las Tablas ES-1 y ES-2 se presenta el conjunto de datos resultante de la evaluación de los datos validados, el cual de aquí en adelante se refieren como datos de suelos inorgánicos de trasfondo del este de Vieques. La Tabla ES-1 muestra los datos de suelos inorgánicos de trasfondo del este de Vieques y la Tabla ES-2 muestra los datos de subsuelos inorgánicos de trasfondo del este de Vieques. Los valores mostrados son conocidos como Límites de Tolerancia Alta (UTLs). Estos son derivados estadísticamente y representan los valores de partida de trasfondo, de modo que las concentraciones del sitio por debajo de estos valores son considerados indistinguiblemente de trasfondo. Estos son los valores que serán comparados a las concentraciones detectadas de superficies de suelo y concentraciones inorgánicas de subsuelos en sitios ambientales bajo investigación en el este de Vieques.

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Executive Summary

Within the former Vieques Naval Training Range (VNTR), also referred to in this report as east Vieques, there are a number of environmental sites being evaluated. These environmental sites have been designated as solid waste management units (SWMUs), areas of concern (AOCs), potential areas of concern (PAOCs), and photo-identified (PI) sites, based on their known or potential past history. The purpose of the evaluations is to make determinations of whether there have been releases of hazardous material or hazardous constituents (in other words, contamination) to the environment from past practices at the sites and, if confirmed, to assess the potential risks to humans, animals, and plants from the contamination. The types of contaminants potentially released at environmental sites include inorganic constituents, as well as contaminants that fall into other categories (volatile organic compounds [VOCs], for example). One challenge to making the determination of whether inorganics detected at a particular environmental site were released from past practices at that particular site is the fact that inorganics occur naturally in the environment and may also be present from anthropogenic (man-made) sources (automobile exhaust, for example) other than the environmental site under investigation. The island of Vieques, as well as every other island and continent in the world, is made of rocks. These rocks, and the soils that develop from and on them, are made up primarily of inorganics. On east Vieques, the environmental sites under investigation lie within four geologic zones whose lithology and soil types vary due to differences in how the rocks were formed.

In order to determine whether inorganics found in the soil of a particular environmental site are associated with past releases from that site, it is necessary to be able to distinguish inorganic concentrations due to site-specific releases from inorganic concentrations that would be there even in the absence of the environmental site. To do this, a background dataset of soil inorganic concentrations must be gathered. The background dataset comprises a group of soil inorganic data that is representative of wide-ranging inorganic concentrations resulting from naturally occurring conditions and/or broad-based anthropogenic sources unrelated to the environmental sites.

In mid-2006, the Naval Facilities Engineering Command, Atlantic Division (Navy) performed a study to collect data representative of background inorganic concentrations in surface soil and subsurface soil within the former VNTR. To do this, the Navy first established a background study objective and the conditions upon which the objective would be met. The background study objective was defined as:

- Establish representative background concentrations of soil inorganics that can be compared to site-specific soil inorganic data to assess whether inorganic concentrations detected at a particular environmental site are attributable to releases from these sites or consistent with background levels.

To achieve the background study objective, the following conditions were defined:

- No samples would be collected within or adjacent to environmental sites

- No samples would be collected within the artillery range fan areas
- No samples would be collected within maintained areas (mowed grass, for example)
- No samples would be collected within areas of obvious surface runoff
- All samples would be collected at least 100 feet away from roads

The purpose of establishing these conditions was to avoid collecting samples within areas where the inorganic concentrations may have been influenced (in other words, increased) such that they would not be representative of the wide-ranging background levels.

In addition to the above, it was determined that 10 background locations per geologic zone, and two depths (surface and subsurface) would be identified so that a statistically sufficient number of soil samples would result for each geologic zone, and each depth in that zone, in the event that the inorganic concentrations from different geologic zones or depths could not be combined.

Based on the above conditions, 40 proposed background soil sample locations were identified (10 locations per geologic zone) by spotting them on a map of east Vieques. In order to verify the proposed locations met the selection criteria, representatives of the Navy and regulatory agencies performed a tour of the proposed locations to assess the appropriateness of surrounding conditions. Based on observations made during the tour, 12 sample locations were re-located to ensure adherence to the selection criteria. Following the agency tour, members of the public were escorted to various proposed background locations they selected to see. Based on observations made during this tour, an additional sample location was re-located. Further, based on a public comment, the 11 existing sample locations that were proposed for inclusion in the background dataset were eliminated because they did not meet all selection criteria. Eleven replacement locations were subsequently identified that did meet the selection criteria. In addition, explosives analysis was added to the sample analyses at the request of the public.

Upon approval of the *Final Work Plan and Sampling and Analysis Plan, Soil Inorganics Background Investigation, Former Vieques Naval Training Range, Vieques, Puerto Rico* (CH2M HILL, 2006) by the U.S. Environmental Protection Agency (EPA), the background soil sampling effort was conducted in June and July 2006. In consultation with and concurrence by EPA, four additional sample locations were relocated during the field effort. Additionally, one subsurface soil sample was not collected due to the shallow depth of bedrock in that location. However, as demonstrated in Section 3 of this report, statistical evaluation of the resulting dataset indicated many of the data points across multiple geologic zones and at both depths could be combined. Therefore, the single sample not collected was not needed in order to develop a statistically robust dataset that is representative of background.

All soil samples were analyzed by an independent laboratory in accordance with SW-846 and EPA Contract Laboratory Program (CLP) methods, and validated by an independent, third-party validator. The results of the study show that other than antimony, all inorganics were detected among the 79 surface and subsurface soil samples collected on behalf of the Navy. No explosives were detected in any of the 79 samples. During the Background study, EPA provided oversight and split-sample collection at 20 percent (8 locations; 16 samples). Split samples are samples that are taken from the sampling apparatus, mixed in a bowl, and then divided into samples that are analyzed by different laboratories. The purpose of split

sampling is to provide independent verification of the results provided by the Navy-contractor laboratory. Comparison of the data collected on behalf of the Navy and data collected by EPA show very similar results reported for inorganics. One explosive was tentatively detected at a very low level (with respect to the instrument reporting limit) in one subsurface sample analyzed by EPA (no other explosives were reported in the validated EPA data). It is important to note that the actual presence and concentration of the detected explosive are questionable due to instrument reproducibility problems. Further, its presence or absence had no effect on the usability of the inorganic concentrations for that sample; when ranked among other subsurface samples, the inorganic concentrations for this sample are lower. Therefore, to retain the inorganic data for this sample in the Background dataset is more conservative (in other words, to remove it from the dataset would potentially have the effect of raising the mean concentrations).

In addition to comparing the inorganic data collected across east Vieques Background locations to EPA split-sample inorganic data, the east Vieques Background data were also compared to the Background soil inorganic data collected from the same geologic zones on west Vieques. This comparison showed that the east and west Vieques datasets are very similar in terms of detected inorganics and their associated concentrations. This provides additional evidence that the east and west Vieques Background datasets are representative of broad background concentrations.

After comparing the data to the EPA split sample data and the west Vieques Background data, the east Vieques validated data were evaluated using widely accepted, published methods and, to the extent possible and applicable, in accordance with EPA or other standard guidance. As part of this evaluation, the presence of outliers in the dataset was evaluated and, where identified, outliers were eliminated from the dataset. Outliers are those inorganic concentrations that are statistically above or otherwise judged to be significantly higher than the rest of the concentrations for a give inorganic constituent. By removing outliers from the Background dataset, concentrations that would have potentially elevated the calculated values to be used as Background were removed. Although outliers may in actuality be representative of true background conditions, they were eliminated as an extra measure of conservatism and to take into account any isolated influence on the inorganic concentrations at a particular background location.

The dataset resulting from the evaluation of the validated data, hereafter referred to as the east Vieques soil inorganics background data, is displayed in Tables ES-1 and ES-2. Table ES-1 displays the east Vieques background surface soil inorganic data and Table ES-2 displays the east Vieques background subsurface soil inorganic data. The values shown are known as Upper Tolerance Limits (UTLs). They are statistically derived and represent background threshold values, such that site concentrations below these values are considered to be indistinguishable from background. These are the values that will be compared to surface soil and subsurface soil inorganic concentrations detected at environmental sites under investigation on east Vieques.

Table ES-1
 East Vieques Background Surface Soil Inorganics UTLs
 East Vieques Background Soil Inorganics Investigation
 Former Vieques Naval Training Range, Vieques, Puerto Rico

Inorganic Constituent	Background Concentration UTL			
	KTd	Kv	Qa	TI
Aluminum	35,000	35,000	35,000	35,000
Antimony	NA	NA	NA	NA
Arsenic	1.6	1.6	1.6	9.2
Barium	147	212	212	212
Beryllium	0.27	0.27	0.27	0.95
Cadmium	2.2	2.2	2.2	2.4
Calcium	8,840	8,840	11,900	417,000
Chromium	72	72	72	70
Cobalt	16	26	16	16
Copper	66	94	53	94
Cyanide	0.33	0.33	0.33	0.45
Iron	38,100	43,200	38,100	38,100
Lead	5.4	5.4	5.4	16
Magnesium	3,710	22,200	22,200	22,200
Manganese	1,630	1,630	1,630	1,630
Mercury	0.057	0.057	0.057	0.31
Nickel	22	41	22	41
Potassium	5,270	5,270	5,270	10,800
Selenium	0.51	0.51	0.51	1.3
Silver	0.22	0.22	0.22	0.22
Sodium	1,590	1,590	1,590	1,590
Thallium	0.13	0.13	0.13	0.13
Vanadium	144	144	144	56
Zinc	32	32	32	32

Notes:

All concentrations in mg/kg

NA = not applicable

Table ES-2
 East Vieques Background Subsurface Soil Inorganics UTLs
 East Vieques Background Soil Inorganics Investigation
 Former Vieques Naval Training Range, Vieques, Puerto Rico

Inorganic Constituent	Background Concentration UTL			
	KTd	Kv	Qa	Tl
Aluminum	35,000	35,000	35,000	35,000
Antimony	NA	NA	NA	NA
Arsenic	1.6	1.6	1.6	9.2
Barium	147	212	212	212
Beryllium	0.27	0.27	0.27	0.95
Cadmium	2.2	2.2	2.2	2.4
Calcium	8,840	8,840	11,900	417,000
Chromium	72	72	72	70
Cobalt	16	26	16	16
Copper	66	94	53	94
Cyanide	0.89	0.89	0.89	2.8
Iron	38,100	43,200	38,100	38,100
Lead	3.3	3.3	3.3	7.7
Magnesium	3,710	22,200	22,200	22,200
Manganese	1,630	1,630	1,630	1,630
Mercury	0.057	0.057	0.057	0.31
Nickel	22	41	22	41
Potassium	2,000	2,000	2,000	10,800
Selenium	0.51	0.51	0.51	1.3
Silver	0.22	0.22	0.22	0.22
Sodium	2,250	2,250	2,250	2,250
Thallium	0.13	0.13	0.13	0.13
Vanadium	144	144	144	56
Zinc	32	32	32	32

Notes:

All concentrations in mg/kg

NA = not applicable

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Acronyms and Abbreviations

ANOVA	Analysis of Variance
AOC	Area of Concern
bls	below land surface
CLEAN	Comprehensive Long-Term Environmental Action Navy
CLP	Contract Laboratory Program
EDQI	Environmental Data Quality, Inc.
EPA	U.S. Environmental Protection Agency
FWS	U.S. Fish and Wildlife Service
GPS	Global Positioning System
ID	Identification
MDL	Method Detection Limit
NAVFAC	Naval Facilities Engineering Command
NOAA	National Oceanic and Atmospheric Administration
PAOC	Potential Area of Concern
PI	Photo-identified
PREQB	Puerto Rico Environmental Quality Board
PRG	Preliminary Remediation Goal
RL	Reporting Limit
SOP	Standard Operating Procedure
SWMU	Solid Waste Management Unit
TAL	Target Analyte List
TOC	Total Organic Carbon
UTL	Upper Tolerance Limit
USGS	U.S. Geological Survey
VNTR	Vieques Naval Training Range
VOC	Volatile Organic Compound

SECTION 1

Introduction

This report describes the soil inorganics background investigation at the former Vieques Naval Training Range (VNTR), Vieques, Puerto Rico, and was prepared under the Naval Facilities Engineering Command (NAVFAC), Atlantic, Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract N62470-02-D-3052, Contract Task Order 039. The purpose of the soil inorganics background investigation is to:

- Establish representative background concentrations of soil inorganics that can be compared to site-specific soil inorganic data to assess whether inorganic concentrations detected at a particular environmental site (solid waste management unit [SWMU], area of concern [AOC], potential area of concern [PAOC], or photo-identified [PI] site) are attributable to releases from these sites or consistent with background levels.

The soil inorganics background investigation was conducted in accordance with the *Final Work Plan and Sampling and Analysis Plan, Soil Inorganics Background Investigation, Former Vieques Naval Training Range, Vieques, Puerto Rico* (CH2M HILL, 2006), which was reviewed by the U.S. Environmental Protection Agency (EPA) Region 2, Puerto Rico Environmental Quality Board (PREQB), and the U.S. Fish and Wildlife Service (FWS). In addition, comments from the community were solicited and addressed, as appropriate, in the Final Work Plan, which was given formal approval by EPA in a letter to the Navy dated May 24, 2006.

This report is divided into four sections and four appendices:

Section 1 contains objective of the background investigation and physical characteristics of the study area.

Section 2 provides the sampling rationale and technical approach.

Section 3 provides summarizes the sample analytical results and statistical evaluation.

Section 4 lists the references used in preparing this report.

The logs prepared for the soil borings are presented in Appendix A. Photographs taken at the sample locations are displayed in Appendix B. Appendix C contains the validated data summary tables for the samples collected by CH2M HILL, and Appendix D summarizes the data quality evaluation for the surface and subsurface soil data.

All tables and figures are presented at the end of the sections in which they are first referenced.

1.1 Physical Characteristics of the Study Area

The general background of the former VNTR is described in Section 1 of the Master Work Plan (CH2M HILL, 2003a). A regional location map of the former VNTR is provided as Figure 1-1, and a map of east Vieques is provided as Figure 1-2.

A large extent of the former VNTR area is overgrown with very dense vegetation, including much of the former operational areas. Camp Garcia and the associated runway and the helicopter landing area are the only periodically maintained areas in the former VNTR. These features lie within the one of the few relatively flat portions of the study area, while the majority of the remaining area is covered with hills, stream valleys, and coastal zones. Outside the Camp Garcia area, where all of the background soil samples were collected, the vegetation is generally dense, which required manual clearance of access paths to each sampling location.

1.2 Geologic Zones

The geology at the former VNTR is characterized by volcanic and plutonic bedrock overlain by alluvial unconsolidated sediments. The volcanic bedrock consists primarily of andesites of Cretaceous age (Baker, 1999). The plutonic bedrock consists largely of granodiorite and quartz-diorite that is exposed over a large percentage of the island. The alluvium consists of a mixture of sand, silt, and clay.

To ensure that sufficient background soil samples were collected within the same geologic zones as the environmental sites (i.e., SWMUs, AOCs, PAOCs, PI sites), the geology of Vieques Island map (Torres-Gonzalez, 1989) was used to identify the general location and extent of the different geological zones, potentially representative of different soil types developed upon the different lithology. This map was then used to identify sufficient background sample locations within each geologic zone, which were then ground-truthed during a multi-agency site visit, as described in Section 2. Geologic observations made during soil sample collection are summarized in Section 2.3.

Figures 1-3 and 1-4 show the following four geological zones (soil types) in which the environmental sites are located:

1. Qa - Alluvial deposits (sand, silt, and clay)
2. Tl - Marine sedimentary rocks (report indicated variable limestones)
3. Kv - Sandstone, siltstone, conglomerate, lava, tuff, and *tuffaceous breccia*
4. KTd - Plutonic rock made up largely of granodiorite and quartz diorite

Figures 1-3 and 1-4 describe in more detail the lithology of the various geologic zones. Several of the samples shown in Figures 1-3 and 1-4 are shown to lie within a different geologic zone than their designations indicate. However, the geologic zone boundaries shown on the figures are not accurate to within that small a scale. A site visit was made to each sample location to ensure that the soil types collected accurately reflect the soil designations intended.

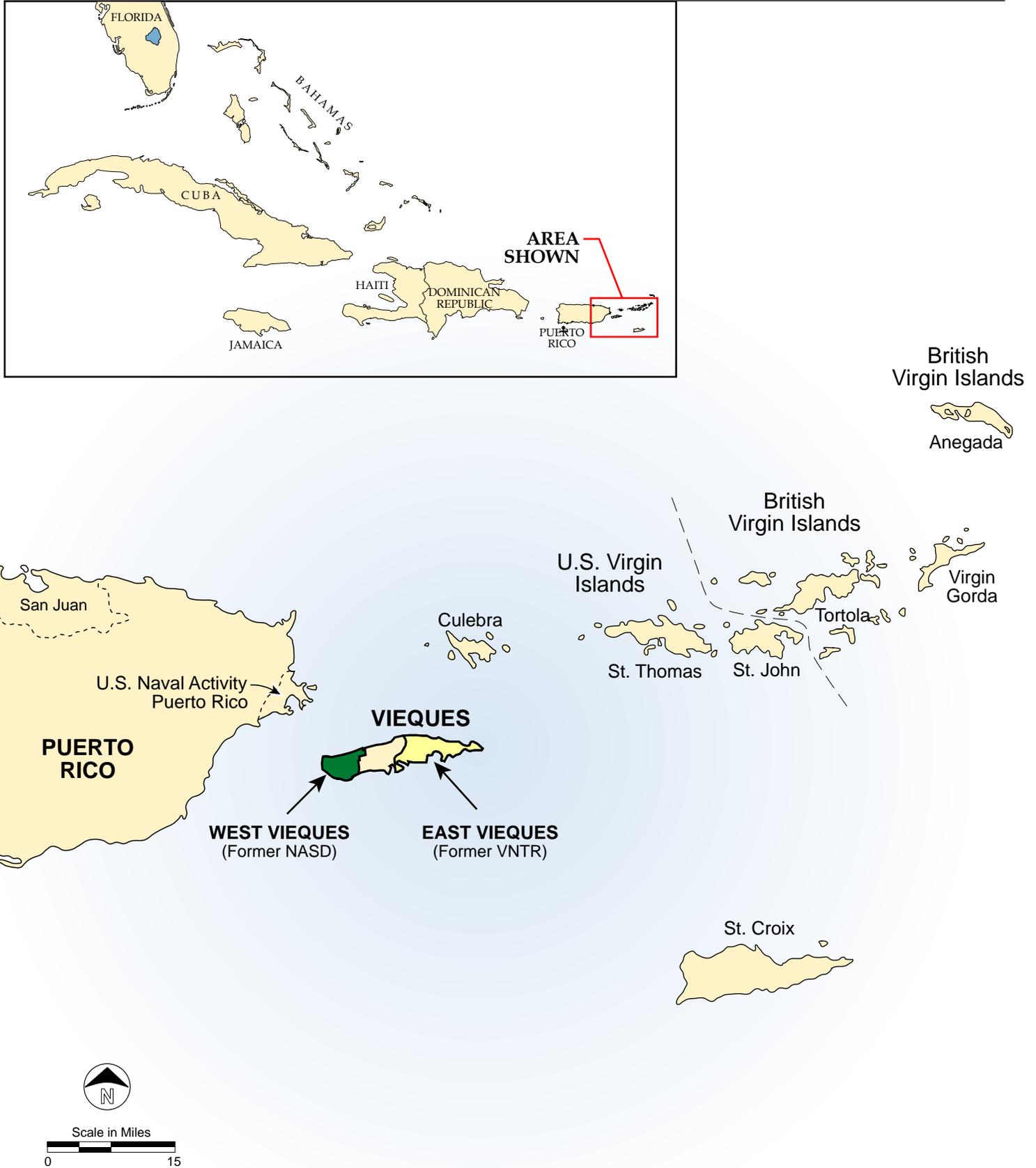
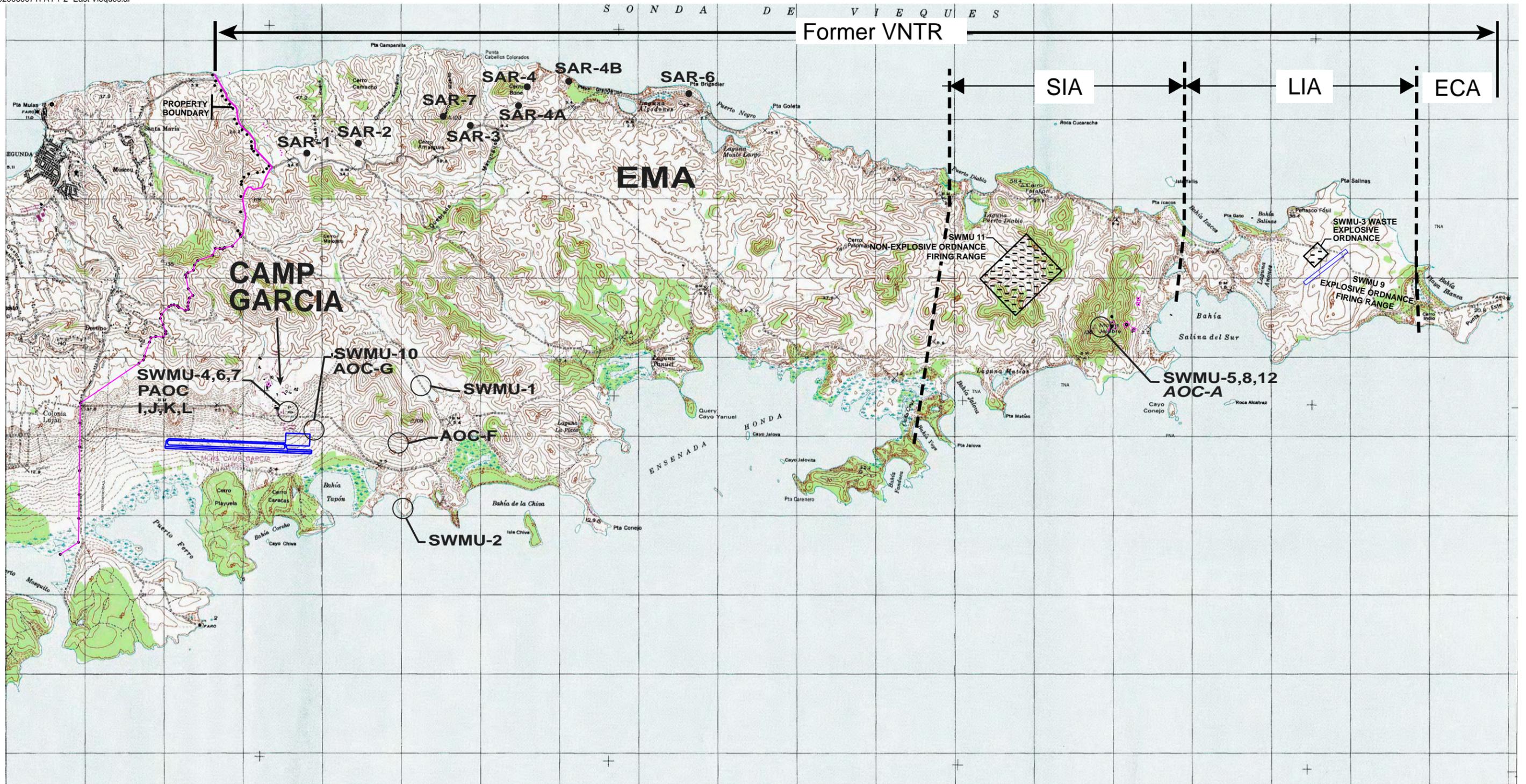


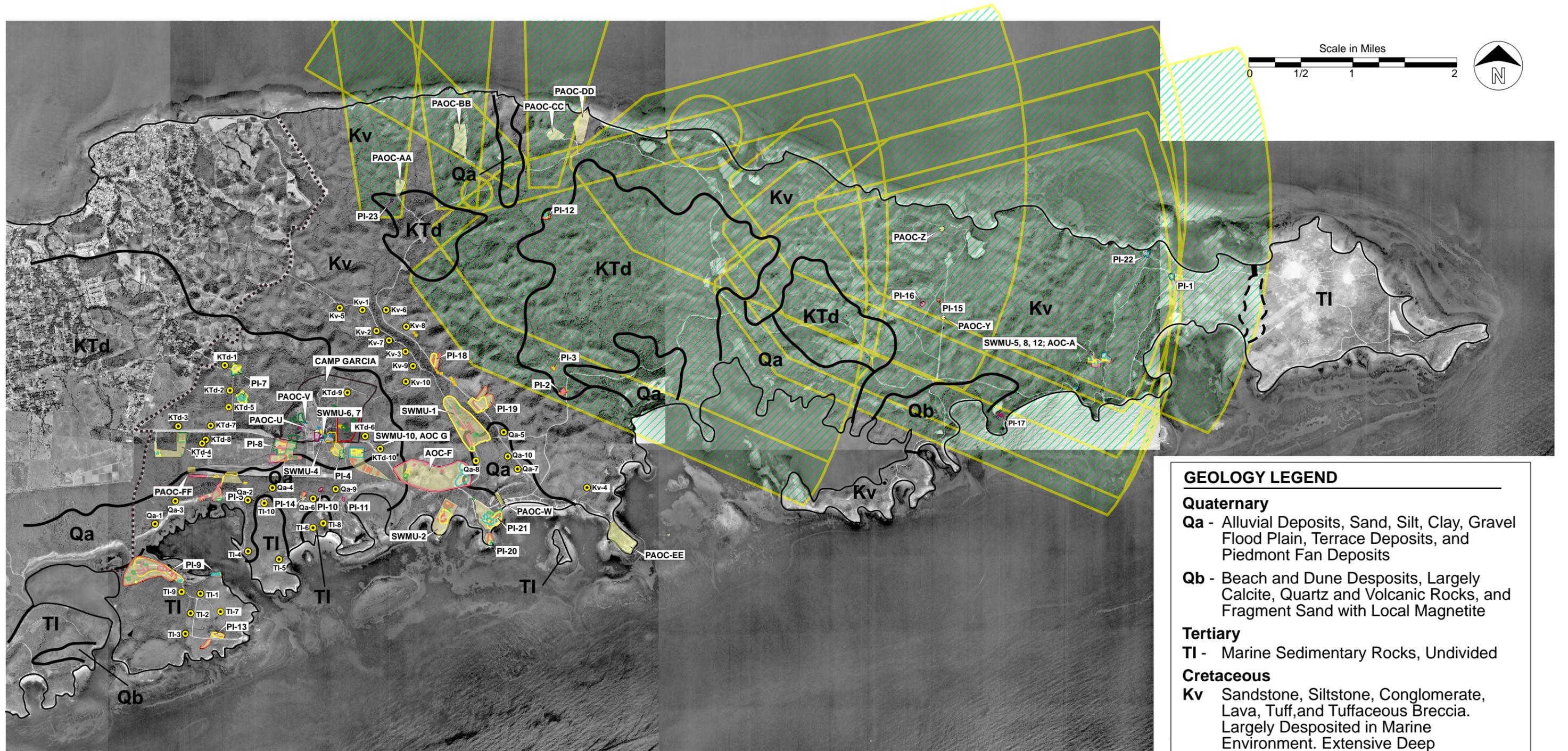
Figure 1-1
Regional Location Map
East Vieques Background Soil Inorganics Investigation
Former Vieques Naval Training Range, Vieques, Puerto Rico



- LEGEND**
- VNTR - Vieques Naval Training Range
 - EMA - Eastern Maneuver Area
 - SIA - Surface Impact Area
 - LIA - Live Impact Area
 - ECA - Eastern Conservation Area
 - SWMU - Solid Waste Management Unit
 - AOC - Area Of Concern
 - PAOC - Potential Area Of Concern
 - SAR - Small Arms Range



FIGURE 1-2
East Vieques
 East Vieques Background Soil Inorganics Investigation
 Former Vieques Naval Training Range, Vieques, Puerto Rico



GEOLOGY LEGEND

Quaternary
Qa - Alluvial Deposits, Sand, Silt, Clay, Gravel Flood Plain, Terrace Deposits, and Piedmont Fan Deposits
Qb - Beach and Dune Desposits, Largely Calcite, Quartz and Volcanic Rocks, and Fragment Sand with Local Magnetite

Tertiary
TI - Marine Sedimentary Rocks, Undivided

Cretaceous
Kv Sandstone, Siltstone, Conglomerate, Lava, Tuff, and Tuffaceous Breccia. Largely Deposited in Marine Environment. Extensive Deep Weathering. Some Limestone.
KTd- Plutonic Rocks, Largely Grandiorite, and Quartz Diorite, Locally Deeply Weathered (from Torres-Gonzalez, 1989)

Base imagery is comprised of 1994 1-meter USGS Digital Ortho-imagery quarter quadrangles (DOQQs).

Aerial Photographic Analysis Findings

- SWMU, AOC, PI Sites
- 1994
- 1985
- 1970
- 1967
- 1964
- 1962
- 1959
- 1936-37

SYMBOL LEGEND

- Soil Sample Locations
- Artillery Safetyfan
- AOC = Area of Concern
- PAOC = Potential Area of Concern
- PI = Photo Identified Site
- SWMU = Solid Waste Management Unit
- Western Perimeter Property Boundary

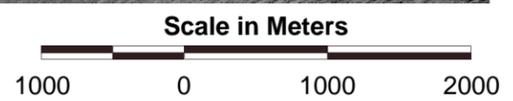
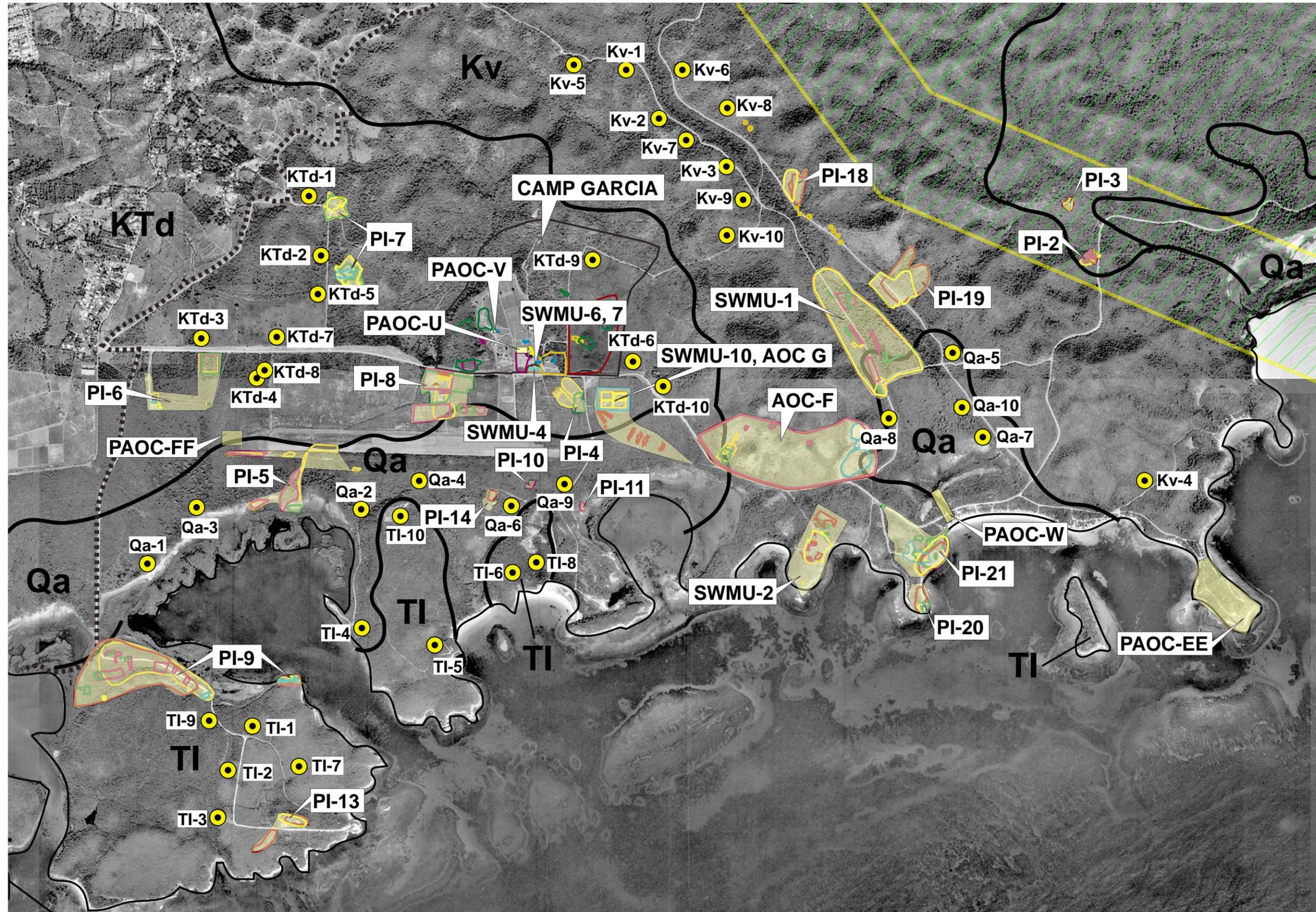


Figure 1-3
Locations of Environmental Sites, Munitions Features, Geologic Zones, and Background Soil Samples
 East Vieques Background Soil Inorganics Investigation
 Former Vieques Naval Training Range, Vieques, Puerto Rico



GEOLOGY LEGEND

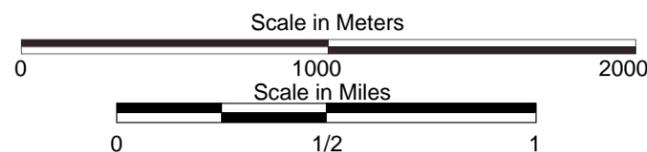
- Quaternary**
Qa - Alluvial Deposits, Sand, Silt, Clay, Gravel Flood Plain, Terrace Deposits, and Piedmont Fan Deposits
- Tertiary**
TI - Marine Sedimentary Rocks, Undivided
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Base imagery is comprised of 1994 1-meter USGS Digital Ortho-imagery quarter quadrangles (DOQQs).

Figure 1-4
Background Sample Locations
 East Vieques Background Soil Inorganics Investigation
 Former Vieques Naval Training Range, Vieques, Puerto Rico

Sampling Rationale and Technical Approach

This section summarizes the sample location selection rationale and technical approach for collecting the background soil samples.

2.1 Sample Location Rationale

As noted previously, the purpose of the background investigation is to provide sufficient data to establish representative background concentration data for inorganics that occur in soil throughout the former VNTR, but that are not indicative of contaminants resulting from releases at a particular site or from any other isolated release. Here, “representative” means a sample set that is typical of the population being sampled. It is also important to emphasize that the background sample locations were chosen to be representative of the target population (i.e., background in this case), which does not require an indiscriminate form of randomness be applied to identifying the locations. Background samples were collected within the same geologic conditions as the environmental sites that are investigated (i.e., SWMUs, AOCs, PAOCs, and PIs) to ensure constituent variations attributable to soil classification differences, if present, are taken into account. Ten soil sample locations (each with a surface soil and subsurface soil sample) were proposed for each of the four geologic units (for a total of 40 locations and, therefore, 80 samples). This was done to ensure sufficient soil data existed for each geologic unit in case the statistical differences in inorganic concentrations among the various geologic units and between the surface and subsurface soil were sufficient enough to prevent combining the various datasets. However, as discussed in Section 3, much of the data among the geologic units and between the surface and subsurface soil were statistically comparable, which permitted various combinations of inorganic concentrations.

Choosing background soil sampling locations required screening out areas of suspected contamination or areas of potential isolated releases [e.g., maintained areas, areas near roads, etc.]. Potential sources of contamination that were avoided in selecting locations for the background samples included SWMUs, AOCs, PIs, PAOCs (i.e., environmental sites), and the known target and fan areas for ordnance fired from either marine artillery gun positions or small arms ranges. The areas of potential impact from live firing were mapped as a series of range fans during the Preliminary Range Assessment (CH2M HILL, 2003b). Background sample locations were not proposed within or adjacent to the environmental sites, nor within the range fan areas. In addition, known roadways and areas of mowing were avoided when identifying background sample locations. All sample locations were a minimum of 100 feet from roadways or mowed areas. Samples were also not collected within areas of obvious surface runoff.

An historical aerial photograph analysis conducted for the former VNTR aided in the selection of appropriate background sampling locations. This analysis evaluated aerial photographs dated 1936-37, 1959, 1962, 1964, 1967, 1970, 1985, and 1994. All of these

photographs were evaluated for the Navy by a firm specializing in the analysis of aerial photography. The aerial photographic analysis was used to:

- Track the operational history of previously identified sites of known or potential contamination
- Track the history of site operations from pre-Navy occupation (pre-World War II) to near-present
- Identify anomalies (e.g., ground scars, cleared areas, debris piles, and possible disposal areas)

The locations and descriptions of the PI sites are summarized in the Draft Final Environmental Baseline Survey for the former VNTR (NAVFACENGCOM, 2003). The locations of the SWMUs, AOCs, PI sites, and PAOCs in relation to the background sample locations are presented in Figures 1-3 and 1-4. The locations of firing fans, illustrating potential impact areas of ordnance fired from marine artillery and small arm ranges, are presented in the Final Draft Preliminary Range Assessment Report (CH2M HILL, 2003b), and are shown on Figure 1-3.

Based on the information above, all background soil samples were collected away from former bombing areas, SWMUs, AOCs, PAOCs, and PIs, and at least 100 feet from roadways or mowed areas. Prior to initiating the investigation, each proposed background sample location was inspected in the field to ensure they met the above selection criteria and that there were no visible signs of anthropogenic influence. On May 6, 2005, representatives from Navy, EPA, PREQB, FWS, National Oceanic and Atmospheric Administration (NOAA) attended a joint site visit to review and concur upon the background soil sample locations proposed in the Draft Final Background Soil Inorganics Work Plan (CH2M HILL, 2005). During the site visit, all except nine proposed locations were concurred upon by the agencies. Nine of the locations were relocated during the site visit to locations mutually concurred upon by all agencies. Visual observations made during the site visit suggested the proposed location of each of these nine soil samples was in close proximity to past activity or other feature that may have influenced the inorganic concentrations. Appendix A of the Final Work Plan (CH2M HILL, 2006) provides a detailed discussion regarding relocation of each of the nine samples.

On May 12, 2005, members of the public were escorted to background sample locations that they selected to see. Based on public comments received during the site visit and additional comments submitted to EPA following the site visit, several additional modifications were made to the background soil sampling locations.

All of the background soil sample location modifications are summarized below:

- Nine soil boring locations (TI-7, Kv-4, Kv-6, Kv-8, Qa-3, Qa-8, Qa-9, Qa-10, and KTd-8) were relocated during the agency site visit (see Appendix A of CH2M HILL, 2006).
- Based on public comment during the site visit, one soil boring (QA-8) was relocated during the public site visit from the downhill side of the road to the uphill side of the road to avoid an area of potential surface runoff.

- Three soil borings (Qa-4, Qa-6, and Qa-9) were relocated during the site visit because FWS noted that their proposed locations were actually within the TI geologic zone even though the U.S. Geological Survey (USGS) map indicated their locations were within the Qa geologic zone.
- Based on public comment made during the site visit and received by EPA, because the 11 existing soil samples proposed for use in the background data set were not collected at least 100 feet from roadways, 11 replacement soil borings were added, to bring to 40 the total number of soil boring locations.
- Based on public comments received by EPA, analysis of explosives was added for all background soil samples. These analyses were conducted to evaluate whether the background sample locations were impacted by the bombing activities at the Live Impact Area.

2.2 Field Sampling Activities

Based on the criteria discussed above, 40 background sample locations were sampled between June 19 and July 7, 2006. From these 40 locations, 40 surface soil samples (0 to 6 inches below land surface [bls]) and 39 co-located subsurface samples (4 to 6 feet bls or from the interval just above bedrock or the water table if either were encountered at a depth shallower than 6 feet) were collected. The subsurface soil sample at location TI-1 was not collected due to the shallow presence of bedrock (see Section 2.5 for more detailed explanation). The locations of all background soil samples are shown in Figure 1-3 and Figure 1-4.

All soil samples were analyzed for Target Analyte List (TAL) inorganics by Method ILM05.3 and explosives by Method SW846 8330. In addition, all samples were analyzed for the characteristic parameters pH by method SW9045, Total Organic Carbon (TOC) by method SW9060MOD, redox potential by SM2580 B, and cation exchange capacity by method 9081. These characteristic parameters can assist in the interpretation of physical and chemical conditions of the different geologic units, if necessary.

All 40 surface soil samples and 39 subsurface samples were collected according to the applicable Standard Operating Procedures (SOPs) for the collection of soil samples. These SOPs can be found in the Master Work Plan (CH2M HILL, 2003a). Pertinent information regarding the soil characteristics and other surrounding features were recorded on each soil boring log (Appendix A) and two photographs were taken at each sample location (one of the entrance to the sampling location and the other at the sample location itself). The pictures of the sample locations are presented in Appendix B. Table 2-1 shows the coordinates of each sampling location, which were recorded using a hand held global positioning system (GPS) unit.

Surface soil samples were collected with a stainless steel hand auger. At each location, the top 6 inches of soil were placed into a stainless steel bowl and mixed with a stainless steel spoon. The surface soil sample was then transferred to the appropriate sampling containers using the stainless steel spoon. At split sample locations, the surface soil samples were split following mixing in the stainless steel bowl.

In order to collect samples for lithologic description between the surface and subsurface depths, continuous soil sampling was continued from the bottom of the surface soil interval to the final depth of each soil boring. A stainless steel hand auger was utilized until downward progress was too difficult, at which time a slide hammer (with an acetate liner) was substituted to finish the soil boring. Once the slide hammer penetrated to 6 feet bls (or encountered bedrock or groundwater above 6 feet bls), the soil in the acetate liner or hand auger in the interval above bedrock (or groundwater) was placed into a stainless steel bowl with the aid of a stainless steel spoon. The soil was then mixed and transferred to the appropriate sampling containers using the stainless steel spoon. At split sample locations, the subsurface soil samples were split following mixing in the stainless steel bowl.

Table 2-2 lists each sample location and the corresponding depths at which the samples were collected. If the subsurface sample was collected above the 4-to-6-ft interval, the reason is listed.

2.3 Sample Location Geology

As noted in Section 1.1.1, there are four geologic zones in which the east Vieques environmental sites are located. Each geological zone represents different depositional environments, different soil characteristics, and potentially different chemical characteristics. The descriptions of the soils collected at each boring location are discussed in this subsection; more detailed information can be found on each soil boring log in Appendix A.

Typically, the terrain for the Qa samples is low-lying coastal areas, while KTd, Kv, and TI samples are in the more upland areas throughout the study area. As anticipated, the Qa locations have a mixture of different soils, which range from Poorly Graded Sand with Clay, to Lean Clay with Sand, to Sandy Silt with Gravel. These soil types generally extend from ground surface to at least 6 feet bls (maximum final depth of borings). Six locations within the Qa soil type did not reach 6 feet bls: two locations encountered groundwater, two locations reached competent bedrock, and two locations encountered weathered bedrock.

Generally, the top 2 feet of KTd soil borings consist of a moist Lean Clay with Sand or a Sandy Lean Clay. With depth, the amount of sand increases, and the majority of the material below 2 feet bls is a dry Sandy Lean Clay. Bedrock was not reached at the majority of the KTd boring locations. At the two locations where it was encountered, the bedrock was observed to be weathered.

The Kv soil generally consists of a moist Lean Clay or Lean Clay with gravel in the upper 1 to 2 feet bls. Below approximately 2 feet bls, about half of Kv locations consist of a dry, Sandy Lean Clay soil, and the other half consists of a dry Sandy Lean Clay with Gravel. Six of the 10 boring locations reached weathered bedrock between 3 and 5 feet bls.

For the TI locations, 9 of the 10 borings encountered moist Organic Soil for approximately the top 2 feet, many with an abundance of roots. Below the Organic Soil, all of the soil borings encountered competent bedrock at a depth of 2 feet bls or less.

2.4 Sample Identification and Analyses

Table 2-3 presents the sample identifications (IDs) used for all surface and subsurface samples taken during the background investigation (samples split with EPA are shown with a double asterisk in the table). Each sample was given a unique sample ID with information on the location name, sample number, depth interval, and collection date.

Example Surface Soil Sample

EBGKTD-SS01-06-06B

where: E - East Vieques, BG - Background, KTD - geological zone, SS01 - Surface Soil sample #1, 06 - sample collected 0 to 6 inches bls, 06B - sampled in the second calendar quarter (i.e., B) of 2006.

Example Subsurface Soil Sample

EBGKTD-SB01-46-06B

where: E - East Vieques, BG - Background, KTD - geological zone, SB01 - Subsurface Soil sample #1, 46 - sample collected from 4 to 6 feet bls, 06B - sampled in the second calendar quarter of 2006.

The background samples collected by CH2M HILL were shipped to CompuChem Laboratory of Cary, North Carolina for analysis. Once analyzed, the data were sent to Environmental Data Quality, Inc. (EDQI) of Exton, Pennsylvania, who performed the independent, third-party data validation. The validated data are presented in Appendix C. The Data Quality Evaluation Reports for the surface soil and subsurface soil are presented in Appendix D. These Data Quality Evaluation Reports summarize the assessment of the effect of the overall analytical process on the quality and usability of the data.

2.5 Deviations from the Work Plan

During the field effort, there were several deviations from the Final Work Plan (CH2M HILL, 2006). However, none of the deviations adversely affected the integrity or quality of the samples; the background dataset acquired is both robust and appropriate for its intended use. This subsection describes the Work Plan deviations and the rationale/explanation for the deviations.

Four sampling locations were moved during the field event from the locations shown in the Final Work Plan (CH2M HILL, 2006). These locations were KTd-1, KTd-10, TI-4, and Qa-6, all of which were relocated within the same geologic zone as the original sample locations. All sample location changes were discussed with and approved by the EPA and EQB prior to the locations being moved. KTd-1 and KTd-10 were moved to more accessible locations. The original locations of KTd-1 and KTd-10 were too far into the dense vegetation to be reached safely by the field team while carrying sampling equipment. TI-4 was moved from original location due to the presence of bedrock at 6 inches below ground surface. Qa-6 was moved from its original location because the original location was inundated with water at the time of the sampling event. Although collected in a different location than originally planned, each of the relocated samples still met the sample location selection criteria documented in

the Final Work Plan (CH2M HILL, May 2006) and, therefore, appropriately represented background locations.

All subsurface samples were to be taken from 4-to-6 feet bls or just above bedrock or groundwater when encountered at depths shallower than 6 feet bls. At the TI-1 sampling location, bedrock was reached at 6 inches bls, so a subsurface sample was not taken at this location. Of the nine subsurface samples collected in the geological zone TI, four were collected from 6 inches to 1 foot bls, two were collected from 6 inches to 18 inches bls, and three were collected from 6 inches to 2 feet bls due to the presence of shallow bedrock. Although technically a deviation from the Work Plan, subsurface sample collection depths other than 4-to-6 feet bls accurately reflect the subsurface soil conditions within the geologic zones and are, therefore, appropriate representations of background conditions. Further, the absence of one subsurface soil sample (i.e., at TI-1) does not adversely affect the quality of the background dataset because there are a sufficient number of subsurface soil samples from other geologic units that are statistically comparable to the TI dataset to permit combining data.

The explosives reporting limit (RL) in the Work Plan, which referenced the 2003 Master QAPP (CH2M HILL, 2003a), is 250 $\mu\text{g}/\text{kg}$. However, the laboratory utilized achievable reporting limits provided in a more recent QAPP, following the process provided in the Draft Final Master Quality Assurance Project Plan, Environmental Restoration Program, Vieques, Puerto Rico (CH2M HILL, February 2007), which superseded the 2003 Master QAPP. The lab achieved RLs of 620 $\mu\text{g}/\text{kg}$ for some explosives and 1,200 $\mu\text{g}/\text{kg}$ for others (see validated analytical data tables in Appendix C). Although the laboratory RLs were higher than those stated in the Work Plan, this did not adversely affect the objective of the study to collect a statistically robust and representative set of background data for soil inorganics. First, EPA collected split samples from all soil types during the background investigation, and their explosives data demonstrate explosives are not ubiquitous at the background locations. Of the 16 split samples collected by EPA, only one explosive was reported (at an estimated concentration) in the validated data. The reporting limit for the EPA split samples was 100 $\mu\text{g}/\text{kg}$ for some explosives and 200 $\mu\text{g}/\text{kg}$ for others. Second, the potential presence of explosives at the one location does not correspond to increased inorganic concentrations (see Section 3.1.1 for a more detailed discussion). Third, comparison of the inorganic data collected from the 40 locations across the background study area shows good statistical comparability within soil types, with depth, and, in many cases, across soil types (see Section 3 for detailed discussion). Further, the data collected from east Vieques background locations shows good comparability with data collected from west Vieques background locations, which are several miles further from the former bombing range (see Section 3.1.2 for more detailed discussion). Fourth, and most importantly, the data evaluation process applied to the dataset was designed specifically to identify and remove inorganic data that displayed elevated concentrations with respect to the other data. This outlier testing process was performed as an extra measure of conservatism to ensure inorganic concentrations significantly higher than the general population were eliminated from the background dataset, even if in reality they were appropriately representative of background conditions. Section 3.2.2 discusses the outlier testing and results.

It should also be noted that laboratory method detection limits (MDLs) are the limits to which the laboratory instruments can generally detect constituents, and are below the RLs. Therefore, if explosives were present above the MDLs in the soil samples, they likely would have been detected and qualified as estimated.

TABLE 2-1
 GPS Coordinates for Background Sample Locations
East Vieques Background Soil Inorganics Investigation
Former Vieques Naval Training Range, Vieques, Puerto Rico

Sample Location	Latitude	Longitude	Northing	Easting
KTd-01	N 18.12882	W 65.42612	2006130	243290
KTd-02	N 18.12570	W 65.42554	2005784	243346
KTd-03	N 18.12142	W 65.43272	2005320	242580
KTd-04	N 18.11982	W 65.42948	2005137	242920
KTd-05	N 18.12401	W 65.42558	2005597	243339
KTd-06	N 18.12045	W 65.40857	2005179	245135
KTd-07	N 18.12141	W 65.42833	2005312	243044
KTd-08	N 18.12016	W 65.42915	2005175	242956
KTd-09	N 18.12653	W 65.41162	2005856	244821
KTd-10	N 18.11889	W 65.40666	2005003	245335
Kv-01	N 18.13616	W 65.40980	2006920	245028
Kv-02	N 18.13322	W 65.40699	2006590	245320
Kv-03	N 18.13028	W 65.40312	2006260	245727
Kv-04	N 18.11462	W 65.38035	2004494	248115
Kv-05	N 18.13647	W 65.41230	2006958	244763
Kv-06	N 18.13604	W 65.40664	2006902	245362
Kv-07	N 18.13232	W 65.40574	2006488	245452
Kv-08	N 18.13325	W 65.40366	2006589	245673
Kv-09	N 18.12929	W 65.40259	2006149	245781
Kv-10	N 18.12760	W 65.40239	2005962	245800
Qa-01	N 18.10965	W 65.43523	2004020	242297
Qa-02	N 18.11288	W 65.42341	2004361	243553
Qa-03	N 18.11214	W 65.43271	2004292	242567
Qa-04	N 18.11439	W 65.41972	2004524	243946
Qa-05	N 18.12119	W 65.39135	2005237	246959
Qa-06	N 18.11353	W 65.41535	2004422	244408
Qa-07	N 18.11882	W 65.39054	2004973	247042
Qa-08	N 18.11780	W 65.39464	2004866	246606
Qa-09	N 18.11424	W 65.41247	2004496	244713
Qa-10	N 18.11704	W 65.38919	2004775	247182
Tf-01	N 18.10116	W 65.42919	2003072	242924
Tf-02	N 18.09921	W 65.43022	2002858	242812
Tf-03	N 18.09647	W 65.43050	2002554	242778
Tf-04	N 18.10678	W 65.42313	2003685	243574
Tf-05	N 18.10541	W 65.41926	2003528	243981
Tf-06	N 18.10991	W 65.41661	2004023	244269
Tf-07	N 18.09961	W 65.42744	2002898	243108
Tf-08	N 18.11113	W 65.41314	2004152	244638
Tf-09	N 18.10166	W 65.43134	2003130	242697
Tf-10	N 18.11337	W 65.42179	2004413	243726

Note:
 Northing and Easting positions are in Universal Transverse Mercator (UTM) 20Q North American Datum (NAD) 83

TABLE 22
 Background Surface and Subsurface Sample Depths
East Vieques Background Soil Inorganics Investigation
Former Vieques Naval Training Range, Vieques, Puerto Rico

Soil Sample Location	Surface Soil Sample Depth	Subsurface Soil Sample Depth	Reason for Collecting Subsurface Soil Above 4-6'
KTd - 1	0 - 6"	4' - 6'	
KTd - 2	0 - 6"	4' - 6'	
KTd - 3	0 - 6"	4' - 6'	
KTd - 4	0 - 6"	4' - 6'	
KTd - 5	0 - 6"	4' - 6'	
KTd - 6	0 - 6"	4' - 6'	
KTd - 7	0 - 6"	4' - 6'	
KTd - 8	0 - 6"	4' - 6'	
KTd - 9	0 - 6"	2' - 4'	Bedrock Encountered
KTd - 10	0 - 6"	1' - 3'	Bedrock Encountered
Kv - 1	0 - 6"	2' - 4'	Bedrock Encountered
Kv - 2	0 - 6"	3' - 5'	Bedrock Encountered
Kv - 3	0 - 6"	4' - 6'	
Kv - 4	0 - 6"	3' - 5'	Bedrock Encountered
Kv - 5	0 - 6"	1' - 3'	Bedrock Encountered
Kv - 6	0 - 6"	4' - 6'	
Kv - 7	0 - 6"	4' - 6'	
Kv - 8	0 - 6"	2' - 3'	Bedrock Encountered
Kv - 9	0 - 6"	2' - 4'	Bedrock Encountered
Kv - 10	0 - 6"	4' - 6'	
Qa - 1	0 - 6"	2' - 4'	Groundwater Encountered
Qa - 2	0 - 6"	4' - 6'	
Qa - 3	0 - 6"	2' - 4'	Groundwater Encountered
Qa - 4	0 - 6"	4' - 6'	
Qa - 5	0 - 6"	1' - 3'	Bedrock Encountered
Qa - 6	0 - 6"	2' - 4'	Bedrock Encountered
Qa - 7	0 - 6"	4' - 6'	
Qa - 8	0 - 6"	1' - 3'	Bedrock Encountered
Qa - 9	0 - 6"	4' - 6'	
Qa - 10	0 - 6"	1' - 3'	Bedrock Encountered
TI - 1	0 - 6"	No Sample Taken*	Bedrock Encountered
TI - 2	0 - 6"	6" - 2'	Bedrock Encountered
TI - 3	0 - 6"	6" - 1'	Bedrock Encountered
TI - 4	0 - 6"	6" - 18"	Bedrock Encountered
TI - 5	0 - 6"	6" - 1'	Bedrock Encountered
TI - 6	0 - 6"	6" - 18"	Bedrock Encountered
TI - 7	0 - 6"	6" - 1'	Bedrock Encountered
TI - 8	0 - 6"	6" - 2'	Bedrock Encountered
TI - 9	0 - 6"	6" - 1'	Bedrock Encountered
TI - 10	0 - 6"	6" - 2'	Bedrock Encountered

*See Section 2.4 for explanation.

TABLE 2-3
 Background Soil Sample IDs
East Vieques Background Soil Inorganics Investigation
Former Vieques Naval Training Range, Vieques, Puerto Rico

KTd Locations	Kv Locations	Qa Locations	TI Locations
EBGKTD-SS01-06-06B	EBGKV-SS01-06-06B	EBGQA-SS01-06-06B	EBGTI-SS01-06-06B
EBGKTD-SB01-46-06B	EBGKV-SB01-24-06B	EBGQA-SB01-24-06B	No Sample Taken*
EBGKTD-SS02-06-06B	EBGKV-SS02-06-06B	EBGQA-SS02-06-06B	EBGTI-SS02-06-06B
EBGKTD-SB02-46-06B	EBGKV-SB02-35-06B	EBGQA-SB02-46-06B	EBGTI-SB02-12-06B
EBGKTD-SS03-06-06B	EBGKV-SS03-06-06B	EBGQA-SS03-06-06B	EBGTI-SS03-06-06B
EBGKTD-SB03-46-06B	EBGKV-SB03-46-06B	EBGQA-SB03-24-06B	EBGTI-SB03-61-06B
EBGKTD-SS04-06-06B	EBGKV-SS04-06-06B**	EBGQA-SS04-06-06B**	EBGTI-SS04-06-06B
EBGKTD-SB04-46-06B	EBGKV-SB04-35-06B**	EBGQA-SB04-46-06B**	EBGTI-SB04-62-06B
EBGKTD-SS05-06-06B**	EBGKV-SS05-06-06B	EBGQA-SS05-06-06B	EBGTI-SS05-06-06B
EBGKTD-SB05-46-06B**	EBGKV-SB05-13-06B	EBGQA-SB05-13-06B	EBGTI-SB05-61-06B
EBGKTD-SS06-06-06B**	EBGKV-SS06-06-06B**	EBGQA-SS06-06-06B	EBGTI-SS06-06-06B**
EBGKTD-SB06-46-06B**	EBGKV-SB06-46-06B**	EBGQA-SB06-24-06B	EBGTI-SB06-12-06B**
EBGKTD-SS07-06-06B	EBGKV-SS07-06-06B	EBGQA-SS07-06-06B	EBGTI-SS07-06-06B**
EBGKTD-SB07-46-06B	EBGKV-SB07-46-06B	EBGQA-SB07-46-06B	EBGTI-SB07-61-06B**
EBGKTD-SS08-06-06B	EBGKV-SS08-06-06B	EBGQA-SS08-06-06B**	EBGTI-SS08-06-06B
EBGKTD-SB08-46-06B	EBGKV-SB08-23-06B	EBGQA-SB08-13-06B**	EBGTI-SB08-62-06B
EBGKTD-SS09-06-06B	EBGKV-SS09-06-06B	EBGQA-SS09-06-06B	EBGTI-SS09-06-06B
EBGKTD-SB09-24-06B	EBGKV-SB09-24-06B	EBGQA-SB09-46-06B	EBGTI-SB09-61-06B
EBGKTD-SS10-06-06B	EBGKV-SS10-06-06B	EBGQA-SS10-06-06B	EBGTI-SS10-06-06B
EBGKTD-SB10-13-06B	EBGKV-SB10-46-06B	EBGQA-SB10-13-06B	EBGTI-SB10-62-06B

*See Section 2.4 for explanation.

**Split sample with EPA

SECTION 3

Background Sampling Analytical Results and Statistical Evaluation

This section summarizes the background soil inorganic results, provides the rationale for grouping the various data, and presents the summary statistics performed.

3.1 Summary of Analytical Results

Tables 3-1 and 3-2 summarize the detected concentrations for the background surface and subsurface soil samples, respectively, collected during the east Vieques soil background investigation. Notably, explosives were not detected in any of the background soil samples analyzed by CompuChem.

Validated analytical data tables are presented in Appendix C. The data quality evaluation reports for the surface and subsurface soil data are presented in Appendix D. These reports show that the data are of the appropriate quality for the intended use. Information regarding the various constituents detected, the ranges of concentrations detected, and the statistical evaluations performed are presented in Section 3.2.

3.1.1 Comparison of Split Sample Data

During the background investigation, EPA provided oversight and collected split samples at 20 percent of the background sample locations. The purpose of the oversight and split sampling was to ensure proper sampling procedures were followed by the Navy contractor and to provide verification analyses for a representative number of the samples collected by the Navy contractor.

The split samples collected by EPA were analyzed for TAL inorganics by the EPA Laboratory Branch in Edison, New Jersey, and for explosives by GPL Laboratories in Frederick, Maryland. TAL inorganic analyses were conducted via EPA Method 200.7, Revision 4.4; Method 245.1, Revision 3.0 (for mercury); and Method 335.4 (for cyanide). Explosives analyses were conducted via Method SW846 8330. The inorganic data were validated by EPA; the explosives data were validated by TechLaw of Pennsville, New Jersey, EPA's oversight contractor.

Table 3-3 provides a summary comparison of validated split sample results for the inorganics analyzed by CompuChem (Navy-contractor) and EPA laboratories and for the explosives analyzed by CompuChem (Navy-contractor) and GPL (EPA) laboratories. The table shows there to be good comparison between the split sample results for both inorganics and explosives. The small differences in the concentrations of inorganics between the laboratories are attributable to: (1) the fact that the samples were analyzed by physically distinct laboratory equipment at physically distinct laboratories, which have inherent performance criteria differences, and (2) the fact that there is some level of innate heterogeneity in soil.

Table 3-3 shows that no explosives were detected in any of the split samples analyzed by CompuChem, but that an estimated concentration of 2,6-dinitrotoluene (2,6-DNT) was detected in sample TI-6B, the split subsurface soil sample collected at background location TI-6 (see Figure 1-4). However, the actual presence and/or concentration of this constituent are questionable for several reasons. First, the concentration is reported as estimated because of instrument reproducibility problems. The result from the primary column was reported as 120 µg/kg, while the secondary column result was 19 µg/kg (i.e., 84 percent difference). Percent differences greater than 90 percent are normally rejected upon validation for non-CLP methods such as 8330 (explosives); percent differences greater than 25 percent are normally qualified as estimated (i.e., J) for non-CLP methods. If the explosives analytical method (8330) was a CLP method and validated accordingly, the 84 %D would have resulted in the 2,6-dinitrotoluene detection being rejected upon validation. Second, no explosives were detected in the split surface soil sample collected at the same location and analyzed by the same laboratory. Third, no explosives were reported in the validated data for any of the other split samples collected by EPA, nor any of the samples collected by CH2M HILL.

It is important to note that regardless of whether the detection of 2,6-DNT represents actual presence in the EPA split subsurface sample at TI-06, it has no effect on the use of the inorganic concentrations at that location. With the exception of calcium and magnesium, the concentration of each inorganic constituent in the subsurface soil at TI-06 is less than the concentration of the same inorganic constituent in the surface soil at the same location. Calcium and magnesium are associated with marine sedimentary carbonates (e.g., limestone) and shales that make up the rocks beneath the soil. The lower concentrations in surface soil likely represent natural weathering of the calcite and dolomite minerals that formed the soil profile and preferential removal (leaching) of magnesium and calcium from the soil by this natural process. Therefore, even if there is an explosive constituent in the subsurface soil at this location, its presence does not correspond to elevated inorganic concentrations. Further, none of the inorganic concentrations in the subsurface soil sample collected at TI-06 was identified as an outlier. Therefore, removal of the inorganic concentrations of this single sample from the background dataset is not warranted. In fact, to do so would typically raise the concentration average for the inorganics. For instance, in considering the 17 metals that were detected at least 50 percent of the time at all background locations, the average subsurface concentration rank (across these 17 metals and all subsurface samples) was 19 (where higher ranks are associated with higher concentrations), while the average rank of the subsurface sample at TI-06 was 12 across the 17 metals (indicating lower concentrations). For 13 of these 17 metals, the subsurface concentration at TI-06 was even below the mean subsurface concentration. Therefore, to leave the data point in the dataset is the more conservative option.

3.1.2 Comparison of West and East Vieques Background Data

Tables 3-4 and 3-5 display a comparison of inorganic data collected in the same geologic zones during the west and east Vieques background investigations. Table 3-4 displays the comparison for surface soil inorganics and Table 3-5 displays the comparison for the subsurface soil inorganics. Both tables reflect the surface soil/subsurface soil combinations determined via statistical analyses. See *Final Soil, Groundwater, Surface Water, and Sediment Background Investigation Report, U.S. Naval Ammunition Support Detachment, Vieques Island*,

Puerto Rico (CH2M HILL, 2002) for statistical analysis of west Vieques background data and Section 3.2 below for statistical analysis of east Vieques background data.

A comparison of data collected from both the Qa and KTd soil types shows that the concentrations are very similar (i.e., within an order of magnitude) and that the only significant difference (i.e., greater than an order of magnitude) in concentrations is for thallium. However, this is likely due to the fact that a more sensitive method for thallium analysis, and one that is less prone to false positive detections, was available at the time the east Vieques Background Investigation was conducted than was available at the time of the west Vieques Background Investigation, which was conducted in 2000.

The information above helps support the finding that the dataset gathered from east Vieques background locations (as well as that for west Vieques) is representative of broad background concentrations and, therefore, appropriate for its intended use.

3.2 Statistical Analysis

Statistical analysis was conducted on the validated analytical data, where one-half the RL was used as a proxy concentration for inorganic results reported as not detected. The statistical process was used to develop a statistically sound dataset representative of background inorganic concentrations. This subsection discusses the evaluation of the inorganic data with regard to combining data sets by soil type and depth, evaluating outliers, and developing descriptive summary statistics. These summary statistics include the calculation of 95 percent upper confidence limits of the 95th percentile, known as 95/95 UTLs. These UTLs will serve as background values for comparisons to soil inorganic concentrations at individual environmental sites under investigation.

3.2.1 Determination of Soil Type and Depth Groupings

To determine which soil types (KTd, Kv, Qa, and TI) and soil depths (surface and subsurface) should be combined when calculating background summary statistics, analysis of variance (ANOVA) and scatter plots were used to establish whether significant differences exist among soil types and soil depths.

ANOVA is a technique designed to determine whether the mean values of multiple groups are statistically different from one another. Environmental data are often not consistently normally nor lognormally distributed, particularly because the data contain non-detects and outliers (EPA, 2002). Thus, a non-parametric ANOVA, using the ranks of the data, as opposed to the concentrations themselves, was used for the background data. For instance, the lowest of ten concentrations would have the rank of 1 while the highest would have the rank of 10.

The ANOVA was performed on each constituent where at least 50 percent of the concentrations were detected measurements. Navy guidance (NAVFAC, 2002) and EPA guidance (EPA, 2002) recommends this for the Wilcoxon Rank-Sum test, which is essentially a two-group version of the multi-group non-parametric ANOVA. When few detects are available, quantitative methods of evaluating differences between groups carry an increasing level of uncertainty as the number of detects decreases, and there are no standard methods recommended by guidance for these circumstances (i.e., multiple groups of data compared simultaneously). Therefore, for constituents that shared a detect percentage of

less than 50 percent, soil types and depths (with the exception of antimony which had no detections in any soil type or depth) were evaluated visually using the scatter plots in Figure 3-1 (note that for comparison, scatter plots are presented for all detected constituents, including those with greater than 50 percent detects). The constituents with less than 50 percent detections comprised beryllium, cyanide, mercury, selenium, silver, sodium, and thallium. The plots in Figure 3-1 present detected concentrations as closed, blue circles and the non-detect values as open, green circles. The ratios shown in Figure 3-1 represent the number of detects divided by the total number of samples for each constituent.

For those constituents with less than 50 percent detects, the scatter plot evaluation suggests that there is a significant difference in concentrations of beryllium, cyanide, mercury, and selenium between the TI soil type and the other three soil types. Here, significant difference is determined by professional judgment based on visual observation. The concentrations of silver, sodium, and thallium among all soil types are similar. The visual evaluation also suggests significant differences in the concentrations of cyanide and sodium with depth (surface versus subsurface, as shown in Figure 3-1), but similarity with depth for beryllium, mercury, selenium, silver, and thallium. Here again, significant difference is determined by professional judgment based on visual observation.

Table 3-6 summarizes the initial ANOVA performed on the 17 constituents that were detected at least 50 percent of the time. This ANOVA studied both soil types and depth simultaneously. The calculated p-values (probabilities that the observed differences between the soil types or depths could be due to random variability) are provided in this table. The p-values for soil type are lower than the p-values for depth in most cases, indicating that the differences between soil types are typically more significant than the differences between depths in terms of influence on inorganic concentrations. For this reason, the subsequent ANOVA analysis with multiple comparisons (to demonstrate which soil types or depths were significantly different from one another) was first performed by soil type, and then by depth. It was necessary to run separate ANOVA analyses for these two effects so that a “multiple comparison” technique (due to multiple soil types and multiple soil depths) could be used to determine which soil types (and subsequently depths) should be combined and which should be kept separate.

For those constituents where these ANOVA analyses were applied, the probability (p-value) that observed differences between the soil types or depths could be due to random variability in the data was calculated. This p-value was compared to a significance level of 0.05 (the most common significance level in most statistical works, including environmental statistics guidance [EPA, 2000]), which limits the potential false conclusion that the populations are not different (when they actually are) to one in 20 times. If the p-value for the comparison by soil type or depth was less than 0.05, the soil types or depths, respectively, were considered to be significantly different. Otherwise they were determined to be statistically similar to one another. The results of these comparisons are shown in Table 3-7 and Table 3-8 for soil type and depth, respectively.

With respect to soil type, all four soil types were found to be statistically similar for aluminum and zinc (see “Soil Type p-value” column in Table 3-7). For the other inorganics, at least one soil type appeared significantly different from the others. For most of the inorganic constituents evaluated via the ANOVA method, the depths were found to be

statistically similar. The exceptions were lead and potassium (see “Depth p-value” column in Table 3-8).

For all those constituents that had significantly different soil type or depths, a commonly used “multiple comparison” technique, Tukey’s significant difference test (Mason, Gunst, and Hess, 1993) was used to help determine which of the groups were dissimilar. The results of the Tukey’s comparison techniques are presented as alphabetic characters (A, B, etc.), as shown in Table 3-7 (for soil types) and Table 3-8 (for soil depths). Tukey’s Test was applied with a significance level of 0.05. A calculated probability lower than the significance level of 0.05 is defined as “statistically different.” Conversely, a calculated probability higher than or equal to the significance level of 0.05 is defined as “statistically similar.”

Application of Tukey’s test is as follows: For each constituent, the soil type with the highest mean value is assigned the letter A. If the mean values of all soil types are statistically (or visually for less than 50 percent detects) similar to one another, then they all are assigned the letter A. For example, as shown in Table 3-7, the aluminum values are statistically similar for all four soil types; hence, they are all assigned the letter A.

If the mean value of a constituent from one soil type is statistically lower than the one designated as A, then it is designated as a B. For example, as shown in Table 3-7, the mean value of arsenic in soil type TI is statistically higher than the mean values of arsenic in soil types KTd, Kv, and Qa, which are statistically similar. Thus, the arsenic value in soil type TI is assigned the letter A, and the arsenic values of soil types KTd, Kv, and Qa are assigned the letter B.

If the mean value of a constituent in still another soil type is statistically lower than the mean value of the soil types assigned the letter B, then it is assigned the letter C, and so on.

It is possible for the mean value of a constituent to fall between two categories that are statistically different, where the intermediate value is not statistically different from either of the other two. For example, as shown in Table 3-7, the mean value of barium in soil type KTd (designated A) is statistically higher than that in soil type TI (designated B), and the mean values of barium in soil types Kv and Qa are similar to each other and not statistically different from those in A or B. Therefore, barium is assigned the designation AB for soil types Kv and Qa. Similarly, the BC designation for a particular soil type is not statistically different from soil types designated B or C (i.e., copper in Table 3-7).

Based on the above, a soil type designated AB could be grouped with either A or B soil types. Because each soil type must have only one discrete group for the calculation of summary statistics, the dual groupings (AB and BC) were consistently assigned to the lower category. In other words, ABs were combined with Bs and BCs were combined with Cs. For example, barium values in soil types Kv and Qa were combined with barium values in soil type TI. Thus, barium was assigned two overall soil groupings for summary statistics: “Kv Qa TI” and “KTd.”

Once the soil type groupings were assigned, soil depth groupings were assigned using a similar process, as depicted in Table 3-8. Because there were only two soil depths (surface and subsurface), the Tukey characters are limited to A and B for soil depth. For example, with barium, the depth evaluation for both the “Kv Qa TI” and “KTd” demonstrated surface

and subsurface values to be similar. Thus, a single depth category was defined for barium, that being “SS SB” (that is, a combination of surface and subsurface soil concentrations).

Based on the statistical evaluation of soil depths, the surface soil concentrations are statistically similar to the subsurface soil concentrations for all inorganics except cyanide, lead, potassium, and sodium. In reality, the surface soil and subsurface soil cyanide concentrations are also similar (i.e., 1.24 mg/kg [SS] versus 1.36 mg/kg [SB] for the KTd-Kv-Qa soil grouping and 1.03 mg/kg [SS] versus 0.98 mg/kg [SB] for the TI soil type), but are separated into surface soil and subsurface soil for UTL calculations to ensure consistent application of the statistical process for all inorganics. That they were subdivided into SS and SB groupings is simply due to the low concentrations detected, which result in high percent differences between the concentrations.

For sodium and potassium, the differences in mean surface versus subsurface soil concentrations (i.e., 363 mg/kg [SS] versus 484 mg/kg [SB] for sodium, and 1,650 mg/kg [SS] versus 892 mg/kg [SB] for potassium) likely reflect the natural leaching of these generally mobile constituents, as well as differences in depositional and post-depositional environments of the rocks and degree of soil development, especially considering that sodium and potassium are prevalent cations in seawater and sodium is a common cation in rainfall in this type of environment.

Like potassium, the mean lead concentration in surface soil is higher than that in the subsurface soil (i.e., 2.3 mg/kg [SS] versus 1.2 mg/kg [SB] for the KTd-Kv-Qa soil grouping, and 6.2 mg/kg [SS] versus 3.3 mg/kg [SB] for the TI soil type). Unlike potassium, however, the likely reason for this is both natural and anthropogenic. Under natural soil forming processes, lead is one of the least mobile metals in a surface soil environment because it is strongly adsorbed to the ubiquitous iron oxide (the reason for the soil color); it precipitates as the essentially insoluble lead carbonate mineral cerussite; and it also precipitates as a very insoluble lead phosphate suite of minerals called pyromorphite. Lead therefore can be higher in soils than in the natural substrate (i.e., rock) through accumulation in these three forms.

Since the 1920s, regional and global use of lead as an additive in gasoline resulted in abnormally high lead levels in the atmosphere. According to a statement on EPA’s website, the largest source of lead in the atmosphere has been leaded gasoline combustion. This fact, and the potential health and environmental risks associated with lead, paved the way for the leaded gasoline phase-down provision of the 1970 Clean Air Act. It is important to note, however, that even though the mean lead concentration in background surface soil is higher than in the subsurface soil, even the maximum lead concentration detected (10.6 mg/kg) is more than an order of magnitude lower than EPA’s lead action level of 400 mg/kg.

Other than lead and potassium, none of the remaining inorganics displays statistically higher concentrations in the surface soil than in the subsurface soil. This indicates that the background sample locations have not been influenced by widespread aerial deposition (other than potentially by lead, as described above).

3.2.2 Evaluation of Outliers

Once the soil type and depth groupings were determined, each grouping was evaluated for mathematical outliers. Outlier analysis was performed for all inorganics detected in each soil type. Per EPA guidance (EPA, 2000), two separate outlier tests were used depending on

the available sample size. Each was applied at the 0.05 significance level. For sample sizes of 25 or more, Rosner's test was applied. For sample sizes less than 25 (i.e., where the Tukey test indicated a particular soil type should be evaluated separately for a given constituent), Dixon's Extreme Value test was used. Both were applied in such a way that multiple outliers would all be identified as mathematical outliers. With multiple outliers, a given extreme value may be masked by another, slightly lower value and initially be found not to be a mathematical outlier. When testing for multiple outliers, however, both values may actually be outliers. For instance, if the lower of two elevated values was identified as an outlier, both of the values were designated as outliers.

Both of the outlier tests are based on an assumption of normality for those concentrations remaining after the statistical outlier(s) is excluded. Thus, various transformations were considered, based on the Shapiro-Wilk test (a test for normality) to achieve the best adherence to normality with the remaining concentrations (Gilbert, 1987; EPA, 2000). The data were transformed using one of three transformations. These were the square root transformation, the cubic root transformation, and the natural logarithmic transformation. The logarithmic transformation is a standard transformation in environmental applications, while the square root and cubic root transformations offer options that are appropriate for intermediate levels of data skewness.

The mathematical outliers identified via this approach are presented in Table 3-9. These concentrations were not included in the background data set used to calculate summary statistics. The transformations used for each outlier analysis are included in Table 3-9. The concentrations of the outliers relative to the other concentrations (for each soil type and depth grouping) are presented in the probability plots shown in Figure 3-2. The probability plots show the actual concentrations versus the expected quantiles if the data were normal. The quantiles in these plots are the number of standard deviations from the mean. These graphs help visualize the ascending concentrations so that the most elevated concentrations can be viewed with respect to the lower concentrations.

In the probability plots, detected concentrations are plotted as closed circles. Non-detects are plotted as open circles. The mathematical outliers are plotted as Xs. For combined surface/subsurface soil data, the concentrations are plotted in purple. Where surface and subsurface data are considered separately, the surface soil concentrations are in blue and the subsurface soil concentrations are in red. As an example, for magnesium concentrations, the 'KTd' soil type grouping for both depths are combined, and outliers are presented as Xs. For the "TI" soil type grouping for lead, the surface and subsurface concentrations are plotted separately (blue and red, respectively) with no mathematical outliers identified.

3.2.2.1 Outlier Observations

Several observations can be made on the outliers listed in Table 3-9. First, the majority of outliers (i.e., 20 of 38) are for calcium, magnesium, potassium, and sodium, none of which are contaminants of concern and all of which are the most common components of seawater (together with chloride) which likely reflects the marine influence on the formation of soils on the island.

Second, there is no high frequency of outliers in any particular sample or small group of samples. In fact, for the majority of samples in which an outlier was identified, only one

outlier was identified (17 of 24 samples). In only two samples were three outliers identified, and in one of them (i.e., KTd-SB06) all three outliers were calcium, magnesium, and sodium.

It is important to note that the outliers may actually be part of the normal background population of data. Outlier identification was performed by establishing a widely accepted, conservative significance value of 0.05 and eliminating any constituent concentration that exceeded this significance value (via the outlier test) from the background UTL calculation. While this process likely eliminates true background “upper tail” concentrations from the background UTL calculations, it does provide a conservative measure to avoid elevating the background UTLs in case outlier concentrations are not representative of background. In addition to eliminating outliers from the background UTL calculations, the outliers were compared to EPA Region IX preliminary remediation goals (PRGs) and, as applicable, to the concentrations of the same inorganics in the other soil type groupings. These comparisons are discussed in Section 3.4.

Note in Table 3-9 that the beryllium outliers identified by the mathematical operation were removed as outliers (i.e., added back to the background data set) after review of the data demonstrated the five results identified as outliers were the only detections, with a range of 0.72 to 0.95 mg/kg, versus the non-detect RL range of 0.54 to 0.77 mg/kg. What caused them to be identified as outliers was using half the RLs to obtain proxy values for the non-detects.

3.3 Summary Statistics

Using the dataset generated via the soil grouping and outlier evaluations, summary statistics for each constituent, soil type, and depth grouping are presented in Table 3-10. The statistics comprise the mean, median, standard deviation, minimum RL, maximum RL, minimum detect, maximum detect, number of detects, number of samples, and percent detects for all concentrations retained in the data set, after removal of outliers, and are reported to three significant figures. These statistics also include the normality and lognormality probabilities (p-values) that the concentrations are the result of normal or lognormal distributions, respectively, as calculated by the Shapiro-Wilk test (W test). When this p-value is less than 0.05, the assumption of normality (or lognormality) was rejected, as suggested by multiple guidance and texts (e.g., EPA, 2000). These p-values are reported for each case, although the assumption of lognormality is considered appropriate only when the number of concentrations is large (30 or more) because the use of the lognormal distribution causes unreliable statistics with small data sets (EPA, 1997). Therefore, when fewer than 30 samples were available within a group, the normal or non-parametric methods were used.

These assumptions of normality and lognormality are also included in Table 3-10 (as shown in the “Applied Distribution” column) and were used to determine the approach to calculating background threshold values, the process for which is depicted in Figure 3-3. The background threshold values presented in Table 3-10 are UTLs and are derived parametrically (from assumptions of normality or lognormality) or non-parametrically (rank based) as described below.

The distributional assumptions play a key role in determining how the UTLs of the background data are calculated. As is customary, the goal is that these UTLs are calculated as 95 percent upper confidence bounds of the 95th percentiles of the background data (EPA, 1989). When UTLs are calculated non-parametrically, that is, without a definitive distributional assumption of the data (i.e., normal or lognormal), these goals are not met completely (EPA, 1992), but the percentile with 95 percent confidence is estimated.

Normal UTLs were calculated using the following equation:

$$UTL = \bar{x} + (K \times s), \text{ where}$$

\bar{x} is the sample mean

K is the tolerance factor

s is the sample standard deviation

When the data appears to be lognormally distributed, the UTLs were calculated using the following equation:

$$UTL = e^{\bar{x} + (K \times s_x)}, \text{ where}$$

\bar{x} is the sample mean of the log-transformed sample data

K is the tolerance factor

s is the sample standard deviation of the log-transformed sample data

For data sets that do not appear normally or lognormally distributed, non-parametric UTLs were calculated. A non-parametric UTL is computed by first ranking the concentrations and then choosing the lowest ranked detected concentration that provides a coverage of 95 percent with 95 percent confidence. For data sets with less than 59 concentrations, 95 percent coverage is not possible with 95 percent confidence, even when the maximum concentration is assigned as the UTL. This was the case for some data in this study, so the estimated percentile (95th or lower) associated with the chosen concentration (the highest concentration) was calculated. This percentile was calculated using the following equation:

$$p = B_{0.95, n, m}, \text{ where}$$

B is a beta distribution defined by n (the number of sample results) and m (the rank of the concentration used, which is 1 for this evaluation of the background dataset because the maximum concentration is used)

Thus, the percentile estimated via the parametric (95 percent confidence) UTLs (normal or lognormal) was the 95th percentile, but some of the non-parametric UTLs are estimates of lower percentiles with 95 percent confidence. This occurred when the number of concentrations available was smaller (compared to when soil types could be combined) due to calculating a UTL for a single soil type (e.g. TI). Estimating a lower percentile indicates that the calculated UTL is likely lower than an estimate of 95th percentile. There is always a chance that a site dataset equivalent to background might result in exceedances of the UTL because the UTL merely estimates the 95th percentile of the background data. When the UTL estimates a lower percentile of the background data, the probability of one or more of these chance exceedances is higher. Thus, the UTLs with lower estimated percentiles are generally

additionally conservative because of the increased probability of false exceedances of site-specific concentrations compared to them. The UTLs were included in the probability plots presented in Figure 3-2 as horizontal lines, enabling the reader to visually note the position of these background threshold values relative to the available data.

3.4 Inorganic Constituent-by-Constituent Summary

The discussions in Sections 3.2 and 3.3 provide the statistical results for the inorganics in the broad context of soil type and depth, including how concentrations were determined to be similar and, therefore, grouped together. This section summarizes the statistical results on a constituent-by-constituent basis. Table 3-10 summarizes the statistical calculations for each constituent, including the mean, median, minimum detect, maximum detect, and UTL.

Aluminum

Evaluation by ANOVA for aluminum background concentrations determined that all four soil types (KTd, Kv, Qa, and TI) and both depths (SS and SB, corresponding to “surface soil” and “subsurface soil,” respectively) could be combined into one data set. No mathematical outliers were determined for aluminum. Thus, all sample concentrations were used to calculate the summary statistics.

A lognormal distributional assumption was determined for the aluminum background concentrations resulting in a UTL of 35,000 mg/kg, as shown in Table 3-10.

Antimony

All antimony background concentrations were reported as non-detects. Thus, no antimony background UTL was calculated.

Arsenic

Evaluation by ANOVA for arsenic background concentrations determined that three soil types (KTd, Kv, and Qa) demonstrated similar concentrations to each other. Thus, the concentrations from these three soil types were combined. The concentrations from soil type TI were handled as a separate group. For each of these soil groupings, the ANOVA indicated that both depths (SS and SB) could be combined into one data set.

Of all the samples collected within the Kv-KTd-Qa sample grouping for arsenic, only five mathematical outliers were identified (from locations EBGKV-SO04, EBGKTD-SO10, and EBGQA-SO06 as shown in Table 3-9). It is very likely that these outlying concentrations represent the upper tail of actual background concentrations. Note that the 1.6 mg/kg to 5 mg/kg range of outlying concentrations is within the range of arsenic concentrations detected in the TI sample set. However, the arsenic outliers were excluded from background concentration calculation as a conservative measure. It is noted that these outlier concentrations exceed the EPA Region IX preliminary remediation goals (PRGs) for both residential (0.39 mg/kg) and industrial (1.6 mg/kg) soil. However, it is common for natural arsenic concentrations to exceed these levels. According to the Sandia National Laboratory website, worldwide background arsenic concentrations in soil range from about 2.2 to 25 mg/kg. Further, arsenic is preferentially adsorbed to iron oxide in the soil and remains

irreversibly adsorbed to the iron oxide under the natural oxidizing environment of surface soils. Therefore, similar to lead, arsenic can be higher in soils than in the substrate.

For the KTd-Kv-Qa grouping, a nonparametric approach was used to determine an arsenic background UTL of 1.6 mg/kg. For the TI grouping, a normal assumption was made to calculate a UTL of 9.2 mg/kg, as shown in Table 3-10. The higher arsenic concentrations in the TI deposits are likely due to its marine origin, enhanced by the adsorption of arsenic to iron oxide in the soil. Marine shales often contain elevated concentrations of arsenic associated with iron sulfides. Regardless of the origin, the fact that the arsenic concentrations are similar across the TI soil type indicates the levels are representative of background.

Barium

Evaluation by ANOVA for barium background concentrations determined that three soil types (Kv, Qa, and TI) demonstrated similar concentrations to each other. Thus, the concentrations from these three soil types were combined. The concentrations from soil type KTd were handled as a separate group. For each of these soil groupings, the ANOVA indicated that both depths (SS and SB) could be combined into one data set.

One mathematical outlier of 292 mg/kg was identified for barium from location EBGKTD-SO07 as shown in Table 3-9. It is very likely that this outlying concentration represents the upper tail of actual background concentrations. Note that the 292 mg/kg concentration is within the range of barium concentrations detected in the Kv-Qa-TI sample set. However, the barium outlier was excluded from background concentration calculation as a conservative measure. Note that the 292 mg/kg outlier concentration of barium is more than an order of magnitude below the Region IX PRG for residential soil (5,400 mg/kg).

For the Kv-Qa-TI grouping, a lognormal assumption was made to calculate a UTL of 212 mg/kg. For the KTd grouping, a normal distributional assumption was determined for the background concentrations resulting in a UTL of 147 mg/kg as shown in Table 3-10.

Beryllium

Due to fewer than 50 percent detects for beryllium, comparisons of soil types and depths were performed visually by inspecting the scatter plots in Figure 3-1. This evaluation concluded that three soil types (KTd, Kv, and Qa) demonstrated similar concentrations to each other (here, similarity was determined by professional judgment based on visual observation). Thus, the concentrations from these three soil types were combined. The concentrations from soil type TI were handled as a separate group. For each of these soil groupings, the visual inspection indicated that both depths (SS and SB) could be combined into one data set.

Five mathematical outliers were identified for beryllium from locations EBGTI-SO01, EBGTI-SO02, EBGTI-SO03, and EBGTI-SO07, as shown in Table 3-9. However, the mathematical outliers were identified only because they were the only detected results (0.72-0.95 mg/kg), versus the non-detect reporting limit range of 0.54-0.77 mg/kg. Therefore, none of the detected results were excluded from background conclusions.

For the KTd-Kv-Qa grouping, a nonparametric approach was used to determine a background UTL of 0.27 mg/kg. For the TI grouping, a nonparametric approach was used to determine a background UTL of 0.95 mg/kg, as shown in Table 3-10.

Cadmium

Evaluation by ANOVA for cadmium background concentrations determined that three soil types (KTd, Kv, and Qa) demonstrated similar concentrations to each other. Thus, the concentrations from these three soil types were combined. The concentrations from soil type TI were handled as a separate group. For each of these soil groupings, the ANOVA indicated that both depths (SS and SB) could be combined into one data set. No mathematical outliers were identified for cadmium. Thus, all sample concentrations were used to calculate the summary statistics.

For the KTd-Kv-Qa grouping, a lognormal distributional assumption was determined for the background concentrations, resulting in a UTL of 2.2 mg/kg. For the TI grouping, a normal distributional assumption was determined for the background concentration, resulting in a UTL of 2.4 mg/kg.

Calcium

Evaluation by ANOVA for calcium background concentrations determined that two soil types (KTd and Kv) demonstrated similar concentrations to each other. Thus, the concentrations from these two soil types were combined. The concentrations from soil types Qa and TI were handled as separate groups. For each of these soil groupings, the ANOVA indicated that both depths (SS and SB) could be combined into one data set.

From all the samples analyzed for calcium, mathematical outliers were identified for only eight samples (i.e., from locations EBGKV-SO02 and 07; EBGKTD-SO06; and EBGQA-SO02, 06, and 09, as shown in Table 3-9). It is very likely that these outlying concentrations represent the upper tail of actual background concentrations. Note that the outlying concentrations are within the range of calcium concentrations detected in the TI sample set. However, the calcium outliers were excluded from background concentration calculations to be consistent with the process used for other inorganics. It is important to note that although background values were calculated for calcium because it is part of the TAL inorganics, site-specific calcium concentrations are not evaluated with respect to nature and extent of contamination and potential risk because calcium is not a contaminant associated with past practices on Vieques.

For the KTd-Kv grouping, a lognormal distributional assumption was determined for the background concentrations, resulting in a UTL of 8,840 mg/kg. For the Qa grouping, a nonparametric approach was used to determine a background UTL of 11,900 mg/kg. For the TI grouping, a normal assumption was made to calculate a UTL of 417,000 mg/kg, as shown in Table 3-10. The difference in calcium concentrations between the soil groupings likely reflects the differences in calcium-bearing rocks from which the soil was developed. The TI soil type is formed on rocks of primarily limestone origin, which is predominantly calcium carbonate (i.e., calcite). The wide variation in calcium concentrations also is likely due to the preferential but variable leaching of calcium (as well as magnesium, sodium, and potassium) relative to other inorganics. Most of the calcium and magnesium are derived from the underlying limestone substrate and their variability is related to the variable rate of

the natural soil forming processes controlled by very localized environmental conditions within the sampled terrain.

Chromium

Evaluation by ANOVA for chromium background concentrations determined that three soil types (KTd, Kv, and Qa) demonstrated similar concentrations to each other. Thus, the concentrations from these three soil types were combined. The concentrations from soil type TI were handled as a separate group. For each of these soil groupings, the ANOVA indicated that both depths (SS and SB) could be combined into one data set. No mathematical outliers were identified for chromium. Thus, all sample concentrations were used to calculate the summary statistics.

For the KTd-Kv-Qa grouping, a nonparametric approach was used to determine a chromium background UTL of 72 mg/kg. For the TI grouping, a normal distributional assumption was determined for the background concentrations resulting in a UTL of 70 mg/kg.

Cobalt

Evaluation by ANOVA for cobalt background concentrations determined that three soil types (KTd, Qa, and TI) demonstrated similar concentrations to each other. Thus, the concentrations from these three soil types were combined. The concentrations from soil type Kv were handled as a separate group. For each of these soil groupings, the ANOVA indicated that both depths (SS and SB) could be combined into one data set. No mathematical outliers were identified for cobalt. Thus, all sample concentrations were used to calculate the summary statistics.

For the KTd-Qa-TI grouping, a lognormal distributional assumption was determined for the background concentrations, resulting in a UTL of 16 mg/kg. For the Kv grouping, a normal distributional assumption was determined for the background concentrations, resulting in a UTL of 26 mg/kg.

Copper

Evaluation by ANOVA for copper background concentrations determined that two soil types (Kv and TI) demonstrated similar concentrations to each other. Thus, the concentrations from these two soil types were combined. The concentrations from soil types KTd and Qa were handled as separate groups. For each of these soil groupings, the ANOVA indicated that both depths (SS and SB) could be combined into one data set. No mathematical outliers were identified for copper. Thus, all sample concentrations were used to calculate the summary statistics.

For the Kv-TI grouping, a lognormal assumption was made to calculate a background UTL of 94 mg/kg. For the KTd grouping, a normal assumption was made to calculate a UTL of 66 mg/kg. For the QA grouping, a normal assumption was made to calculate a UTL of 53 mg/kg, as shown in Table 3-10.

Cyanide

Due to fewer than 50 percent detects for cyanide, comparisons of soil types and depths were performed visually by inspecting the scatter plots in Figure 3-1. This evaluation concluded

that three soil types (KTd, Kv, and Qa) demonstrated similar concentrations to each other (here, similarity was determined by professional judgment based on visual observation). Thus, the concentrations from these three soil types were combined. The concentrations from soil type TI were handled as a separate group. For each of these soil groupings, the visual inspection indicated that SS and SB should be handled separately. No mathematical outliers were identified for cyanide. Thus, all sample concentrations were used to calculate the summary statistics.

For the KTd-Kv-Qa grouping a nonparametric approach was used to determine background UTLs for both the SS and SB depths. The SS UTL was determined to be 0.33 mg/kg and the SB UTL was determined to be 0.89 mg/kg. For the TI grouping, a nonparametric approach was used to determine the SS UTL of 0.45 mg/kg, while the SB UTL was calculated, based on a normal assumption, to be 2.8 mg/kg, as shown in Table 3-10.

Although the percent differences between the surface soil and subsurface soil cyanide concentrations are high, this is due to the fact that at such low concentrations (i.e., all detected concentrations were between approximately 0.2 and 1 mg/kg), small differences in actual concentrations equate to large percent differences. However, all detected concentrations were more than an order of magnitude below the Region IX PRG for residential soil.

Iron

Evaluation by ANOVA for iron background concentrations determined that three soil types (KTd, Qa, and TI) demonstrated similar concentrations to each other. Thus, the concentrations from these three soil types were combined. The concentrations from soil type Kv were handled as a separate group. For each of these soil groupings, the ANOVA indicated that both depths (SS and SB) could be combined into one data set. No mathematical outliers were identified for iron. Thus, all sample concentrations were used to calculate the summary statistics.

For the KTd-Qa-TI grouping, a normal distributional assumption was determined for the background concentrations resulting in a UTL of 38,100 mg/kg. For the Kv grouping, a lognormal distributional assumption was determined for the background concentration, resulting in a UTL of 43,200 mg/kg, as shown in Table 3-10.

Lead

Evaluation by ANOVA for lead background concentrations determined that three soil types (KTd, Kv, and Qa) demonstrated similar concentrations to each other. Thus, the concentrations from these three soil types were combined. The concentrations from soil type TI were handled as a separate group. For each of these soil groupings, the ANOVA indicated that the two depths (SS and SB) should be evaluated separately. No mathematical outliers were identified for lead.

For the KTd-Kv-Qa grouping, a lognormal distributional assumption was determined for both the SS and SB depths. The SS UTL was calculated to be 5.4 mg/kg. The SB UTL was calculated to be 3.3 mg/kg. For the TI grouping, a nonparametric approach was used to determine an SB background UTL of 7.7 mg/kg. For the SS depth, a normal distributional

assumption was determined for the background concentrations resulting in a UTL of 16 mg/kg.

There are a couple of notable observations for lead. First, the surface soil lead concentrations in both soil groupings are higher than the subsurface lead concentrations, although not by much in terms of actual, detected concentrations. This difference may be due to regional or global anthropogenic sources of lead, such as leaded gasoline that had widespread use since the 1920s (although its use has been declining since the 1970s). The second observation is that, much like many of the other inorganics, the highest concentrations of lead are in the TI soil type. Like the other inorganics, the higher lead concentrations are likely due to the different rock type composing the TI type, depositional and post-depositional processes (e.g., mineral precipitation), and the weathering of that rock type to produce the TI soils. A geochemical study of Vieques (Learned *et. al.*, 1973) showed that rocks of the TI type contained lead concentrations up to approximately 30 mg/kg. It is also notable that even the highest lead UTL (i.e., 16 mg/kg for TI surface soil) is more than an order of magnitude below EPA's lead action level of 400 mg/kg.

Magnesium

Evaluation by ANOVA for magnesium background concentrations determined that three soil types (Kv, Qa, and TI) demonstrated similar concentrations to each other. Thus, the concentrations from these three soil types were combined. The concentrations from soil type KTd were handled as a separate group. For each of these soil groupings, the ANOVA indicated that both depths (SS and SB) could be combined into one data set.

From all the samples analyzed for magnesium, mathematical outliers were identified for only five samples (i.e., from locations EBGKTD-SO01, 02, 06, and 10, as shown in Table 3-9). It is very likely that these outlying concentrations represent the upper tail of actual background concentrations. Note that the outlying concentrations are within the range of magnesium concentrations detected in the Kv-Qa-TI sample set. However, the magnesium outliers were excluded from background concentration calculations to be consistent with the process used for other inorganics. It is important to note that although background values were calculated for magnesium because it is part of the TAL inorganics, site-specific magnesium concentrations are not evaluated with respect to nature and extent of contamination and potential risk because magnesium is not a contaminant associated with past practices on Vieques.

For the Kv-Qa-TI grouping, a lognormal assumption was made to calculate a UTL of 22,200 mg/kg. For the KTd grouping, a normal distributional assumption was determined for the background concentrations, resulting in a UTL of 3,710 mg/kg, as shown in Table 3-10. The wide variation in magnesium concentrations is likely due to the differences in rock types associated with the different soil types, as well as the preferential leaching of magnesium (as well as calcium, sodium, and potassium) relative to other inorganics. Magnesium shares many of the same mobility characteristics as calcium in the natural soil forming process.

Manganese

Evaluation by ANOVA for manganese background concentrations determined that all four soil types (KTd, Kv, Qa, and TI) and both depths (SS and SB) could be combined into one

data set. No mathematical outliers were determined for manganese. Thus, all sample concentrations were used to calculate the summary statistics.

A nonparametric approach was used to determine a background UTL of 1,630 mg/kg, as shown in Table 3-10.

Mercury

Due to fewer than 50 percent detects for mercury, comparisons of soil types and depths were performed visually by inspecting the scatter plots in Figure 3-1. This evaluation concluded that three soil types (KTd, Kv, and Qa) demonstrated similar concentrations to each other (here, similarity was determined by professional judgment based on visual observation). Thus, the concentrations from these three soil types were combined. The concentrations from soil type TI were handled as a separate group. For each of these soil groupings, the visual inspection indicated that both depths (SS and SB) could be combined into one data set.

From all the samples analyzed for mercury, mathematical outliers were identified for only samples (i.e., from locations EBGKV-SO07, EBGKV-SO02, and EBGQA-SO06, as shown in Table 3-9). It is very likely that these outlying concentrations represent the upper tail of actual background concentrations. Note that the 0.08 mg/kg to 0.1 mg/kg range of outlying concentrations is within the range of mercury concentrations detected in the TI sample set. However, the mercury outliers were excluded from background concentration calculation as a conservative measure. It is noted that these outlier concentrations, as well as the highest mercury concentration detected in any of the samples collected (0.31 mg/kg), are more than an order of magnitude below the EPA Region IX PRG for residential soil (23 mg/kg).

For the KTd-Kv-Qa grouping, a nonparametric approach was used to determine a background UTL of 0.057 mg/kg. For the TI grouping, a nonparametric approach was used to determine a UTL of 0.31 mg/kg, as shown in Table 3-10.

Nickel

Evaluation by ANOVA for nickel background concentrations determined that two soil type pairs (KTd-Qa and Kv-TI) demonstrated similar concentrations to each other. Thus, the concentrations from each of these soil type pairs were combined. For each of these soil groupings, the ANOVA indicated that both depths (SS and SB) could be combined into one data set. No mathematical outliers were identified for nickel. Thus, all sample concentrations were used to calculate the summary statistics.

For the KTd-Qa grouping, a lognormal distributional assumption was determined for the background concentrations, resulting in a UTL of 22 mg/kg. For the Kv-TI grouping, a lognormal distributional assumption was determined for the background concentrations, resulting in a UTL of 41 mg/kg, as shown in Table 3-10.

Potassium

Evaluation by ANOVA for potassium background concentrations determined that three soil types (KTd, Kv, and Qa) demonstrated similar concentrations to each other. Thus, the concentrations from these three soil types were combined. The concentrations from soil type TI were handled as a separate group. For the KTd-Kv-Qa soil grouping, the ANOVA

indicated that the two depths (SS and SB) should be evaluated separately. For the TI soil grouping, the ANOVA indicated that both depths (SS and SB) could be combined into one combined data set.

From all the samples analyzed for potassium, mathematical outliers were identified for only two samples (i.e., from subsurface soil sample locations EBGKV-SO07 and EBGQA-SO08, as shown in Table 3-9). It is very likely that these outlying concentrations represent the upper tail of actual background concentrations. Note that the outlying concentrations are within the range of potassium concentrations detected in the surface soil samples from the same soil type. However, the potassium outliers were excluded from background concentration calculations to be consistent with the process used for other inorganics. It is important to note that although background values were calculated for potassium because it is part of the TAL inorganics, site-specific potassium concentrations are not evaluated with respect to nature and extent of contamination and potential risk because potassium is not a contaminant associated with past practices on Vieques.

For the KTd-Kv-Qa grouping and SB depth, a normal assumption was made to calculate a UTL of 2,000 mg/kg. The SS UTL for the same soil grouping was based on a lognormal assumption and calculated to be 5,270 mg/kg. For the TI grouping (where SS and SB depths were combined), a normal distributional assumption was determined for the background concentrations, resulting in a UTL of 10,800 mg/kg. The wide variation in potassium concentrations is likely due to the differences in rock types associated with the different soil types, as well as the preferential but variable leaching of potassium (as well as calcium, sodium, and magnesium) relative to other inorganics. The potassium concentrations are also variable because it dominantly occurs in two minerals, potash feldspar and the clay mineral illite. Potassium feldspar is typically weathered at a slower rate than carbonates but it is still significantly more soluble than the clay mineral illite. The variability in the potassium concentration is likely related to the variable amount of these two minerals weathered from the substrate in the natural soil forming process.

Selenium

Due to fewer than 50 percent detects for selenium, comparisons of soil types and depths were performed visually by inspecting the scatter plots in Figure 3-1. This evaluation concluded that three soil types (KTd, Kv, and Qa) demonstrated similar concentrations to each other (here, similarity was determined by professional judgment based on visual observation). Thus, the concentrations from these three soil types were combined. The concentrations from soil type TI were handled as a separate group. For each of these soil groupings, the visual inspection indicated that both depths (SS and SB) could be combined into one data set. No mathematical outliers were identified for selenium. Thus, all sample concentrations were used to calculate the summary statistics.

For the KTd-Kv-Qa grouping, a nonparametric approach was used to determine a selenium background UTL of 0.51 mg/kg. For the TI grouping, a nonparametric approach was used to determine a selenium background UTL of 1.3 mg/kg, as shown in Table 3-10.

Silver

Due to fewer than 50 percent detects for silver, comparisons of soil types and depths were performed visually by inspecting the scatter plots in Figure 3-1. This evaluation concluded

that all four soil types (KTd, Kv, Qa, and TI) demonstrated similar concentrations to each other (here, similarity was determined by professional judgment based on visual observation). Thus, the concentrations from all four soil types were combined. The visual inspection indicated that both depths (SS and SB) could be combined into one data set. No mathematical outliers were identified for silver. Thus, all sample concentrations were used to calculate the summary statistics.

A lognormal distributional assumption was determined for the silver background concentrations, resulting in a UTL of 0.22 mg/kg, as shown in Table 3-10.

Sodium

Due to fewer than 50 percent detects for sodium, comparisons of soil types and depths were performed visually by inspecting the scatter plots in Figure 3-1. This evaluation concluded that all four soil types (KTd, Kv, Qa, and TI) demonstrated similar concentrations to each other (here, similarity was determined by professional judgment based on visual observation). Thus, the concentrations from all four soil types were combined. The visual inspection indicated that SS and SB should be handled separately. The lower range of sodium concentrations in the surface soil than in the subsurface soil likely reflects the relatively high solubility (and, therefore, high leaching ability) of sodium.

From all the samples analyzed for sodium, mathematical outliers were identified for only five samples (i.e., from locations EBGKTD-SO06, EBGKV-SO10, EBGQA-SO07, EBGQA-SO03, and EBGQA-SO01, as shown in Table 3-9). It is very likely that these outlying concentrations represent the upper tail of actual background concentrations, especially considering that sodium is the most prevalent cation in seawater, in which the majority of rocks in Vieques were deposited. However, the sodium outliers were excluded from background concentration calculations to be consistent with the process used for other inorganics. It is important to note that although background values were calculated for sodium because it is part of the TAL inorganics, site-specific sodium concentrations are not evaluated with respect to nature and extent of contamination and potential risk because sodium is not a contaminant associated with past practices on Vieques.

A nonparametric approach was used to determine the background UTL of both the SS and SB depths. For the SS depth, a UTL of 1,590 mg/kg was determined. For the SB depth, a UTL of 2,250 mg/kg was determined, as shown in Table 3-10. The variation in sodium concentrations is likely due to the differences in rock types associated with the different soil types, the depositional and post-depositional environment of the rocks, and the preferential but variable leaching of sodium (as well as calcium, magnesium, and potassium) relative to other inorganics. In addition, unlike calcium, magnesium and potassium, rain entrains marine aerosols containing sodium chloride to produce natural rainfall with a sodium chloride water chemistry type in this environment. Both sodium and chloride are among the most mobile elements in water but their concentrations also depend on the relative permeability of the soils. In permeable soils, both infiltrate into the substrate, but where less permeable, both tend to increase in concentration by evaporation and transpiration. Therefore, their variable concentrations are influenced by physical hydraulic conditions. However, unlike chloride, sodium occurs in the plagioclase feldspar mineral albite and is also variably exchanged with calcium on smectite clays. Therefore, the sodium concentration variability is likely related not only to hydraulic conditions but also the

degree of weathering of plagioclase feldspar, the amount of smectite clay in the soil profile, and the degree of ion exchange that has occurred at each sample location.

Thallium

Due to fewer than 50 percent detects for thallium, comparisons of soil types and depths were performed visually by inspecting the scatter plots in Figure 3-1. This evaluation concluded that all four soil types (KTd, Kv, Qa, and TI) demonstrated similar concentrations to each other (here, similarity was determined by professional judgment based on visual observation). Thus, the concentrations from all four soil types were combined. The visual inspection indicated that both depths (SS and SB) could be combined into one data set.

From all the samples analyzed for thallium, only one mathematical outlier was identified (i.e., from location EBGTI-SO03, as shown in Table 3-9). Although the percent difference between the outlier concentration and the next highest concentration is high, the actual concentration difference between the outlier (0.41 mg/kg) and the next highest concentration (0.13 mg/kg) is not. However, the thallium outlier was excluded from the background concentration calculation as a conservative measure. It is noted that the outlier concentration is an order of magnitude below the EPA Region IX PRG for residential soil (5.2 mg/kg).

A lognormal distributional assumption was determined for the thallium background concentrations, resulting in a UTL of 0.13 mg/kg, as shown in Table 3-10.

Vanadium

Evaluation by ANOVA for vanadium background concentrations determined that three soil types (KTd, Kv, and Qa) demonstrated similar concentrations to each other. Thus, the concentrations from these three soil types were combined. The concentrations from soil type TI were handled as a separate group. For each of these soil groupings, the ANOVA indicated that both depths (SS and SB) could be combined into one data set. No mathematical outliers were identified for vanadium. Thus, all sample concentrations were used to calculate the summary statistics.

For the KTD-Kv-Qa grouping, a lognormal distributional assumption was determined for the background concentrations, resulting in a UTL of 144 mg/kg. For the TI grouping, a normal distributional assumption was determined for the background concentrations, resulting in a UTL of 56 mg/kg.

Zinc

Evaluation by ANOVA for zinc background concentrations determined that all four soil types (KTd, Kv, Qa, and TI) and both depths (SS and SB) could be combined into one data set.

From all the samples analyzed for zinc, mathematical outliers were identified in only three samples (i.e., from locations EBGKV-SO04 and 09, as shown in Table 3-9). Although these outlier concentrations may be part of true background (representing the upper tail of actual background concentrations), they were excluded from background data calculations as a conservative measure. It is noted that the outlier concentrations are more than two orders of magnitude below the EPA Region IX PRG for residential soil.

A normal distributional assumption was determined for the zinc background concentrations, resulting in a UTL of 32 mg/kg, as shown in Table 3-10.

3.5 Statistics Summary

Based on the information presented in Sections 3.3 and 3.4, Table 3-11 summarizes the background surface soil inorganic UTLs to be used for comparison to surface soil inorganic data collected at east Vieques environmental sites under investigation. Similarly, Table 3-12 summarizes the background subsurface soil inorganic UTLs to be used for comparison to subsurface soil inorganic data collected at east Vieques environmental sites under investigation.

Table 3-1
 Summary of Constituents Detected in Background Surface Soil Samples
 East Vieques Background Soil Inorganics Investigation
 Former Vieques Naval Training Range, Vieques, Puerto Rico

Station ID	EBGKTD-SO01	EBGKTD-SO02	EBGKTD-SO03	EBGKTD-SO04	EBGKTD-SO05	EBGKTD-SO06	EBGKTD-SO07	EBGKTD-SO08	EBGKTD-SO09
Sample ID	EBGKTD-SS01-06-06B	EBGKTD-SS02-06-06B	EBGKTD-SS03-06-06B	EBGKTD-SS04-06-06B	EBGKTD-SS05-06-06B	EBGKTD-SS06-06-06B	EBGKTD-SS07-06-06B	EBGKTD-SS08-06-06B	EBGKTD-SS09-06-06B
Sample Date	07/03/06	07/02/06	06/24/06	06/26/06	06/21/06	06/21/06	06/24/06	06/26/06	07/06/06
Chemical Name									
Explosives									
None detected									
Total Metals (MG/KG)									
Aluminum	10,900	9,810	8,300	5,500	6,370	12,300	5,740	6,150	8,880
Antimony	6.8 U	6.7 U	7.3 U	6.4 U	6.6 U	7.1 U	6.8 U	6.2 U	6.4 U
Arsenic	1.1 U	1.1 U	0.64 J	1.1 U	1.1 UJ	1.2 UJ	1.1 U	1 U	1.1 U
Barium	120 J	119 J	100	53	73	64.4	47.7	78.2	48.4
Beryllium	0.57 U	0.56 U	0.61 U	0.53 U	0.55 U	0.59 U	0.57 U	0.52 U	0.53 U
Cadmium	0.72 J	0.77 J	0.4 J	0.22 J	0.42 J	0.85	0.24 J	0.33 J	0.53 U
Calcium	4,530	4,310	3,010	2,230	1,800	3,420	1,740	4,610	4,670
Chromium	3.9 J	4.7 J	3.4	2.5	3.3	14.8	3.3	3.2	4.6
Cobalt	7.2 J	8.1 J	6.7	5 J	6.5	8.5	3.7 J	5.2	6.3
Copper	35.6 J	61.4 J	37.3	21.8	25.7	37.7	23.9	34	32.7 R
Cyanide	0.2 J	2.8 R	3.2 U	2.8 U	2.9 U	3 U	2.9 U	2.8 U	2.7 U
Iron	16,200 J	16,900 J	14,200 J	7,790 J	11,500 J	18,800 J	9,770 J	9,120 J	12,100
Lead	1.9	1.1 J	2.7	2.1	2	3.3	1.7	2.9	4.5
Magnesium	2,060 J	5,440 J	2,800 J	909 J	1,400 J	2,740 J	778 J	1,820 J	2,460 J
Manganese	736 J	498 J	669 J	602 J	795	594	372 J	668 J	419
Mercury	0.11 U	0.11 U	0.1 U	0.11 U	0.12 U	0.12 U	0.11 U	0.11 U	0.11 U
Nickel	1.9 J	3.3 J	2.1 J	1.1 J	1.8 J	6.2	1.2 J	1.7 J	2.4 J
Potassium	1,860	1,700	1,380 J	923 J	1,320	2,180	570 U	1,220 J	1,700
Selenium	4 U	3.9 U	4.3 U	3.7 U	3.9 UJ	4.2 UJ	4 U	3.6 U	3.7 UJ
Silver	1.1 U	1.1 U	1.2 U	1.1 U	0.091 J	1.2 U	1.1 U	1 U	1.1 U
Sodium	569 U	556 U	610 U	532 U	551 U	594 U	570 U	521 U	530 U
Thallium	0.037 J	0.017 J	0.032 J	0.027 J	0.34 U	0.36 U	0.026 J	0.028 J	0.32 U
Vanadium	45.6 J	43.1 J	38.2	23.8	36.9	68.5	33.7	26.4	36.2
Zinc	17.2 J	22.4 J	35	9.2	12.4 J	21.3 J	7.5	26.7	30.2
Wet Chemistry									
Cation Exchange Capacity (MEQ/100G)	26.8	22.4	6.14	5.68	8.46	18.9	4.5	7.76	19
Redox (MV)	316	274	448	361	384	435	404	324	307
Total organic carbon (TOC)	19,400	7,350	8,650	9,780	11,900	13,300	11,200	15,100	12,800
pH	7.31	7.79	6.59	7.15	6.19	6.75	6.33	8.16	8.04

Notes:
 MG/KG = Milligrams per kilogram
 MEQ/100G = Milli-equivalents per 100 grams
 MV = Millivolts
 J = Analyte present; reported value may or may not be accurate or precise
 R = Unreliable result
 UJ = Analyte not detected; quantitation limit may be inaccurate or imprecise
 U = Analyte not detected
 Shading represents detect

Table 3-1
 Summary of Constituents Detected in Background Surface Soil Samples
 East Vieques Background Soil Inorganics Investigation
 Former Vieques Naval Training Range, Vieques, Puerto Rico

Station ID	EBGKTD-SO10	EBGKV-SO01	EBGKV-SO02	EBGKV-SO03	EBGKV-SO04	EBGKV-SO05		EBGKV-SO06	EBGKV-SO07
Sample ID	EBGKTD-SS10-06-06B	EBGKV-SS01-06-06B	EBGKV-SS02-06-06B	EBGKV-SS03-06-06B	EBGKV-SS04-06-06B	EBGKV-SS05-06-06B	EBGKV-SS05P-06-06B	EBGKV-SS06-06-06B	EBGKV-SS07-06-06B
Sample Date	07/04/06	06/28/06	06/28/06	06/29/06	06/22/06	06/28/06	06/28/06	06/22/06	06/29/06
Chemical Name									
Explosives									
None detected									
Total Metals (MG/KG)									
Aluminum	19,900	11,500	19,400	9,900	19,900	11,300	12,400	5,300	14,300
Antimony	9.4 U	6.9 U	7 UJ	7.1 U	6.5 U	6.8 UJ	6.9 U	6.7 U	7.5 U
Arsenic	2.1	0.5 J	0.48 J	0.69 J	1.6 J	1.1 U	0.53 J	1.1 UJ	0.54 J
Barium	68.8 J	80.4	81.2 J	63.7 J	54.3	43.6	49	31	84.2 J
Beryllium	0.78 U	0.57 U	0.26 J	0.24 J	0.54 U	0.56 U	0.57 U	0.56 U	0.27 J
Cadmium	1.3 J	0.79	1.6	0.44 J	2.2	0.47 J	0.47 J	0.43 J	0.93
Calcium	7,270	2,890	3,940 J	2,960 J	1,950	3,060	3,080	1,380	4,120 J
Chromium	53.6 J	18.2	40.7	19	10	4.9	5.4	4.8	42.9
Cobalt	13.4 J	15.3	21	13.8	12.7	7.6	7.9	2.9 J	18.4
Copper	48.7 J	29	102 J	21.9 J	20.2	10.2	10.7	6	42.4 J
Cyanide	0.29 J	2.9 U	2.9 U	0.19 J	2.8 U	2.8 U	2.9 U	2.9 U	3.3 U
Iron	25,200 J	22,400 J	38,400 J	20,500 J	39,500 J	16,800 J	18,100 J	9,860 J	30,600 J
Lead	2.7	2	1.7	2.5	2.8	0.9 J	0.98 J	1.8	3.1
Magnesium	4,340 J	4,020 J	7,150 J	2,360 J	7,820 J	3,220 J	3,390 J	1,420 J	3,580 J
Manganese	558 J	1,110 J	1,050 R	513 R	1,360	519 J	523 J	372	1,040 R
Mercury	0.16 U	0.054 J	0.089 J	0.054 J	0.099 U	0.11 U	0.1 U	0.11 U	0.077 J
Nickel	24.5 J	12.8	28.4	6.5	5.5	3.3 J	3.9 J	1.2 J	14.7
Potassium	1,960	1,820 J	3,540	1,610	1,120	865 J	872 J	871	3,160
Selenium	5.5 U	4 U	4.1 UJ	4.1 UJ	3.8 UJ	3.9 U	4 U	0.32 J	4.4 UJ
Silver	1.6 U	0.11 J	0.22 J	1.2 U	0.21 J	1.1 U	1.1 U	1.1 U	0.14 J
Sodium	785 U	572 U	580 U	592 U	542 U	563 U	574 U	559 U	626 U
Thallium	0.061 J	0.063 J	0.35 U	0.36 U	0.34 U	0.044 J	0.046 J	0.34 U	0.4 U
Vanadium	109 J	69.1	108 J	63.7 J	81.1	53.3	57.6	28.2	105 J
Zinc	22.2 J	29	20.3 J	14.1 J	61.5 J	11.2	11.8	11.3 J	25.2 J
Wet Chemistry									
Cation Exchange Capacity (MEQ/100G)	55.9	13.2	35.6	3.53	14	6.94	20.5	9.96	27.1
Redox (MV)	336	391	331	385	422	447	417	456	304
Total organic carbon (TOC)	36,400	15,100	16,700	17,500	15,900	15,800	9,030	13,700	16,100
pH	7.64	6.16	6.38	5.67	6.42	6.34	6.31	6.21	6.82

Notes:
 MG/KG = Milligrams per kilogram
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 J = Analyte present; reported value may or may not be accurate or precise
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 UJ = Analyte not detected; quantitation limit may be inaccurate or imprecise
 U = Analyte not detected
 Shading represents detect

Table 3-1
 Summary of Constituents Detected in Background Surface Soil Samples
 East Vieques Background Soil Inorganics Investigation
 Former Vieques Naval Training Range, Vieques, Puerto Rico

Station ID	EBGKV-SO08	EBGKV-SO09	EBGKV-SO10	EBGQA-SO01	EBGQA-SO02	EBGQA-SO03	EBGQA-SO04	EBGQA-SO05	EBGQA-SO06	EBGQA-SO07
Sample ID	EBGKV-SS08-06-06B	EBGKV-SS09-06-06B	EBGKV-SS10-06-06B	EBGQA-SS01-06-06B	EBGQA-SS02-06-06B	EBGQA-SS03-06-06B	EBGQA-SS04-06-06B	EBGQA-SS05-06-06B	EBGQA-SS06-06-06B	EBGQA-SS07-06-06B
Sample Date	06/27/06	06/29/06	06/29/06	07/04/06	06/23/06	07/04/06	06/21/06	06/27/06	07/04/06	06/27/06
Chemical Name										
Explosives										
None detected										
Total Metals (MG/KG)										
Aluminum	7,180	11,400	13,800	7,900	4,600	10,600	6,230	17,800	19,300	11,300
Antimony	6.7 U	6.7 U	6.8 U	7.1 U	6.3 U	7.2 U	6.8 U	6.6 U	7.3 U	7.1 U
Arsenic	0.82 J	1.1 J	1.6	1.2 U	1.1 UJ	1.2 U	1.1 UJ	0.52 J	5	1 J
Barium	74.3	43.5 J	75.5 J	44.2 J	29.9	104 J	36.7	133 J	70.5 J	38.4 J
Beryllium	0.56 U	0.24 J	0.56 U	0.59 U	0.53 U	0.6 U	0.57 U	0.55 U	0.6 U	0.59 U
Cadmium	0.34 J	0.62	0.64 J	0.33 J	0.64	0.5 J	0.58	0.84	1.4 J	0.63
Calcium	1,330	2,670 J	2,740	881	30,800	11,900	3,340	4,230 J	89,900	5,040 J
Chromium	2.4	25.5	9.8 J	2.8 J	6.5	3.3 J	8.9	4.9	16.1 J	23.3
Cobalt	4.3 J	13.6	24 J	2.4 J	4.2 J	5.5 J	5.8	11.8	6.2 J	10.7
Copper	9.7	43.6 J	18.9 J	21.3 J	18.1	33.5 J	29.7	13.5 J	25.5 J	28.9 J
Cyanide	2.8 U	2.8 U	0.22 J	3 U	2.8 U	3.1 U	2.9 U	2.8 U	0.33 J	2.9 U
Iron	14,800 J	22,900 J	25,500 J	9,230 J	9,020 J	12,400 J	13,300 J	21,200 J	15,400 J	19,700 J
Lead	2	1.1	1.5 J	2.9	1 J	1.6 J	1.7	4.1	4.5	2.9
Magnesium	1,420 J	4,860 J	2,750 J	1,370 J	3,500 J	3,570 J	1,810 J	6,760 J	6,170 J	4,660 J
Manganese	503 J	512 R	308 J	152 J	255	494 J	279	756 R	515 J	536 R
Mercury	0.05 J	0.052 J	0.11 U	0.12 U	0.094 U	0.12 U	0.1 U	0.057 J	0.11 J	0.051 J
Nickel	1 J	14.4	4.2 J	0.87 J	2.5 J	1.8 J	3.2 J	3.1 J	8.2 J	9.9
Potassium	805 J	622	934	777	710	814	1,320	2,800	5,520	1,450
Selenium	3.9 U	3.9 UJ	4 U	4.1 U	0.51 J	4.2 U	0.47 J	3.9 UJ	4.2 U	4.1 UJ
Silver	1.1 U	1.1 U	1.1 U	1.2 U	0.11 J	1.2 U	0.1 J	1.1 U	1.2 U	1.2 U
Sodium	559 U	556 U	565 U	987	526 U	1,590	567 U	550 U	600 U	898 J
Thallium	0.34 U	0.34 U	0.059 J	0.032 J	0.34 U	0.045 J	0.34 U	0.33 U	0.092 J	0.35 U
Vanadium	32.5	74.1 J	61 J	46.5 J	39.3	46.7 J	52.7	42.5 J	26 J	71.6 J
Zinc	16	122 J	7.5 J	9.9 J	11.2 J	14.5 J	13.3 J	29.1 J	26.3 J	26.4 J
Wet Chemistry										
Cation Exchange Capacity (MEQ/100G)	7.31	17.7	25.2	57.2	10.1	7.74	8.47	17.1	111	12.9
Redox (MV)	380	378	377	358	300	267	453	322	271	320
Total organic carbon (TOC)	11,800	21,200	21,600	5,080	16,300	6,380	12,800	13,600	67,200	38,200
pH	6.25	6.4	6.35	7.18	8.48	8.16	6.06	6.76	7.63	7.79

Notes:
 MG/KG = Milligrams per kilogram
 MEQ/100G = Milli-equivalents per 100 grams
 MV = Millivolts
 J = Analyte present; reported value may or may not be accurate or precise
 R = Unreliable result
 UJ = Analyte not detected; quantitation limit may be inaccurate or imprecise
 U = Analyte not detected
 Shading represents detect

Table 3-1
 Summary of Constituents Detected in Background Surface Soil Samples
 East Vieques Background Soil Inorganics Investigation
 Former Vieques Naval Training Range, Vieques, Puerto Rico

Station ID	EBGQA-SO08		EBGQA-SO09	EBGQA-SO10	EBGTI-SO01	EBGTI-SO02		EBGTI-SO03	EBGTI-SO04	EBGTI-SO05
Sample ID	EBGQA-SS08-06-06B	EBGQA-SS08P-06-06B	EBGQA-SS09-06-06B	EBGQA-SS10-06-06B	EBGTI-SS01-06-06B	EBGTI-SS02-06-06B	EBGTI-SS02P-06-06B	EBGTI-SS03-06-06B	EBGTI-SS04-06-06B	EBGTI-SS05-06-06B
Sample Date	06/22/06	06/22/06	06/26/06	06/27/06	06/30/06	06/30/06	06/30/06	07/05/06	07/02/06	06/23/06
Chemical Name										
Explosives										
None detected										
Total Metals (MG/KG)										
Aluminum	22,600	23,300	9,370	12,500	26,900	25,800	23,000	41,500	21,700	24,900
Antimony	7.2 U	6.7 U	6.4 U	6.5 U	8.6 U	8.7 U	7.6 U	7.6 U	7.8 U	9.2 U
Arsenic	1.1 J	0.95 J	0.8 J	0.71 J	3.3	5.2	4.3	5.1	3.8	5.7 J
Barium	244	245	76.7	55.8 J	82.5 J	72.3 J	63.9 J	114	52.8	65.7
Beryllium	0.6 U	0.56 U	0.53 U	0.54 U	0.72	0.73	0.65	0.95	0.65 U	0.77 U
Cadmium	2.2	2.3	0.68	0.68	1.4	1.5	1.3	2	1	1.8
Calcium	3,470	3,620	40,000	4,420 J	67,900 J	76,200 J	70,300 J	23,100	47,700	77,300
Chromium	19.4	20	10.7	20.1	42.7	44.5	39.9	58.8	38.3	29.8
Cobalt	18.9	17.2	8.9	10.3	6.8 J	7.6	6.8	7.6	5.7 J	6.2 J
Copper	33.4	33.1	39.8	26.5 J	15.6 J	17.8 J	16 J	26 R	19.9 R	17.1
Cyanide	3.1 U	3 U	2.7 U	2.8 U	3.9 U	3.7 U	3.3 U	0.24 J	0.37 J	0.45 J
Iron	37,400 J	37,700 J	13,900 J	20,400 J	22,700 J	24,400 J	22,000 J	33,300	13,400	17,800 J
Lead	1.1 J	0.99 J	2.2	2.2	8.6	8.4	7.8	10.6	5.2	6.9
Magnesium	9,680 J	9,730 J	7,160 J	4,030 J	3,950 J	3,740 J	3,250 J	4,440 J	5,790 J	5,320 J
Manganese	617	580	667 J	516 R	832 R	660 R	594 R	895	785	631
Mercury	0.12 U	0.12 U	0.091 U	0.055 J	0.16	0.15	0.12 J	0.096 J	0.27	0.19
Nickel	9.5	9.5	5.4	8.6	11.5	12.1	10.9	17.7	9.3	9.7
Potassium	2,790	2,750	1,510 J	1,880	6,020	5,910	5,220	8,090	4,140	7,350
Selenium	4.2 UJ	3.9 UJ	3.7 U	3.8 UJ	5 UJ	5.1 UJ	4.5 UJ	4.5 UJ	4.6 UJ	1.3 J
Silver	0.14 J	0.11 J	1.1 U	1.1 U	1.4 U	1.5 U	1.3 U	1.3 U	0.12 J	1.5 U
Sodium	600 U	559 U	532 U	544 U	716 U	727 U	637 U	637 U	654 U	765 U
Thallium	0.37 U	0.37 U	0.33 U	0.34 U	0.46 U	0.5	0.4 U	0.41	0.42 U	0.46 U
Vanadium	112	113	60.7	71.2 J	32 J	36.1 J	32.5 J	50.3	27.2	27.5
Zinc	13.2 J	12.9 J	15.4	24.1 J	22.7 J	19.8 J	17.2 J	34.6	23.6	22.1 J
Wet Chemistry										
Cation Exchange Capacity (MEQ/100G)	21.2	18.8	11.2	12.6	65.7	64.3	45	19.6	11	44.6
Redox (MV)	394	403	287	274	280	281	264	279	207	276
Total organic carbon (TOC)	21,100	19,100	8,150	12,500	45,500	44,200	41,800	40,500	86,800	47,800
pH	6.48	6.35	8.35	7.75	7.61	8.12	7.87	7.77	8	7.95

Notes:
 MG/KG = Milligrams per kilogram
 MEQ/100G = Milli-equivalents per 100 grams
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 R = Unreliable result
 UJ = Analyte not detected; quantitation limit may be inaccurate or imprecise
 U = Analyte not detected
 Shading represents detect

Table 3-1
 Summary of Constituents Detected in Background Surface Soil Samples
 East Vieques Background Soil Inorganics Investigation
 Former Vieques Naval Training Range, Vieques, Puerto Rico

Station ID	EBGTI-SO06	EBGTI-SO07	EBGTI-SO08	EBGTI-SO09	EBGTI-SO10
Sample ID	EBGTI-SS06-06-06B	EBGTI-SS07-06-06B	EBGTI-SS08-06-06B	EBGTI-SS09-06-06B	EBGTI-SS10-06-06B
Sample Date	06/21/06	06/22/06	07/02/06	06/30/06	07/02/06
Chemical Name					
Explosives					
None detected					
Total Metals (MG/KG)					
Aluminum	10,200	35,300	5,510	12,000	4,600
Antimony	8.2 U	9.7 U	7.1 U	7.6 U	6.6 U
Arsenic	3.1 J	5.2 J	2	9.6	2.5
Barium	55.1	103	38.2	29.1 J	39.7
Beryllium	0.68 U	0.94	0.59 U	0.64 U	0.55 U
Cadmium	1.2	2.1	1.1	1.4 J	0.96
Calcium	210,000	17,800	261,000	219,000	204,000
Chromium	14.2	53.4	6.8	25.9 J	7.3
Cobalt	4.8 J	7.6 J	3.7 J	5 J	3.2 J
Copper	14.7	29	9.7 R	16.2 J	11.6
Cyanide	3.4 U	4.1 U	0.24 J	0.28 J	2.7 U
Iron	6,910 J	30,200 J	3,950	9,980 J	4,280 J
Lead	2.8	10.4	5.6	2 J	1.3
Magnesium	10,200 J	4,960 J	13,800 J	30,200 J	9,970 J
Manganese	563	663	137	287 J	218 J
Mercury	0.097 J	0.11 J	0.087 J	0.1 J	0.091 J
Nickel	6	13.8	2.8 J	9.5 J	3 J
Potassium	1,960	9,050	1,400	1,760	1,020 J
Selenium	0.7 J	1.1 J	4.2 UJ	0.36 J	3.8 U
Silver	1.4 U	1.6 U	1.2 U	1.3 U	1.1 U
Sodium	683 U	812 U	593 U	636 U	546 U
Thallium	0.41 U	0.49 U	0.38 U	0.13 J	0.046 J
Vanadium	14.7	40	9	34.5 J	11.2
Zinc	13.5 J	27.1 J	18.9	15.3 J	14
Wet Chemistry					
Cation Exchange Capacity (MEQ/100G)	2.23	3.42	48.1	59.2	30.7
Redox (MV)	315	336	217	235	249
Total organic carbon (TOC)	58,200	49,000	61,200	68,200	54,900
pH	7.87	7.79	8.13	8.05	7.89

Notes:

MG/KG = Milligrams per kilogram

MEQ/100G = Milli-equivalents per 100 grams

MV = Millivolts

J = Analyte present; reported value may or may not be accurate or precise

R = Unreliable result

UJ = Analyte not detected; quantitation limit may be inaccurate or imprecise

U = Analyte not detected

Shading represents detect

Table 3-2
 Summary of Constituents Detected in Background Subsurface Soil Samples
 East Vieques Background Soil Inorganics Investigation
 Former Vieques Naval Training Range, Vieques, Puerto Rico

Station ID	EBGKTD-SO01		EBGKTD-SO02	EBGKTD-SO03		EBGKTD-SO04	EBGKTD-SO05	EBGKTD-SO06	EBGKTD-SO07
Sample ID	EBGKTD-SB01-46-06B	EBGKTD-SB01P-46-06B	EBGKTD-SB02-46-06B	EBGKTD-SB03-46-06B	EBGKTD-SB03P-46-06B	EBGKTD-SB04-46-06B	EBGKTD-SB05-46-06B	EBGKTD-SB06-46-06B	EBGKTD-SB07-46-06B
Sample Date	07/03/06	07/03/06	07/02/06	06/24/06	06/24/06	06/26/06	06/21/06	06/21/06	06/24/06
Chemical Name									
Explosives									
None detected									
Total Metals (MG/KG)									
Aluminum	8,310	9,610	14,700	7,240	8,910	4,540	7,200	12,300	9,380
Antimony	6.2 U	6.2 U	6.5 UJ	6.3 U	7.3 U	6 U	5.9 U	6.7 U	7.2 U
Arsenic	1 U	1 U	1.1 U	1 U	1.2 U	1 U	0.99 UJ	1.1 UJ	1.2 U
Barium	75.7 J	83.8 J	107 J	72.3	96.3	102	74.6	118	292
Beryllium	0.51 U	0.52 U	0.54 U	0.52 U	0.6 U	0.5 U	0.5 U	0.56 U	0.6 U
Cadmium	0.52 J	0.59 J	0.8 J	0.28 J	0.38 J	0.17 J	0.43 J	1.2	0.45 J
Calcium	3,130	3,290	3,860	2,080	2,720	1,360	2,000	43,600	4,090
Chromium	2.8 J	2.9 J	4 J	3.2	3.7	2.3	2.9	16.5	5.5
Cobalt	5.6 J	6.2 J	7.9 J	5.1 J	5.8 J	4.6 J	5.4	10.2	12.9
Copper	19.6 J	22.8 J	47.8 J	25.1 J	36.7 J	35	35.5	50.2	40.5
Cyanide	2.6 R	2.6 R	2.7 R	2.9 U	3 U	2.6 U	2.6 U	2.8 U	3.1 U
Iron	12,000 J	13,600 J	17,200 J	10,300 J	13,600 J	7,490 J	10,600 J	18,800 J	16,900 J
Lead	0.72 J	0.84 J	1.1	1.7	2.7	0.73 J	1	1.7	3
Magnesium	3,880 J	4,310 J	2,930 J	1,560 J	2,380 J	1,490 J	2,120 J	6,800 J	2,480 J
Manganese	429 J	470 J	732 J	539 J	576 J	496 J	556	685	1,630 J
Mercury	0.1 U	0.1 U	0.11 U	0.097 U	0.12 U	0.1 U	0.1 U	0.11 U	0.11 U
Nickel	2.6 J	2.6 J	2.8 J	1.4 J	1.9 J	1 J	2 J	8.2	2.4 J
Potassium	515 U	516 U	1,640	762 J	1,070 J	641 J	907	1,060	604 U
Selenium	3.6 U	3.6 U	3.8 U	3.7 U	4.2 U	3.5 U	3.5 UJ	3.9 UJ	4.2 U
Silver	1 U	1 U	1.1 U	1 U	1.2 U	1 U	0.99 U	1.1 U	1.2 U
Sodium	515 U	516 U	538 U	524 U	604 U	504 U	495 U	2,320 J	1,140
Thallium	0.012 J	0.013 J	0.026 J	0.032 J	0.036 J	0.024 J	0.32 U	0.33 U	0.056 J
Vanadium	30.1 J	33.3 J	47.8 J	28.6	37	24.3	32.7	80.6	61.7
Zinc	23.9 J	26.6 J	27.3 J	15.2	22.3	10.2	16.2 J	22.1 J	15.2
Wet Chemistry									
Cation Exchange Capacity (MEQ/100G)	19.4	18.9	30	3.91	5.99	0.72	9.05	18.3	7.48
Redox (MV)	356	359	330	409	408	378	411	293	297
Total organic carbon (TOC)	2,130	2,250	3,530	5,900	6,560	1,460	2,640	3,480	2,770
pH	7.93	7.69	8.01	6.82	6.82	7.18	7.39	9.17	9.08

Notes:
 MG/KG = Milligrams per kilogram
 MEQ/100G = Milli-equivalents per 100 grams
 MV = Millivolts
 J = Analyte present; reported value may or may not be accurate or precise
 R = Unreliable result
 UJ = Analyte not detected; quantitation limit may be inaccurate or imprecise
 U = Analyte not detected
 Shading represents detect

Table 3-2
 Summary of Constituents Detected in Background Subsurface Soil Samples
 East Vieques Background Soil Inorganics Investigation
 Former Vieques Naval Training Range, Vieques, Puerto Rico

Station ID	EBGKTD-SO08	EBGKTD-SO09	EBGKTD-SO10		EBGKV-SO01	EBGKV-SO02	EBGKV-SO03	EBGKV-SO04	EBGKV-SO05	EBGKV-SO06
Sample ID	EBGKTD-SB08-46-06B	EBGKTD-SB09-24-06B	EBGKTD-SB10-13-06B	EBGKTD-SB10P-13-06B	EBGKV-SB01-24-06B	EBGKV-SB02-35-06B	EBGKV-SB03-46-06B	EBGKV-SB04-35-06B	EBGKV-SB05-13-06B	EBGKV-SB06-46-06B
Sample Date	06/26/06	07/06/06	07/04/06	07/04/06	06/28/06	06/28/06	06/29/06	06/22/06	06/28/06	06/22/06
Chemical Name										
Explosives										
None detected										
Total Metals (MG/KG)										
Aluminum	5,380	8,320	24,200	21,300	14,600	15,600	8,610	17,600	9,420	10,600
Antimony	5.8 U	6.3 U	7.2 U	8.7 U	5.9 UJ	6.2 UJ	6.4 U	6.3 U	6.1 U	6.6 U
Arsenic	0.96 U	1.1 U	2	2	0.62 J	1 U	0.48 J	0.47 J	0.52 J	1.1 UJ
Barium	90.9	51.1 J	121 J	77 J	75.3	61.6 J	74.3 J	67.9	23.7	117
Beryllium	0.48 U	0.52 U	0.6 U	0.72 U	0.49 U	0.19 J	0.54 U	0.52 U	0.51 U	0.55 U
Cadmium	0.27 J	0.33 J	1.8 J	1.5 J	1.2	1.1	0.61	1.5	0.33 J	0.7
Calcium	1,730	3,950	7,740	6,100	5,440	20,500 J	4,120 J	1,480	3,890	5,330
Chromium	2.5	4.9 J	72 J	65.2 J	24.9	42.2	23.5	3.1	3.9	10.6
Cobalt	4 J	5.9 J	19.4 J	16.3 J	12.6	8.3	12.5	6.6	3.5 J	10
Copper	50.1	29.5 J	53.8 J	49.5 J	76	68.6 J	21.3 J	28.1	4.4	15.4
Cyanide	2.6 U	2.6 U	3 U	3.6 U	2.6 U	2.6 U	2.7 U	2.6 U	2.6 U	2.8 U
Iron	8,860 J	12,200 J	32,400 J	30,400 J	28,700 J	23,400 J	24,700 J	27,700 J	11,000 J	18,600 J
Lead	0.57 J	1.8 J	1.4	1.7	0.84 J	1 U	1.6	1.2	1 U	1.5
Magnesium	1,690 J	2,170 J	4,830 J	4,270 J	9,920 J	15,400 J	3,560 J	10,600 J	3,950 J	4,680 J
Manganese	435 J	407 J	964 J	693 J	639 J	242 R	311 R	1,320	159 J	747
Mercury	0.099 U	0.1 U	0.053 J	0.14 U	0.088 U	0.1 U	0.11 U	0.092 U	0.1 U	0.11 U
Nickel	1.2 J	2.6 J	31.2 J	27.8 J	14	40	7.6	1.9 J	2.2 J	4.8
Potassium	571 J	1,180	1,440	1,430	490 U	966	547	1,110	506 U	1,560
Selenium	3.4 U	3.7 U	4.2 U	5.1 U	3.4 U	3.6 UJ	3.8 UJ	3.7 UJ	3.5 U	3.9 UJ
Silver	0.96 U	1.1 U	1.2 U	1.4 U	0.078 J	1 U	1.1 U	0.16 J	1 U	1.1 U
Sodium	479 U	525 U	603 U	724 U	490 U	567 J	1,110 J	522 U	506 U	1,420 J
Thallium	0.023 J	0.014 J	0.038 J	0.046 J	0.016 J	0.32 U	0.33 U	0.32 U	0.022 J	0.33 U
Vanadium	27.2	40.8 J	142 J	138 J	79.5	92.7 J	103 J	34.8	35.9	56
Zinc	11.8	17.2 J	19.5 J	19.2 J	31.8	13.5 J	9.1 J	71.3 J	9.2	19.4 J
Wet Chemistry										
Cation Exchange Capacity (MEQ/100G)	5.43	14.6	53.6	48.5	15.7	22.8	21	13.2	7.98	16.2
Redox (MV)	352	297	262	285	359	282	260	390	396	286
Total organic carbon (TOC)	1,690	5,530	28,100	24,900	1,900	2,820	4,550	1,470	5,940	2,880
pH	8.12	8.06	8.06	8.11	7.23	8.62	9.14	7.62	7.42	9.27

Notes:
 MG/KG = Milligrams per kilogram
 MEQ/100G = Milli-equivalents per 100 grams
 MV = Millivolts
 J = Analyte present; reported value may or may not be accurate or precise
 R = Unreliable result
 UJ = Analyte not detected; quantitation limit may be inaccurate or imprecise
 U = Analyte not detected
 Shading represents detect

Table 3-2
 Summary of Constituents Detected in Background Subsurface Soil Samples
 East Vieques Background Soil Inorganics Investigation
 Former Vieques Naval Training Range, Vieques, Puerto Rico

Station ID	EBGKV-SO07	EBGKV-SO08	EBGKV-SO09		EBGKV-SO10	EBGQA-SO01	EBGQA-SO02	EBGQA-SO03	EBGQA-SO04	EBGQA-SO05
Sample ID	EBGKV-SB07-46-06B	EBGKV-SB08-23-06B	EBGKV-SB09-24-06B	EBGKV-SB09P-24-06B	EBGKV-SB10-46-06B	EBGQA-SB01-24-06B	EBGQA-SB02-46-06B	EBGQA-SB03-24-06B	EBGQA-SB04-46-06B	EBGQA-SB05-13-06B
Sample Date	06/29/06	06/27/06	06/29/06	06/29/06	06/29/06	07/04/06	06/23/06	07/04/06	06/21/06	06/27/06
Chemical Name										
Explosives										
None detected										
Total Metals (MG/KG)										
Aluminum	13,000	7,920	3,700	3,740	16,400	16,100	4,660	9,550	8,090	22,000
Antimony	6.1 U	6.2 U	6.2 U	6.2 U	6.4 U	7.4 U	6.2 U	7.7 U	6.2 U	6.4 U
Arsenic	0.57 J	1 U	1.5	1.4	0.67 J	1.2 U	1 U	1.3 U	1 UJ	1.1 U
Barium	60.9 J	69.7	20.5 U	20.5 U	209 J	108 J	21	53.4 J	34.8	114 J
Beryllium	0.21 J	0.52 U	0.51 U	0.51 U	0.53 U	0.61 U	0.52 U	0.64 U	0.52 U	0.53 U
Cadmium	1	0.23 J	0.51 U	0.51 U	0.89 J	0.45 J	0.59	0.37 J	0.84	0.91
Calcium	18,000 J	931	1,610 J	1,370 J	4,900	4,230	40,000	11,600 J	3,050	3,400 J
Chromium	36.5	2.9	2.9	2.8	4.8 J	4.6 J	8.3	3.4	15.1	4.6
Cobalt	15.8	5.5	3.5 J	3.4 J	6.7 J	6.4 J	4.6 J	4.6 J	5.8	8.3
Copper	53 J	11.3	4.9 J	4.6 J	12.3 J	34.6 J	25.1	25.9 J	43.7	3.3 J
Cyanide	2.7 U	2.7 U	2.6 U	2.6 U	2.7 R	3.1 U	2.7 U	3.2 U	2.6 U	2.7 U
Iron	26,100 J	14,500 J	5,140 J	5,100 J	21,400 J	15,200 J	10,200 J	12,100 J	22,100 J	21,200 J
Lead	1.4	0.85 J	1 U	1 U	1.1 UJ	2 J	0.73 J	1.8	0.94 J	0.71 J
Magnesium	6,270 J	2,710 J	1,180 J	1,080 J	7,410 J	3,000 J	3,940 J	3,940 J	3,360 J	10,400 J
Manganese	742 R	379 J	136 R	114 R	305 J	738 J	123 J	464 R	189	468 R
Mercury	0.11 U	0.089 U	0.1 U	0.1 U	0.11 U	0.12 U	0.089 U	0.13 U	0.1 U	0.11 U
Nickel	16.4	1.6 J	4.1	3.7 J	2.9 J	2.6 J	2.7 J	1.4 J	5.2	3.1 J
Potassium	3,130	759 J	512 U	513 U	2,010	1,620	521 U	840	424 J	1,370
Selenium	3.6 UJ	3.6 U	3.6 UJ	3.6 UJ	3.7 U	4.3 U	3.6 U	4.5 UJ	3.6 UJ	3.7 UJ
Silver	1 U	1 U	1 U	1 U	1.1 U	1.2 U	1 U	1.3 U	1 U	1.1 U
Sodium	2,250 J	592	512 U	513 U	2,700	4,990	771	3,600 J	550 J	532 U
Thallium	0.33 U	0.033 J	0.31 U	0.31 U	0.064 J	0.049 J	0.017 J	0.38 U	0.31 U	0.32 U
Vanadium	99.3 J	31.9	13.4 J	12.9 J	49.4 J	42 J	54.7	38.3 J	114	40.1 J
Zinc	21.5 J	16.2	9.9 J	9.9 J	10.5 J	20.7 J	12.2	15.1 J	18 J	21.4 J
Wet Chemistry										
Cation Exchange Capacity (MEQ/100G)	22	5.66	9.59	10.5	18.3	35.5	4.04	25.3	9.14	15
Redox (MV)	222	324	330	346	269	266	297	327	328	341
Total organic carbon (TOC)	4,660	2,190	5,170	8,300	1,930	2,080	2,640	3,630	2,870	8,390
pH	9.65	7.01	7.36	7.29	8.53	8.09	8.7	8.02	8.7	7.09

Notes:
 MG/KG = Milligrams per kilogram
 MEQ/100G = Milli-equivalents per 100 grams
 MV = Millivolts
 J = Analyte present; reported value may or may not be accurate or precise
 R = Unreliable result
 UJ = Analyte not detected; quantitation limit may be inaccurate or imprecise
 U = Analyte not detected
 Shading represents detect

Table 3-2
 Summary of Constituents Detected in Background Subsurface Soil Samples
 East Vieques Background Soil Inorganics Investigation
 Former Vieques Naval Training Range, Vieques, Puerto Rico

Station ID	EBGQA-SO06	EBGQA-SO07	EBGQA-SO08	EBGQA-SO09	EBGQA-SO10		EBGTI-SO02	EBGTI-SO03	EBGTI-SO04	
Sample ID	EBGQA-SB06-24-06B	EBGQA-SB07-46-06B	EBGQA-SB08-13-06B	EBGQA-SB09-46-06B	EBGQA-SB10-13-06B	EBGQA-SB10P-13-06B	EBGTI-SB02-12-06B	EBGTI-SB03-61-06B	EBGTI-SB04P-62-06B	EBGTI-SB04-62-06B
Sample Date	07/04/06	06/27/06	06/22/06	06/26/06	06/27/06	06/27/06	06/30/06	07/05/06	07/02/06	07/02/06
Chemical Name										
Explosives										
None detected										
Total Metals (MG/KG)										
Aluminum	4,310	12,900	29,900	9,640	14,200	14,900	6,500	34,000	25,000	25,300
Antimony	6.4 U	7.9 U	6.4 UJ	6.4 U	6.4 U	6.8 U	7 U	7 U	9.2 U	8.4 U
Arsenic	4.5	0.56 J	1.1 UJ	1.1 U	0.58 J	1.1 U	1.6	4.4	4.4	4.2
Barium	35.1 J	51.6 J	344	175	98.6 J	75.7 J	30.1 J	88.8	60.4	58.2
Beryllium	0.53 U	0.66 U	0.53 U	0.54 U	0.53 U	0.56 U	0.58 U	0.77	0.77 U	0.7 U
Cadmium	1.2 J	0.77	3.1	0.49 J	0.7	0.71	1.2 J	2	1.1	1.1
Calcium	361,000	6,720 J	4,170	5,060	3,140 J	3,280 J	354,000	76,900	52,900 J	33,800 J
Chromium	5.6 J	23	30.5	11.4	22.6	23.7	9.1 J	46.3	45.3	45.5
Cobalt	5.3 U	10.2	12.5	9.2	13.2	11.3	4.1 J	6.9	6.7 J	6.5 J
Copper	5.6 J	21.2 J	7.3	42.5	24.6 J	24.1 J	7.4 J	19.2 R	20.7 R	20.3 R
Cyanide	0.89 J	3.3 U	2.7 U	2.7 U	2.8 U	2.8 U	0.25 J	0.52 J	0.32 J	3.5 U
Iron	4,840 J	21,700 J	38,100 J	15,000 J	22,400 J	22,700 J	4,310 J	25,500	15,600	15,900
Lead	1.1 U	1.4	1.1 U	1.1	1.5	1.5	1.2 J	7.7	5.5	5.1
Magnesium	5,080 J	5,500 J	25,200 J	3,040 J	4,820 J	4,880 J	3,210 J	3,780 J	5,850 J	5,340 J
Manganese	86 J	237 R	428	555 J	619 R	450 R	86.9 J	631	972	916
Mercury	0.1 U	0.13 U	0.11 U	0.087 U	0.11 U	0.11 U	0.056 J	0.12	0.31	0.2
Nickel	2.9 J	9.4	15.4	6.3	9.1	8.8	2.9 J	14.3	10.8	10.8
Potassium	630	1,160	2,760	793 J	1,000	1,090	1,500	7,020	4,620	4,610
Selenium	3.7 U	4.6 UJ	3.7 UJ	3.8 U	3.7 UJ	3.9 UJ	4.1 U	4.1 UJ	0.41 J	4.9 UJ
Silver	1.1 U	1.3 U	0.094 J	1.1 U	1.1 U	1.1 U	1.2 U	1.2 U	1.5 U	1.4 U
Sodium	533 U	3,120 J	530 U	538 U	1,070 J	1,100 J	583 U	582 U	765 U	701 U
Thallium	0.024 J	0.4 U	0.32 U	0.33 U	0.34 U	0.34 U	0.1 J	0.37 U	0.46 U	0.42 U
Vanadium	15.3 J	67.3 J	97.6	81.1	76.7 J	74.3 J	8.7 J	39	30.7	31.5
Zinc	6.7 J	22.7 J	18.9 J	14.6	18.2 J	19.4 J	4 J	25.7	25.1	25.2
Wet Chemistry										
Cation Exchange Capacity (MEQ/100G)	18	17	24	9.12	18	19	13.5	49.5	6.09	10.8
Redox (MV)	235	240	394	283	245	252	248	300	234	248
Total organic carbon (TOC)	25,200	7,890	6,310	3,380	6,880	8,320	37,300	27,900	56,600	73,400
pH	8.85	8.02	7.75	8.48	8.32	8.36	8.27	7.29	7.8	7.8

Notes:
 MG/KG = Milligrams per kilogram
 MEQ/100G = Milli-equivalents per 100 grams
 MV = Millivolts
 J = Analyte present; reported value may or may not be accurate or precise
 R = Unreliable result
 UJ = Analyte not detected; quantitation limit may be inaccurate or imprecise
 U = Analyte not detected
 Shading represents detect

Table 3-2
 Summary of Constituents Detected in Background Subsurface Soil Samples
 East Vieques Background Soil Inorganics Investigation
 Former Vieques Naval Training Range, Vieques, Puerto Rico

Station ID	EBGTI-SO05	EBGTI-SO06	EBGTI-SO07	EBGTI-SO08		EBGTI-SO09	EBGTI-SO10
Sample ID	EBGTI-SB05-61-06B	EBGTI-SB06-12-06B	EBGTI-SB07-61-06B	EBGTI-SB08-62-06B	EBGTI-SB08P-62-06B	EBGTI-SB09-61-06B	EBGTI-SB10-62-06B
Sample Date	06/23/06	06/21/06	06/22/06	07/02/06	07/02/06	06/30/06	07/02/06
Chemical Name							
Explosives							
None detected							
Total Metals (MG/KG)							
Aluminum	17,400	5,470	21,600	2,340	2,280	10,400	8,460
Antimony	7.9 U	7 U	8.4 U	6.4 U	6.8 U	7.4 U	7 U
Arsenic	3.8 J	1.8 J	3.9 J	1.1	1.3	7.8	3.4
Barium	46	28.6	63.9	36.8	37.6	25.7 J	48.2 J
Beryllium	0.66 U	0.58 U	0.7 U	0.54 U	0.56 U	0.62 U	0.58 U
Cadmium	1.6	0.85	1.9	0.98	0.98	1.4 J	1.2 J
Calcium	199,000	222,000	190,000	362,000	360,000	222,000	193,000
Chromium	20.2	7.9	30.3	3.4	3.4	22.7 J	11.6 J
Cobalt	5.2 J	3.2 J	6.2 J	3.3 J	3.3 J	5.1 J	4 J
Copper	9.9	7.4	21.2	2.4 R	2.7 R	13.7 J	15.1 J
Cyanide	3.3 U	2.9 U	3.5 U	0.97 J	1 J	0.71 J	0.48 J
Iron	11,400 J	3,640 J	16,400 J	1,480	1,500	8,360 J	7,410 J
Lead	4.3	1.1 J	5.3	0.78 J	1.2	1.8 J	1.4
Magnesium	4,140 J	14,300 J	3,930 J	11,000 J	12,300 J	32,300 J	12,200 J
Manganese	369	245	327	32.2	31.9	234 J	285 J
Mercury	0.17	0.07 J	0.14	0.039 J	0.088 U	0.11 J	0.059 J
Nickel	6.9	3.2 J	8.8	1.5 J	1.5 J	8.3 J	4.5 J
Potassium	5,180	951	6,120	535 U	564 U	1,490	2,190
Selenium	0.71 J	0.38 J	1 J	3.7 UJ	4 UJ	4.3 U	0.31 J
Silver	1.3 U	1.2 U	1.4 U	1.1 U	1.1 U	1.2 U	1.2 U
Sodium	660 U	583 U	701 U	535 U	564 U	616 U	584 U
Thallium	0.4 U	0.35 U	0.42 U	0.34 U	0.34 U	0.13 J	0.069 J
Vanadium	20.1	9.5	23.8	4.8 J	4.9 J	31 J	20.2 J
Zinc	13.4 J	6.8 J	14.7 J	3.2 J	4 J	12.2 J	17.4 J
Wet Chemistry							
Cation Exchange Capacity (MEQ/100G)	29.7	11.4	21.3	14.7	14	47	47
Redox (MV)	294	309	319	208	213	228	283
Total organic carbon (TOC)	54,200	64,200	58,300	36,500	39,900	45,400	50,900
pH	8	8.31	7.99	8.42	8.47	7.95	7.69

Notes:
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 MV = Millivolts
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 UJ = Analyte not detected; quantitation limit may be inaccurate or imprecise
 U = Analyte not detected
 Shading represents detect

Table 3-3
 Comparison of Split Sample Data
 East Vieques Background Soil Inorganics Investigation
 Former Vieques Naval Training Range, Vieques, Puerto Rico

Station ID	EBGKTD-SO05				EBGKTD-SO06			
	EBGKTD-SS05-06-06B	KTD-5A (EPA)	EBGKTD-SB05-46-06B	KTD-5B (EPA)	EBGKTD-SS06-06-06B	KTD-6A (EPA)	EBGKTD-SB06-46-06B	KTD-6B (EPA)
Sample ID								
Sample Date	06/21/06	06/21/06	06/21/06	06/21/06	06/21/06	06/21/06	06/21/06	06/21/06
Chemical Name								
Total Metals (MG/KG)								
Aluminum	6,370	5,500	7,200	5,700	12,300	11,000	12,300	11,000
Antimony	6.6 U	2.3 U	5.9 U	2.2 U	7.1 U	3.4	6.7 U	2.6
Arsenic	1.1 UJ	1.8 U	0.99 UJ	1.8 U	1.2 UJ	1.9 U	1.1 UJ	1.7 U
Barium	73	65	74.6	72	64.4	80	118	95
Beryllium	0.55 U	0.34 U	0.5 U	0.34 U	0.59 U	0.35 U	0.56 U	0.32 U
Cadmium	0.42 J	0.34 U	0.43 J	0.34 U	0.85	0.35 U	1.2	0.32 U
Calcium	1,800	1,700	2,000	1,800	3,420	3,300	43,600	29,000
Chromium	3.3	5.5	2.9	4.0	14.8	16	16.5	19
Cobalt	6.5	7.7	5.4	7.7	8.5	14	10.2	8.7
Copper	25.7	25	35.5	32	37.7	39	50.2	40
Iron	11,500 J	17,000	10,600 J	13,000	18,800 J	25,000	18,800 J	20,000
Lead	2	2.5	1	1.2	3.3	5.5	1.7	1.1 U
Magnesium	1,400 J	1,500	2,120 J	2,200	2,740 J	3,100	6,800 J	7,400
Manganese	795	730	556	620	594	700	685	400
Mercury	0.12 U	0.058 U	0.1 U	0.047 U	0.12 U	0.060 U	0.11 U	0.055 U
Nickel	1.8 J	2.7	2 J	2.8	6.2	7.4	8.2	7.5
Potassium	1,320	1,100	907	710	2,180	1,900	1,060	820
Selenium	3.9 UJ	2.3 U	3.5 UJ	2.2 U	4.2 UJ	2.3 U	3.9 UJ	2.2 U
Silver	0.091 J	0.57 U	0.99 U	0.56 U	1.2 U	0.58 U	1.1 U	0.54 U
Sodium	551 U	170	495 U	230	594 U	330	2,320 J	2,700
Vanadium	36.9	57	32.7	40	68.5	94	80.6	81
Zinc	12.4 J	11	16.2 J	15	21.3 J	20	22.1 J	18
Explosives (UG/KG)								
2,6-Dinitrotoluene	1,200 UJ	100 U						

Notes:

(EPA) = Split sample collected by EPA

NA = Not analyzed

ND = Not detected

U - Analyte not detected

J = Analyte present; reported value may or may not be accurate or precise

UJ = Analyte not detected; quantitation limit may be inaccurate or imprecise

Shading represents detect

Table 3-3
 Comparison of Split Sample Data
 East Vieques Background Soil Inorganics Investigation
 Former Vieques Naval Training Range, Vieques, Puerto Rico

Station ID	EBGKV-SO04				EBGKV-SO06			
	EBGKV-SS04-06-06B	KV-4A (EPA)	EBGKV-SB04-35-06B	KV-4B (EPA)	EBGKV-SS06-06-06B	KV-6A (EPA)	EBGKV-SB06-46-06B	KV-6B (EPA)
Sample ID								
Sample Date	06/22/06	06/22/06	06/22/06	06/22/06	06/22/06	06/22/06	06/22/06	06/22/06
Chemical Name								
Total Metals (MG/KG)								
Aluminum	19,900	21,000	17,600	18,000	5,300	4,600	10,600	10,000
Antimony	6.5 U	5.7	6.3 U	3.7	6.7 U	2.1 U	6.6 U	2.3
Arsenic	1.6 J	2.5	0.47 J	1.7 U	1.1 UJ	1.7 U	1.1 UJ	1.7 U
Barium	54.3	61	67.9	63	31	26	117	100
Beryllium	0.54 U	0.35 U	0.52 U	0.32 U	0.56 U	0.32 U	0.55 U	0.37
Cadmium	2.2	0.35 U	1.5	0.32 U	0.43 J	0.32 U	0.7	0.31 U
Calcium	1,950	1,800	1,480	1,100	1,380	1,300	5,330	4,400
Chromium	10	11	3.1	2.5	4.8	5.3	10.6	13
Cobalt	12.7	19	6.6	8.7	2.9 J	3.5	10	12
Copper	20.2	19	28.1	32	6	6.3	15.4	16
Iron	39,500 J	51,000	27,700 J	32,000	9,860 J	9,000	18,600 J	22,000
Lead	2.8	3.4	1.2	1.1 U	1.8	1.6	1.5	1.6
Magnesium	7,820 J	11,000	10,600 J	13,000	1,420 J	1,500	4,680 J	5,300
Manganese	1,360	1,700	1,320	1,300	372	320	747	630
Mercury	0.099 U	0.048 U	0.092 U	0.046 U	0.11 U	0.050 U	0.11 U	0.049 U
Nickel	5.5	8.5	1.9 J	3.0	1.2 J	2.1 U	4.8	5.5
Potassium	1,120	980	1,110	500	871	750	1,560	1,400
Selenium	3.8 UJ	2.3 U	3.7 UJ	2.1 U	0.32 J	2.1 U	3.9 UJ	2.1 U
Silver	0.21 J	0.58 U	0.16 J	0.53 U	1.1 U	0.53 U	1.1 U	0.52 U
Sodium	542 U	500	522 U	630	559 U	130	1,420 J	1,600
Vanadium	81.1	98	34.8	40	28.2	26	56	66
Zinc	61.5 J	70	71.3 J	80	11.3 J	10	19.4 J	19
Explosives (UG/KG)								
2,6-Dinitrotoluene	1,200 UJ	100 U	1,200 UJ	100 U	1,200 UJ	100 U	1,200 UJ	99 U

Notes:

(EPA) = Split sample collected by EPA

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ND = Not detected

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UJ = Analyte not detected; quantitation limit may be inaccurate or imprecise

Shading represents detect

Table 3-3
 Comparison of Split Sample Data
 East Vieques Background Soil Inorganics Investigation
 Former Vieques Naval Training Range, Vieques, Puerto Rico

Station ID	EBGQA-SO04				EBGQA-SO08				
	EBGQA-SS04-06-06B	QA-4A (EPA)	EBGQA-SB04-46-06B	QA-4B (EPA)	EBGQA-SS08-06-06B	EBGQA-SS08P-06-06B	QA-8A (EPA)	EBGQA-SB08-13-06B	QA-8B (EPA)
Sample ID	06/21/06	06/21/06	06/21/06	06/21/06	06/22/06	06/22/06	06/22/06	06/22/06	06/22/06
Sample Date									
Chemical Name									
Total Metals (MG/KG)									
Aluminum	6,230	5,400	8,090	7,100	22,600	23,300	21,000	29,900	27,000
Antimony	6.8 U	2.1 U	6.2 U	3.4	7.2 U	6.7 U	5.8	6.4 UJ	4.5
Arsenic	1.1 UJ	1.7 U	1 UJ	1.6 U	1.1 J	0.95 J	1.9 U	1.1 UJ	1.7 U
Barium	36.7	36	34.8	31	244	245	240	344	310
Beryllium	0.57 U	0.32 U	0.52 U	0.30 U	0.6 U	0.56 U	0.40	0.53 U	0.32 U
Cadmium	0.58	0.32 U	0.84	0.30 U	2.2	2.3	0.36 U	3.1	0.32 U
Calcium	3,340	2,900	3,050	2,400	3,470	3,620	3,500	4,170	3,300
Chromium	8.9	12	15.1	20	19.4	20	29	30.5	32
Cobalt	5.8	7.4	5.8	7.3	18.9	17.2	24	12.5	14
Copper	29.7	27	43.7	43	33.4	33.1	32	7.3	6.8
Iron	13,300 J	17,000	22,100 J	28,000	37,400 J	37,700 J	50,000	38,100 J	38,000
Lead	1.7	1.7	0.94 J	1.0 U	1.1 J	0.99 J	1.2	1.1 U	1.1 U
Magnesium	1,810 J	2,000	3,360 J	3,300	9,680 J	9,730 J	11,000	25,200 J	27,000
Manganese	279	280	189	140	617	580	610	428	420
Mercury	0.1 U	0.052 U	0.1 U	0.043 U	0.12 U	0.12 U	0.058 U	0.11 U	0.049 U
Nickel	3.2 J	4.2	5.2	6.1	9.5	9.5	12	15.4	16
Potassium	1,320	1,100	424 J	340	2,790	2,750	2,400	2,760	2,100
Selenium	0.47 J	2.1 U	3.6 UJ	2.0 U	4.2 UJ	3.9 UJ	2.4 U	3.7 UJ	2.1 U
Silver	0.1 J	0.53 U	1 U	0.51 U	0.14 J	0.11 J	0.59 U	0.094 J	0.53 U
Sodium	567 U	200	550 J	620	600 U	559 U	440	530 U	620
Vanadium	52.7	66	114	140	112	113	140	97.6	92
Zinc	13.3 J	12	18 J	14	13.2 J	12.9 J	11	18.9 J	19
Explosives (UG/KG)									
2,6-Dinitrotoluene	1,200 UJ	100 U	1,200 UJ	100 U	1,200 UJ	1,200 UJ	100 U	1,200 UJ	100 U

Notes:

(EPA) = Split sample collected by EPA

NA = Not analyzed

ND = Not detected

U - Analyte not detected

J = Analyte present; reported value may or may not be accurate or precise

UJ = Analyte not detected; quantitation limit may be inaccurate or imprecise

Shading represents detect

Table 3-3
 Comparison of Split Sample Data
 East Vieques Background Soil Inorganics Investigation
 Former Vieques Naval Training Range, Vieques, Puerto Rico

Station ID	EBGTI-SO06				EBGTI-SO07			
	EBGTI-SS06-06-06B	TI-6A (EPA)	EBGTI-SB06-12-06B	TI-6B (EPA)	EBGTI-SS07-06-06B	TI-7A (EPA)	EBGTI-SB07-61-06B	TI-7B (EPA)
Sample ID								
Sample Date	06/21/06	06/21/06	06/21/06	06/21/06	06/22/06	06/22/06	06/22/06	06/22/06
Chemical Name								
Total Metals (MG/KG)								
Aluminum	10,200	8,900	5,470	6,300	35,300	28,000	21,600	14,000
Antimony	8.2 U	2.6	7 U	2.5 U	9.7 U	4.6	8.4 U	3.4 U
Arsenic	3.1 J	3.6	1.8 J	3.3	5.2 J	6.1	3.9 J	4.0
Barium	55.1	51	28.6	36	103	87	63.9	50
Beryllium	0.68 U	0.38 U	0.58 U	0.37 U	0.94	0.94	0.7 U	0.51 U
Cadmium	1.2	0.38 U	0.85	0.37 U	2.1	0.47 U	1.9	0.51 U
Calcium	210,000	200,000	222,000	250,000	17,800	24,000	190,000	220,000
Chromium	14.2	15	7.9	10	53.4	52	30.3	26
Cobalt	4.8 J	3.9	3.2 J	2.9	7.6 J	9.6	6.2 J	5.7
Copper	14.7	15	7.4	10	29	24	21.2	18
Iron	6,910 J	7,100	3,640 J	5,000	30,200 J	32,000	16,400 J	15,000
Lead	2.8	3.1	1.1 J	1.6	10.4	15	5.3	6.4
Magnesium	10,200 J	11,000	14,300 J	19,000	4,960 J	4,800	3,930 J	3,600
Manganese	563	550	245	310	663	630	327	310
Mercury	0.097 J	0.13	0.07 J	0.074	0.11 J	0.12	0.14	0.12
Nickel	6	6.5	3.2 J	4.7	13.8	14	8.8	7.9
Potassium	1,960	1,300	951	820	9,050	6,400	6,120	3,200
Selenium	0.7 J	2.6 U	0.38 J	2.5 U	1.1 J	3.2 U	1 J	3.4 U
Silver	1.4 U	0.64 U	1.2 U	0.61 U	1.6 U	0.79 U	1.4 U	0.86 U
Sodium	683 U	640	583 U	730	812 U	600	701 U	800
Vanadium	14.7	15	9.5	13	40	51	23.8	26
Zinc	13.5 J	13	6.8 J	8.4	27.1 J	22	14.7 J	9.3
Explosives (UG/KG)								
2,6-Dinitrotoluene	1,200 UJ	100 U	1,200 UJ	19 J	1,200 UJ	100 U	1,200 UJ	100 U

Notes:

(EPA) = Split sample collected by EPA

NA = Not analyzed

ND = Not detected

U - Analyte not detected

J = Analyte present; reported value may or may not be accurate or precise

UJ = Analyte not detected; quantitation limit may be inaccurate or imprecise

Shading represents detect

Table 3-4
Comparison of West and East Vieques Background Inorganics Concentrations in Surface Soil
Qa and KTd Zones
East Vieques Background Soil Inorganics Investigation
Former Vieques Naval Training Range, Vieques, Puerto Rico

Inorganic Constituent	Qa						KTd					
	West Vieques			East Vieques			West Vieques			East Vieques		
	minimum	maximum	mean									
Aluminum	5,000	29,000	13,350	4,310	29,900	12,678	6,900	18,000	11,346	4,540	24,200	9,771
Antimony	0.59	2.3	0.81	--	--	--	0.52	1.4	0.68	--	--	--
Arsenic	0.66	2.2	0.95	--	1.1	0.75	0.57	1.2	0.65	--	0.64	0.64
Barium	30	320	94	21	344	93	20	190	84	48	121	83
Beryllium	0.13	0.46	0.24	--	--	--	0.13	0.27	0.17	--	--	--
Cadmium	--	--	--	0.33	3.1	0.9	--	--	--	0.17	1.8	0.61
Calcium	1,700	45,000	11,817	881	11,900	4,976	2,800	9,100	4,838	1,360	7,740	3,554
Chromium	4.5	74	26	2.8	31	12	2.2	52	13	2.3	72	11
Cobalt	4.3	25	13	--	19	8.4	6.7	13	9.1	3.7	19.4	7.6
Copper	9.1	68	31	3.3	43.7	25.2	15	47	28	20	61	38
Iron	12,000	39,000	23,167	4,840	38,100	17,740	14,000	28,000	20,692	7,490	32,400	14,417
Lead	1.4	6	3.96	1	4.5	2.4	1.1	5.7	3.2	1.1	4.5	2.5
Magnesium	1,200	16,000	4,625	1,370	25,200	5,849	1,500	7,200	3,985	778	3,880	2,080
Manganese	260	1,200	663	86	738	392	290	1,200	626	372	1,630	639
Mercury	0.0048	0.031	0.018	--	0.057	0.054	0.0037	0.024	0.011	--	0.053	0.053
Nickel	1.8	40	13	0.87	15.4	5.6	1.3	18	5.1	1	31.2	5.1
Potassium	570	1,400	1,023	710	5,520	1,967	520	1,400	875	--	2180	1583
Selenium	0.68	2.0	0.85	--	0.51	0.49	0.73	0.73	0.54	--	--	--
Silver	--	--	--	--	0.14	0.11	--	--	--	--	0.091	0.091
Sodium	50	1,200	367	--	1,590	978	25	310	116	--	1,140	1,140
Thallium*	0.67	0.67	0.43	--	0.092	0.043	0.45	0.46	0.39	--	0.061	0.03
Vanadium	34	130	73	26	114	60	29	80	53	24	142	49
Zinc	17	71	38	6.7	29	18	23	53	36	7.5	35	19

Notes:

All concentrations in mg/kg; outliers not included

mean = arithmetic mean of detects; does not include duplicate results

-- = not detected

*The thallium analytical method used during the east Vieques background study (2006) was more precise and less prone to false positives than the thallium analytical method used during the west Vieques background study (2000)

Table 3-5

Comparison of West and East Vieques Background Inorganics Concentrations in Subsurface Soil
Qa and KTd Zones

East Vieques Background Soil Inorganics Investigation

Former Vieques Naval Training Range, Vieques, Puerto Rico

Inorganic Constituent	Qa						KTd					
	West Vieques			East Vieques			West Vieques			East Vieques		
	minimum	maximum	mean									
Aluminum	5,000	29,000	13,350	4,310	29,900	12,678	6,900	18,000	11,346	4,540	24,200	9,771
Antimony	0.59	2.3	0.81	--	--	--	0.52	1.4	0.68	--	--	--
Arsenic	0.31	0.71	0.43	--	1.1	0.75	0.87	1.0	0.96	--	0.64	0.64
Barium	30	320	94	21	344	93	20	190	84	48	121	83
Beryllium	0.13	0.46	0.24	--	--	--	0.13	0.27	0.17	--	--	--
Cadmium	--	--	--	0.33	3.1	0.9	--	--	--	0.17	1.8	0.61
Calcium	1,700	45,000	11,817	881	11,900	4,976	2,800	9,100	4,838	1,360	7,740	3,554
Chromium	4.5	74	26	2.8	31	12	2.2	52	13	2.3	72	11
Cobalt	4.3	25	13	--	19	8.4	6.7	13	9.1	3.7	19.4	7.6
Copper	9.1	68	31	3.3	43.7	25.2	15	47	28	20	61	38
Iron	12,000	39,000	23,167	4,840	38,100	17,740	14,000	28,000	20,692	7,490	32,400	14,417
Lead	1.4	6	3.96	--	2	1.3	1.1	5.7	3.2	0.57	3	1.4
Magnesium	1,200	16,000	4,625	1,370	25,200	5,849	1,500	7,200	3,985	778	3,880	2,080
Manganese	260	1,200	663	86	738	392	290	1,200	626	372	1,630	639
Mercury	0.0048	0.031	0.018	--	0.057	0.054	0.0037	0.024	0.011	--	0.053	0.053
Nickel	1.8	40	13	0.87	15.4	5.6	1.3	18	5.1	1	31.2	5.1
Potassium	570	1,400	1,023	--	1,620	871	520	1,400	875	--	1,640	1,025
Selenium	0.68	2.0	0.85	--	0.51	0.49	0.73	0.73	0.54	--	--	--
Silver	--	--	--	--	0.14	0.11	--	--	--	--	0.091	0.091
Sodium	50	1,200	367	--	1,590	978	25	310	116	--	1,140	1,140
Thallium	0.67	0.67	0.43	--	0.092	0.043	0.45	0.46	0.39	--	0.061	0.03
Vanadium	34	130	73	26	114	60	29	80	53	24	142	49
Zinc	17	71	38	6.7	29	18	23	53	36	7.5	35	19

Notes:

All concentrations in mg/kg

mean = arithmetic mean of detects; does not include duplicate results

-- = not detected

*The thallium analytical method used during the east Vieques background study (2006) was more precise and less prone to false positives than the thallium analytical method used during the west Vieques background study (2000)

Table 3-6
 Initial ANOVA and Scatter Plot Evaluation of Depth and Soil Type Affect on Inorganics Concentrations
 East Vieques Background Soil Inorganics Investigation
 Former Vieques Naval Training Range, Vieques, Puerto Rico

Inorganic Constituent	Percent Detects	Depth p-value	Soil Type p-value
Aluminum	100	0.552	0.123
Antimony	0	No detections	
Arsenic	58	0.019	0.000
Barium	99	0.733	0.019
Beryllium	14	Percent Detects < 50%	
Cadmium	97	0.930	0.000
Calcium	100	0.159	0.000
Chromium	100	0.459	0.000
Cobalt	99	0.244	0.008
Copper	100	0.598	0.000
Cyanide	22	Percent Detects < 50%	
Iron	100	0.420	0.005
Lead	92	0.000	0.000
Magnesium	100	0.172	0.000
Manganese	100	0.249	0.029
Mercury	36	Percent Detects < 50%	
Nickel	100	0.613	0.003
Potassium	90	0.003	0.000
Selenium	14	Percent Detects < 50%	
Silver	15	Percent Detects < 50%	
Sodium	22	Percent Detects < 50%	
Thallium	44	Percent Detects < 50%	
Vanadium	100	0.481	0.000
Zinc	100	0.098	0.837

Table 3-7
 Tukey's Significant Difference Test Results for Soil Types
 East Vieques Background Soil Inorganics Investigation
 Former Vieques Naval Training Range, Vieques, Puerto Rico

Inorganic Constituent	Soil Type p-value	Are Soil Types Significantly Different?	KTd	Kv	Qa	TI
Aluminum	0.118	No	A	A	A	A
Antimony	No detects					
Arsenic	0.000	Yes	B	B	B	A
Barium	0.018	Yes	A	AB	AB	B
Beryllium	Percent Detects < 50% *	Yes	B	B	B	A
Cadmium	0.000	Yes	B	B	B	A
Calcium	0.000	Yes	C	C	B	A
Chromium	0.000	Yes	B	AB	B	A
Cobalt	0.008	Yes	AB	A	AB	B
Copper	0.000	Yes	A	BC	B	C
Cyanide	Percent Detects < 50% *	Yes	B	B	B	A
Iron	0.005	Yes	B	A	AB	B
Lead	0.000	Yes	AB	B	B	A
Magnesium	0.000	Yes	B	A	A	A
Manganese	0.030	Yes	A	A	A	A
Mercury	Percent Detects < 50% *	Yes	B	B	B	A
Nickel	0.003	Yes	B	A	AB	A
Potassium	0.000	Yes	B	B	B	A
Selenium	Percent Detects < 50% *	Yes	B	B	B	A
Silver	Percent Detects < 50% *	No	A	A	A	A
Sodium	Percent Detects < 50% *	No	A	A	A	A
Thallium	Percent Detects < 50% *	No	A	A	A	A
Vanadium	0.000	Yes	A	A	A	B
Zinc	0.848	No	A	A	A	A

Notes:

* When percent detects is less than 50%, the test of whether the soil types are significantly different and the Tukey classifications were evaluated visually (i.e., non-statistically).

- See Section 3.2.1 for detailed explanation of the A, B,

A = Highest concentration

B = Statistically lower concentration than A

AB = Statistically similar concentration to A and B

C = Statistically lower concentration than B

BC = Statistically similar concentration to B and C

Table 3-8
 Tukey's Significant Difference Test Results for Soil Depths
 East Vieques Background Soil Inorganics Investigation
 Former Vieques Naval Training Range, Vieques, Puerto Rico

Inorganic Constituent	Soil Type	Depth p-value	Are Depths Significantly Different?	Surface Soil	Subsurface Soil
Aluminum	KTD KV QA TI	0.5337	No	A	A
Antimony	No Detects				
Arsenic	KTD KV QA	Percent Detects < 50% *	No	A	A
Arsenic	TI	0.3205	No	A	A
Barium	KTD	0.0815	No	A	A
Barium	KV QA TI	0.5793	No	A	A
Beryllium	KTD KV QA	Percent Detects < 50% *	No	A	A
Beryllium	TI	Percent Detects < 50% *	No	A	A
Cadmium	KTD KV QA	0.8209	No	A	A
Cadmium	TI	0.6363	No	A	A
Calcium	KTD KV	0.3299	No	A	A
Calcium	QA	0.8274	No	A	A
Calcium	TI	0.1235	No	A	A
Chromium	KTD KV QA	0.7535	No	A	A
Chromium	TI	0.3415	No	A	A
Cobalt	KTD QA TI	0.6156	No	A	A
Cobalt	KV	0.0814	No	A	A
Copper	KTD	0.4299	No	A	A
Copper	KV TI	0.3035	No	A	A
Copper	QA	0.5111	No	A	A
Cyanide	KTD KV QA	Percent Detects < 50% *	No	A	A
Cyanide	TI	0.8317	No	A	A
Iron	KTD QA TI	0.6052	No	A	A
Iron	KV	0.5597	No	A	A
Lead	KTD KV QA	0.0000	Yes	A	B
Lead	TI	0.0290	Yes	A	B
Magnesium	KTD	0.3786	No	A	A
Magnesium	KV QA TI	0.3556	No	A	A
Manganese	KTD KV QA TI	0.2820	No	A	A
Mercury	KTD KV QA	Percent Detects < 50% *	No	A	A
Mercury	TI	0.7017	No	A	A
Nickel	KTD QA	0.6805	No	A	A
Nickel	KV TI	0.3047	No	A	A
Potassium	KTD KV QA	0.0039	Yes	A	B
Potassium	TI	0.3016	No	A	A
Selenium	KTD KV QA	Percent Detects < 50% *	No	A	A
Selenium	TI	Percent Detects < 50% *	No	A	A
Silver	KTD KV QA TI	Percent Detects < 50% *	No	A	A
Sodium	KTD KV QA TI	Percent Detects < 50% *	No	A	A
Thallium	KTD KV QA TI	Percent Detects < 50% *	No	A	A
Vanadium	KTD KV QA	0.9128	No	A	A
Vanadium	TI	0.1715	No	A	A
Zinc	KTD KV QA TI	0.0947	No	A	A

Notes:

* When percent detects is less than 50%, the test of whether the depths are significantly different and the Tukey classifications were evaluated visually (non-statistically).

Table 3-9
 Mathematical Outliers Excluded from Background Summary Statistics
 East Vieques Background Soil Inorganics Investigation
 Former Vieques Naval Training Range, Vieques, Puerto Rico

Inorganic Constituent	Sample ID	Soil Type	Depth	Transformation ²	Concentration (mg/kg)	Qualifier
Arsenic	EBGQA-SS06-06-06B	KTD KV QA	SS SB	Logarithm	5	
Arsenic	EBGQA-SB06-24-06B	KTD KV QA	SS SB	Logarithm	4.5	
Arsenic	EBGKTD-SS10-06-06B	KTD KV QA	SS SB	Logarithm	2.1	
Arsenic	EBGKTD-SB10P-13-06B	KTD KV QA	SS SB	Logarithm	2	
Arsenic	EBGKV-SS04-06-06B	KTD KV QA	SS SB	Logarithm	1.6	J
Barium	EBGKTD-SB07-46-06B	KTD	SS SB	Untransformed	292	
Beryllium ¹	EBGTI-SS03-06-06B	TI	SS SB	Logarithm	0.95	
Beryllium ¹	EBGTI-SS07-06-06B	TI	SS SB	Logarithm	0.94	
Beryllium ¹	EBGTI-SB03-61-06B	TI	SS SB	Logarithm	0.77	
Beryllium ¹	EBGTI-SS02-06-06B	TI	SS SB	Logarithm	0.73	
Beryllium ¹	EBGTI-SS01-06-06B	TI	SS SB	Logarithm	0.72	
Calcium	EBGKTD-SB06-46-06B	KTD KV	SS SB	Logarithm	43600	
Calcium	EBGKV-SB02-35-06B	KTD KV	SS SB	Logarithm	20500	J
Calcium	EBGKV-SB07-46-06B	KTD KV	SS SB	Cubic Root	18000	J
Calcium	EBGQA-SB06-24-06B	QA	SS SB	Logarithm	361000	
Calcium	EBGQA-SS06-06-06B	QA	SS SB	Logarithm	89900	
Calcium	EBGQA-SB02-46-06B	QA	SS SB	Logarithm	40000	
Calcium	EBGQA-SS09-06-06B	QA	SS SB	Logarithm	40000	
Calcium	EBGQA-SS02-06-06B	QA	SS SB	Cubic Root	30800	
Magnesium	EBGKTD-SB06-46-06B	KTD	SS SB	Untransformed	6800	J
Magnesium	EBGKTD-SS02-06-06B	KTD	SS SB	Cubic Root	5440	J
Magnesium	EBGKTD-SB10-13-06B	KTD	SS SB	Cubic Root	4830	J
Magnesium	EBGKTD-SS10-06-06B	KTD	SS SB	Cubic Root	4340	J
Magnesium	EBGKTD-SB01P-46-06B	KTD	SS SB	Square Root	4310	J
Mercury	EBGQA-SS06-06-06B	KTD KV QA	SS SB	Logarithm	0.11	J
Mercury	EBGKV-SS02-06-06B	KTD KV QA	SS SB	Logarithm	0.089	J
Mercury	EBGKV-SS07-06-06B	KTD KV QA	SS SB	Logarithm	0.077	J
Potassium	EBGKV-SB07-46-06B	KTD KV QA	SB	Square Root	3130	
Potassium	EBGQA-SB08-13-06B	KTD KV QA	SB	Untransformed	2760	
Sodium	EBGQA-SB01-24-06B	KTD KV QA TI	SB	Logarithm	4990	
Sodium	EBGQA-SB03-24-06B	KTD KV QA TI	SB	Logarithm	3600	J
Sodium	EBGQA-SB07-46-06B	KTD KV QA TI	SB	Logarithm	3120	J
Sodium	EBGKV-SB10-46-06B	KTD KV QA TI	SB	Logarithm	2700	
Sodium	EBGKTD-SB06-46-06B	KTD KV QA TI	SB	Logarithm	2320	J
Thallium	EBGTI-SS03-06-06B	KTD KV QA TI	SS SB	Untransformed	0.41	
Zinc	EBGKV-SS09-06-06B	KTD KV QA TI	SS SB	Logarithm	122	J
Zinc	EBGKV-SB04-35-06B	KTD KV QA TI	SS SB	Cubic Root	71	J
Zinc	EBGKV-SS04-06-06B	KTD KV QA TI	SS SB	Square Root	62	J

Notes:

¹ Although these beryllium results were initially identified as outliers, they were subsequently included in the background dataset after review of the data demonstrated these five results were the only detections with a range of 0.72-0.95 mg/kg versus the non-detect reporting limit range of 0.54-0.77 mg/kg.

² Transformation used to provide closest adherence to normality by the remaining concentrations (aside from the elevated results being evaluated)

Table 3-10
 Summary Statistics for Background Soil Inorganics
 East Vieques Background Soil Inorganics Investigation
 Former Vieques Naval Training Range, Vieques, Puerto Rico

Inorganic Constituent	Soil Type	Depth	Mean	Median	Standard Deviation	Minimum RL	Maximum RL	Minimum Detect	Maximum Detect	Number of Detects	Number of Samples	Percent Detects	Normality p-value	Lognormality p-value	Applied Distribution	K	95% Confidence UTL	Percentile Estimated by UTL (with 95% Confidence)
Aluminum	KTD KV QA TI	SS SB	13100	10600	7920	NN	NN	2340	41500	79	79	100	0.0000	0.9253	Lognormal	1.561	35000	95
Antimony	KTD KV QA TI	SS SB	3.46	3.35	0.397	5.8	9.7	NA *	NA *	0	79	0	0.0000	0.0001	Nonparametric		NA *	96
Arsenic	KTD KV QA	SS SB	0.629	0.55	0.231	0.96	1.3	0.47	1.6	21	53	40	0.0000	0.0000	Nonparametric		1.6	95
Arsenic	TI	SS SB	4.1	3.8	2.09	NN	NN	1.3	9.6	19	19	100	0.1153	0.8206	Normal	1.949	9.2	95
Barium	KTD	SS SB	85.1	83.8	25.6	NN	NN	47.7	121	19	19	100	0.1437	0.0939	Normal	1.949	147	95
Barium	KV QA TI	SS SB	73.9	61.6	55.9	20.5	20.5	21	344	58	59	98	0.0000	0.5626	Lognormal	1.612	212	95
Beryllium	KTD KV QA	SS SB	0.271	0.27	0.0233	0.48	0.66	0.19	0.27	6	59	10	0.0135	0.0007	Nonparametric		0.27	95
Beryllium	TI	SS SB	0.449	0.33	0.237	0.54	0.77	0.72	0.95	5	19	26	0.0001	0.0003	Nonparametric		0.95	85
Cadmium	KTD KV QA	SS SB	0.77	0.635	0.554	0.51	0.53	0.17	3.1	58	60	97	0.0000	0.8712	Lognormal	1.609	2.2	95
Cadmium	TI	SS SB	1.4	1.4	0.395	NN	NN	0.85	2.1	19	19	100	0.1281	0.3596	Normal	1.949	2.4	95
Calcium	KTD KV	SS SB	3330	3080	1600	NN	NN	931	7740	37	37	100	0.0455	0.3625	Lognormal	1.717	8840	95
Calcium	QA	SS SB	5000	4230	3020	NN	NN	881	11900	15	15	100	0.0022	0.0328	Nonparametric		11900	82
Calcium	TI	SS SB	162000	193000	105000	NN	NN	17800	362000	19	19	100	0.0642	0.0261	Normal	1.949	417000	95
Chromium	KTD KV QA	SS SB	13.3	5.55	14.4	NN	NN	2.3	72	60	60	100	0.0000	0.0006	Nonparametric		72	95
Chromium	TI	SS SB	27.3	25.9	17.7	NN	NN	3.4	58.8	19	19	100	0.1617	0.1044	Normal	1.949	70	95
Cobalt	KTD QA TI	SS SB	7.08	6.2	3.52	5.3	5.3	2.4	19.4	58	59	98	0.0000	0.7580	Lognormal	1.612	16	95
Cobalt	KV	SS SB	10.9	11.3	6.05	NN	NN	2.9	24	20	20	100	0.3386	0.2994	Normal	1.926	26	95
Copper	KTD	SS SB	38.3	36.7	11.2	NN	NN	21.8	61.4	19	19	100	0.4324	0.4276	Normal	1.949	66	95
Copper	KV TI	SS SB	24.1	16.2	22.1	NN	NN	4.4	102	33	33	100	0.0000	0.5875	Lognormal	1.749	94	95
Copper	QA	SS SB	25.2	25.7	11.5	NN	NN	3.3	43.7	20	20	100	0.5290	0.0015	Normal	1.926	53	95
Cyanide	KTD KV QA	SB	1.36	1.35	0.139	2.6	3.3	0.89	0.89	1	27	4	0.000	0.000	Nonparametric		0.89	89
Cyanide	KTD KV QA	SS	1.24	1.4	0.467	2.7	3.3	0.19	0.33	5	29	17	0.000	0.000	Nonparametric		0.33	90
Cyanide	TI	SB	0.976	0.855	0.577	2.9	3.5	0.25	1	5	8	63	0.360	0.527	Normal	2.582	2.8	69
Cyanide	TI	SS	1.03	0.9	0.775	2.7	4.1	0.24	0.45	5	10	50	0.022	0.022	Nonparametric		0.45	74
Iron	KTD QA TI	SS SB	15400	13900	8250	NN	NN	1500	38100	59	59	100	0.0121	0.0170	Nonparametric		38100	95
Iron	KV	SS SB	22200	22700	8750	NN	NN	5140	39500	20	20	100	0.9257	0.0581	Normal	1.926	43200	95
Lead	KTD KV QA	SB	1.2	1.05	0.646	1	1.1	0.57	3	24	30	80	0.0046	0.1467	Lognormal	1.777	3.3	95
Lead	KTD KV QA	SS	2.29	2.05	0.964	NN	NN	0.98	4.5	30	30	100	0.0401	0.3350	Lognormal	1.777	5.4	95
Lead	TI	SB	3.28	1.8	2.47	NN	NN	1.1	7.7	9	9	100	0.0475	0.0614	Nonparametric		7.7	72
Lead	TI	SS	6.18	6.25	3.38	NN	NN	1.3	10.6	10	10	100	0.4791	0.1473	Normal	2.355	16	95
Magnesium	KTD	SS SB	2020	2120	661	NN	NN	778	2930	15	15	100	0.5487	0.0515	Normal	2.068	3710	95
Magnesium	KV QA TI	SS SB	6880	4680	6250	NN	NN	1180	32300	59	59	100	0.0000	0.1017	Lognormal	1.612	22200	95
Manganese	KTD KV QA TI	SS SB	533	509	314	NN	NN	32.2	1630	62	62	100	0.0013	0.0016	Nonparametric		1630	95
Mercury	KTD KV QA	SS SB	0.053	0.055	0.00491	0.087	0.13	0.05	0.057	7	55	13	0.0061	0.0080	Nonparametric		0.057	95
Mercury	TI	SS SB	0.133	0.11	0.0686	NN	NN	0.056	0.31	18	18	100	0.0119	0.7690	Nonparametric		0.31	85
Nickel	KTD QA	SS SB	5.33	2.75	6.22	NN	NN	0.87	31.2	40	40	100	0.0000	0.0504	Lognormal	1.697	22	95
Nickel	KV TI	SS SB	8.84	6.9	7.78	NN	NN	1	40	39	39	100	0.0000	0.6222	Lognormal	1.704	41	95
Potassium	KTD KV QA	SB	892	874	495	490	604	424	2010	22	28	79	0.1635	0.0181	Normal	1.799	2000	95
Potassium	KTD KV QA	SS	1650	1420	1070	570	570	622	5520	29	30	97	0.0003	0.8577	Lognormal	1.777	5270	95
Potassium	TI	SS SB	4000	4140	2790	535	535	951	9050	18	19	95	0.0711	0.0600	Normal	1.949	10800	95
Selenium	KTD KV QA	SS SB	1.87	1.9	0.374	3.4	5.5	0.32	0.51	3	60	5	0.0000	0.0000	Nonparametric		0.51	95
Selenium	TI	SS SB	1.51	1.88	0.771	3.7	5	0.31	1.3	8	18	44	0.0193	0.0032	Nonparametric		1.3	85
Silver	KTD KV QA TI	SS SB	0.512	0.55	0.176	0.96	1.6	0.078	0.22	12	79	15	0.0000	0.0000	Nonparametric		0.22	96
Sodium	KTD KV QA TI	SB	484	291	440	479	701	550	2250	9	34	26	0.000	0.000	Nonparametric		2250	92
Sodium	KTD KV QA TI	SS	363	286	247	521	812	898	1590	3	40	8	0.000	0.000	Nonparametric		1590	93
Thallium	KTD KV QA TI	SS SB	0.122	0.16	0.0715	0.31	0.49	0.013	0.13	33	77	43	0.0000	0.0000	Nonparametric		0.13	96
Vanadium	KTD KV QA	SS SB	57.7	48.6	28.8	NN	NN	13.4	142	60	60	100	0.0023	0.4639	Lognormal	1.609	144	95
Vanadium	TI	SS SB	24.8	27.2	12.7	NN	NN	4.9	50.3	19	19	100	0.5609	0.0815	Normal	1.949	56	95
Zinc	KTD KV QA TI	SS SB	17.9	17.2	7.17	NN	NN	4	35	76	76	100	0.3923	0.0073	Normal	1.568	32	95

Notes:
 All concentrations in mg/kg
 NA * = Not applicable; no detections
 SS = surface soil
 SB = subsurface soil
 RL = reporting limit
 NN = not needed; all results were detects

Table 3-11
 East Vieques Background Surface Soil Inorganics UTLs
 East Vieques Background Soil Inorganics Investigation
 Former Vieques Naval Training Range, Vieques, Puerto Rico

Inorganic Constituent	Background Concentration UTL			
	KTd	Kv	Qa	TI
Aluminum	35,000	35,000	35,000	35,000
Antimony	NA	NA	NA	NA
Arsenic	1.6	1.6	1.6	9.2
Barium	147	212	212	212
Beryllium	0.27	0.27	0.27	0.95
Cadmium	2.2	2.2	2.2	2.4
Calcium	8,840	8,840	11,900	417,000
Chromium	72	72	72	70
Cobalt	16	26	16	16
Copper	66	94	53	94
Cyanide	0.33	0.33	0.33	0.45
Iron	38,100	43,200	38,100	38,100
Lead	5.4	5.4	5.4	16
Magnesium	3,710	22,200	22,200	22,200
Manganese	1,630	1,630	1,630	1,630
Mercury	0.057	0.057	0.057	0.31
Nickel	22	41	22	41
Potassium	5,270	5,270	5,270	10,800
Selenium	0.51	0.51	0.51	1.3
Silver	0.22	0.22	0.22	0.22
Sodium	1,590	1,590	1,590	1,590
Thallium	0.13	0.13	0.13	0.13
Vanadium	144	144	144	56
Zinc	32	32	32	32

Notes:

All concentrations in mg/kg

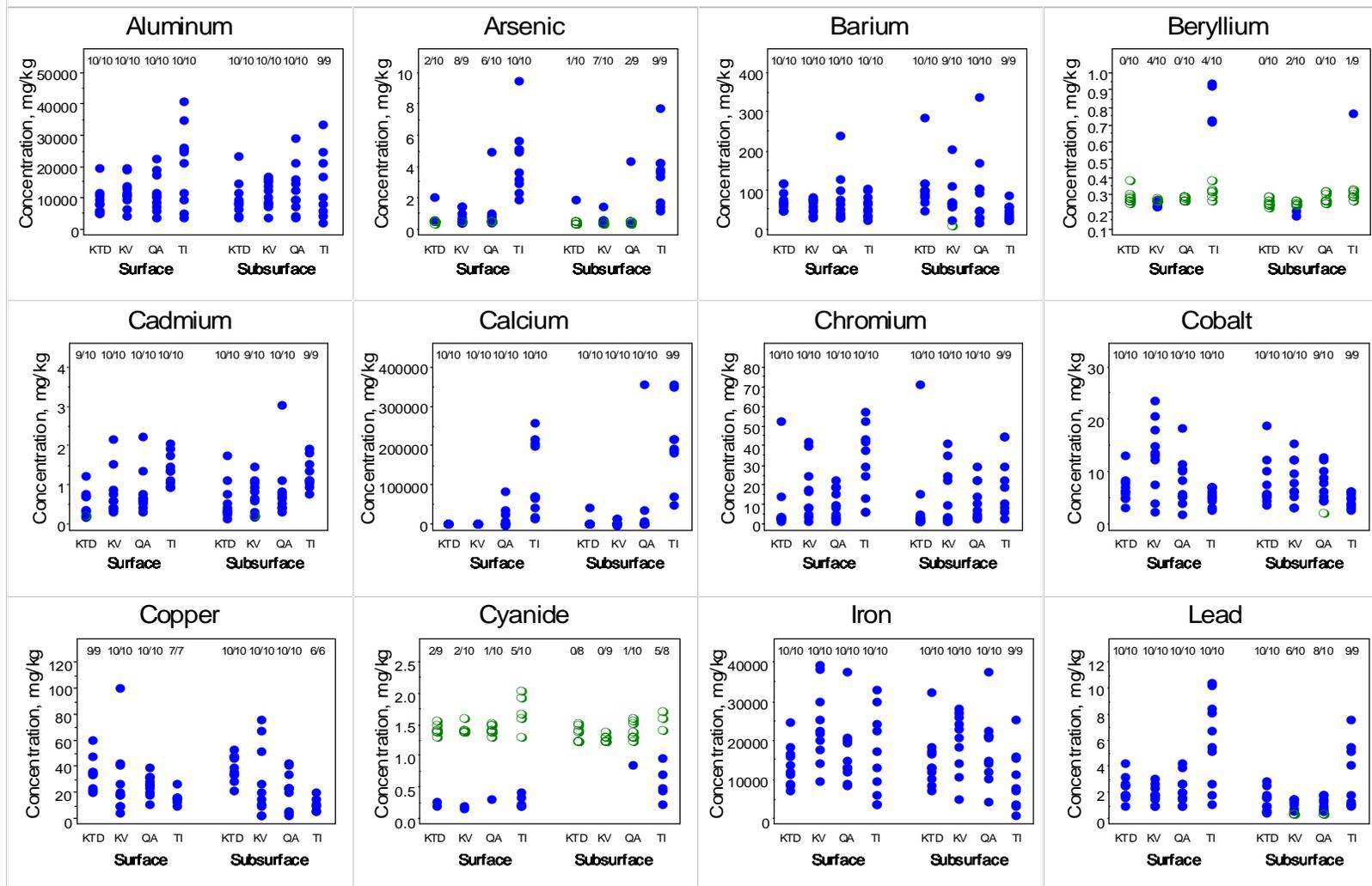
NA = not applicable

Table 3-12
 East Vieques Background Subsurface Soil Inorganics UTLs
 East Vieques Background Soil Inorganics Investigation
 Former Vieques Naval Training Range, Vieques, Puerto Rico

Inorganic Constituent	Background Concentration UTL			
	KTd	Kv	Qa	Tl
Aluminum	35,000	35,000	35,000	35,000
Antimony	NA	NA	NA	NA
Arsenic	1.6	1.6	1.6	9.2
Barium	147	212	212	212
Beryllium	0.27	0.27	0.27	0.95
Cadmium	2.2	2.2	2.2	2.4
Calcium	8,840	8,840	11,900	417,000
Chromium	72	72	72	70
Cobalt	16	26	16	16
Copper	66	94	53	94
Cyanide	0.89	0.89	0.89	2.8
Iron	38,100	43,200	38,100	38,100
Lead	3.3	3.3	3.3	7.7
Magnesium	3,710	22,200	22,200	22,200
Manganese	1,630	1,630	1,630	1,630
Mercury	0.057	0.057	0.057	0.31
Nickel	22	41	22	41
Potassium	2,000	2,000	2,000	10,800
Selenium	0.51	0.51	0.51	1.3
Silver	0.22	0.22	0.22	0.22
Sodium	2,250	2,250	2,250	2,250
Thallium	0.13	0.13	0.13	0.13
Vanadium	144	144	144	56
Zinc	32	32	32	32

Notes:
 All concentrations in mg/kg
 NA = not applicable

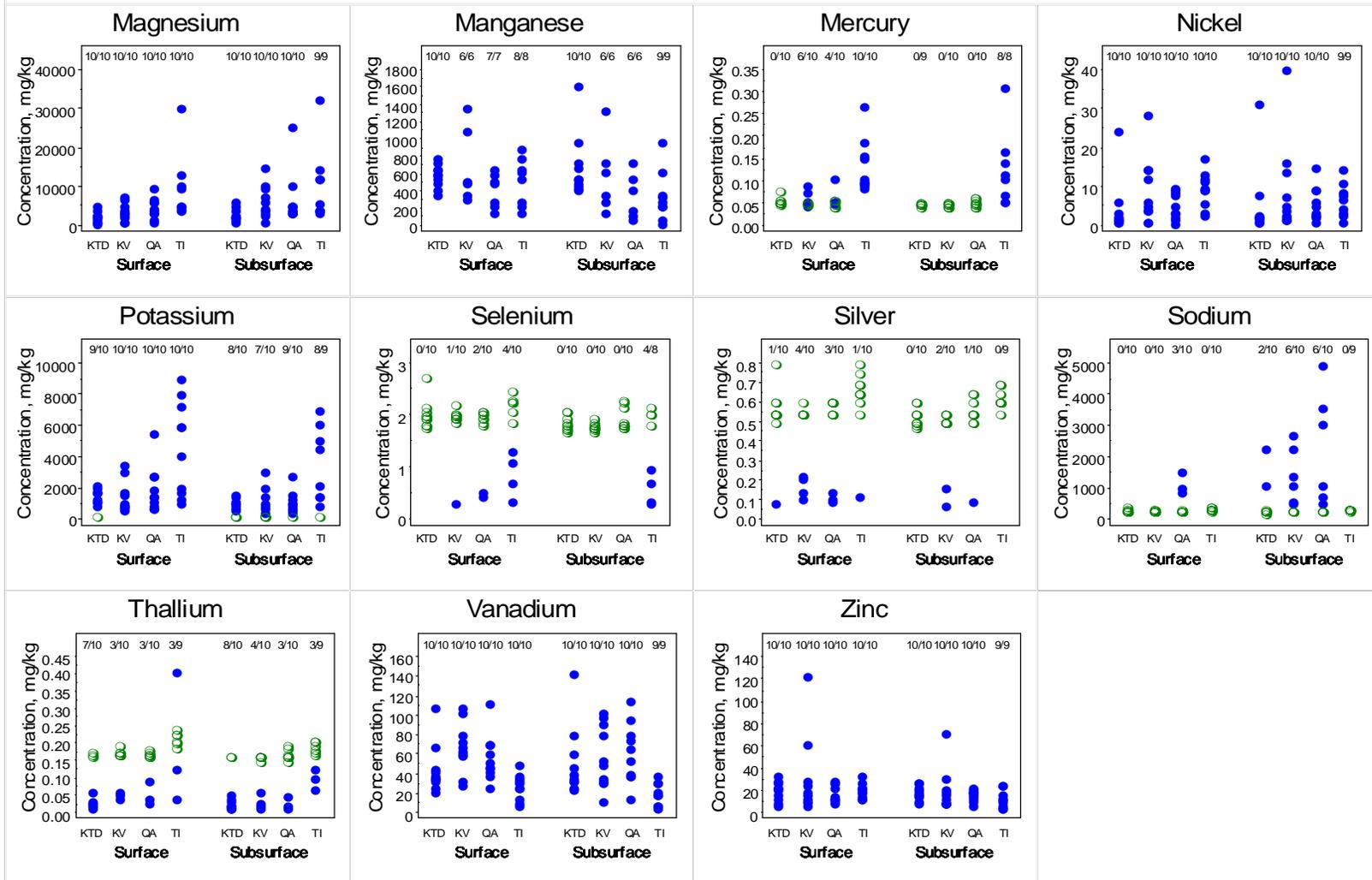
FIGURE 3-1
 Scatter Plots for Inorganics Concentrations
East Vieques Background Soil Inorganics Investigation
Former Vieques Naval Training Range, Vieques, Puerto Rico



Green Open Circles Represent Non-Detect Values; Blue Closed Circles Represent Detects

The ratios shown represent the number of detects divided by the total number of samples for each constituent.

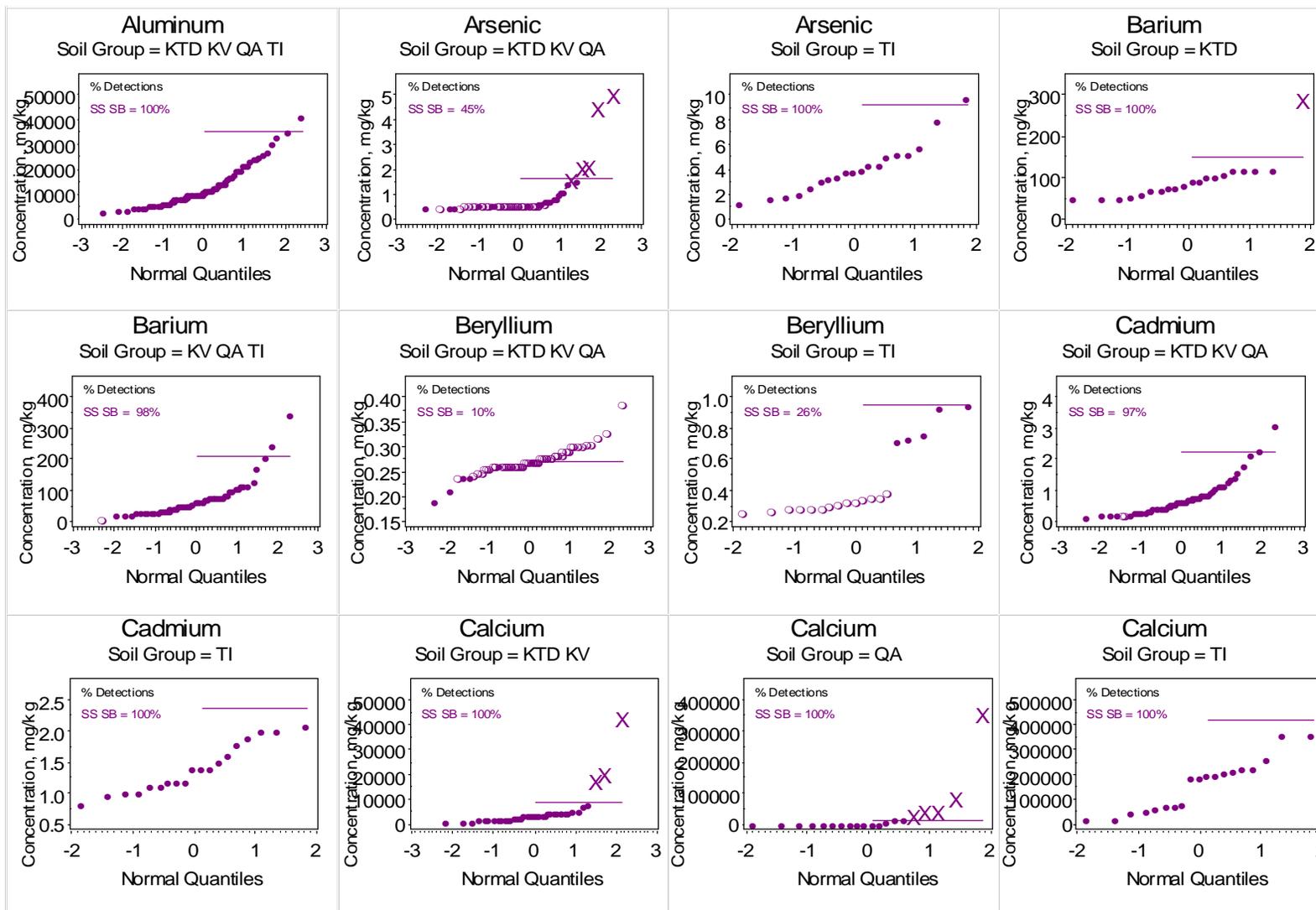
FIGURE 3-1
 Scatter Plots for Inorganics Concentrations
 East Vieques Background Soil Inorganics Investigation
 Former Vieques Naval Training Range, Vieques, Puerto Rico



Green Open Circles Represent Non-Detect Values; Blue Closed Circles Represent Detects

The ratios shown represent the number of detects divided by the total number of samples for each constituent.

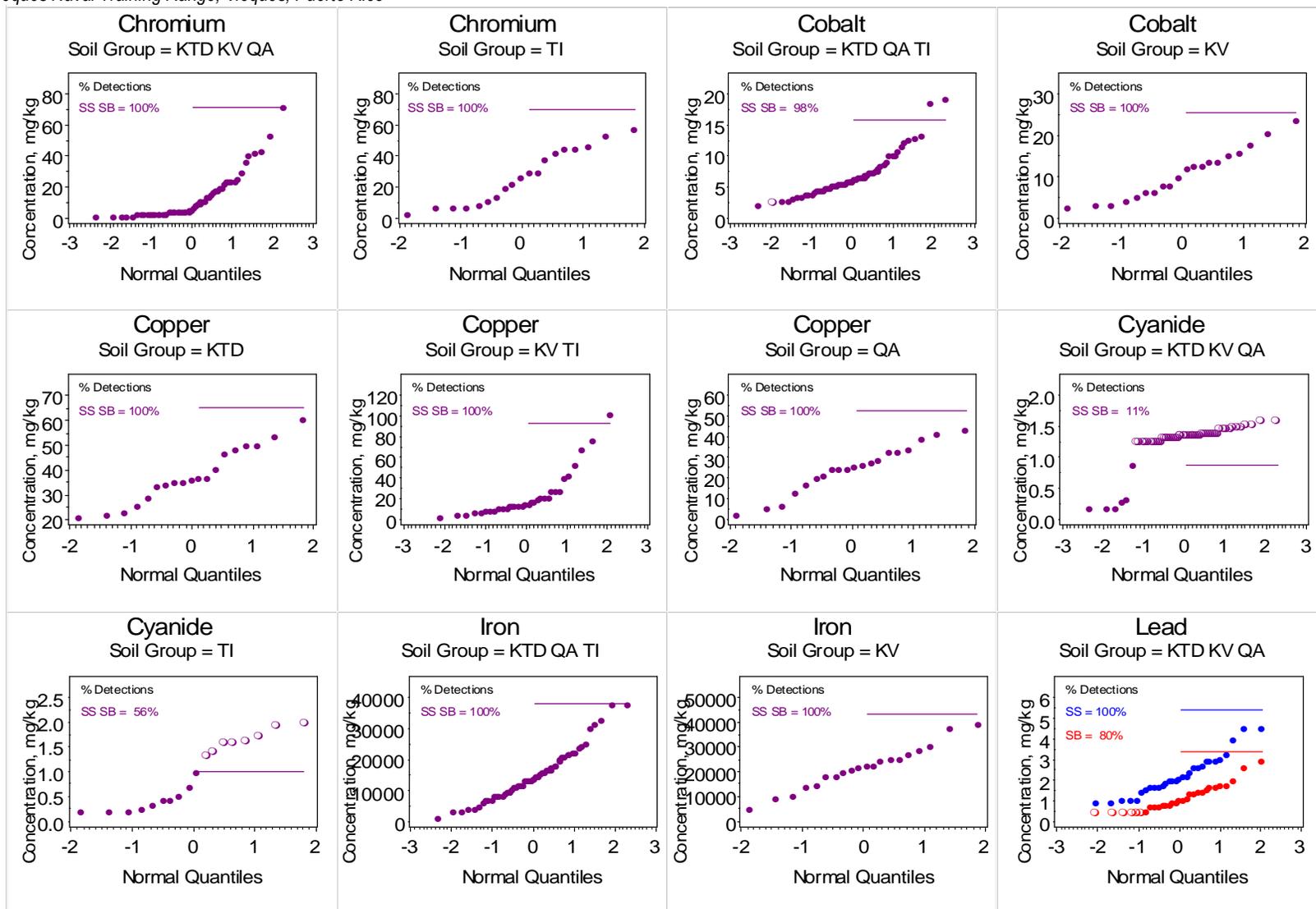
FIGURE 3-2
 Probability Plots for Inorganics Concentrations
 East Vieques Background Soil Inorganics Investigation
 Former Vieques Naval Training Range, Vieques, Puerto Rico



Open Symbol Represents Nondetected Value; X Represents Elevated Value Excluded from Background Data Set
 Horizontal Line at Recommended Background Threshold Value

The UTLs are shown as horizontal lines in the probability plots which enable the reader to visually note the position of the background threshold values relative to the available data.

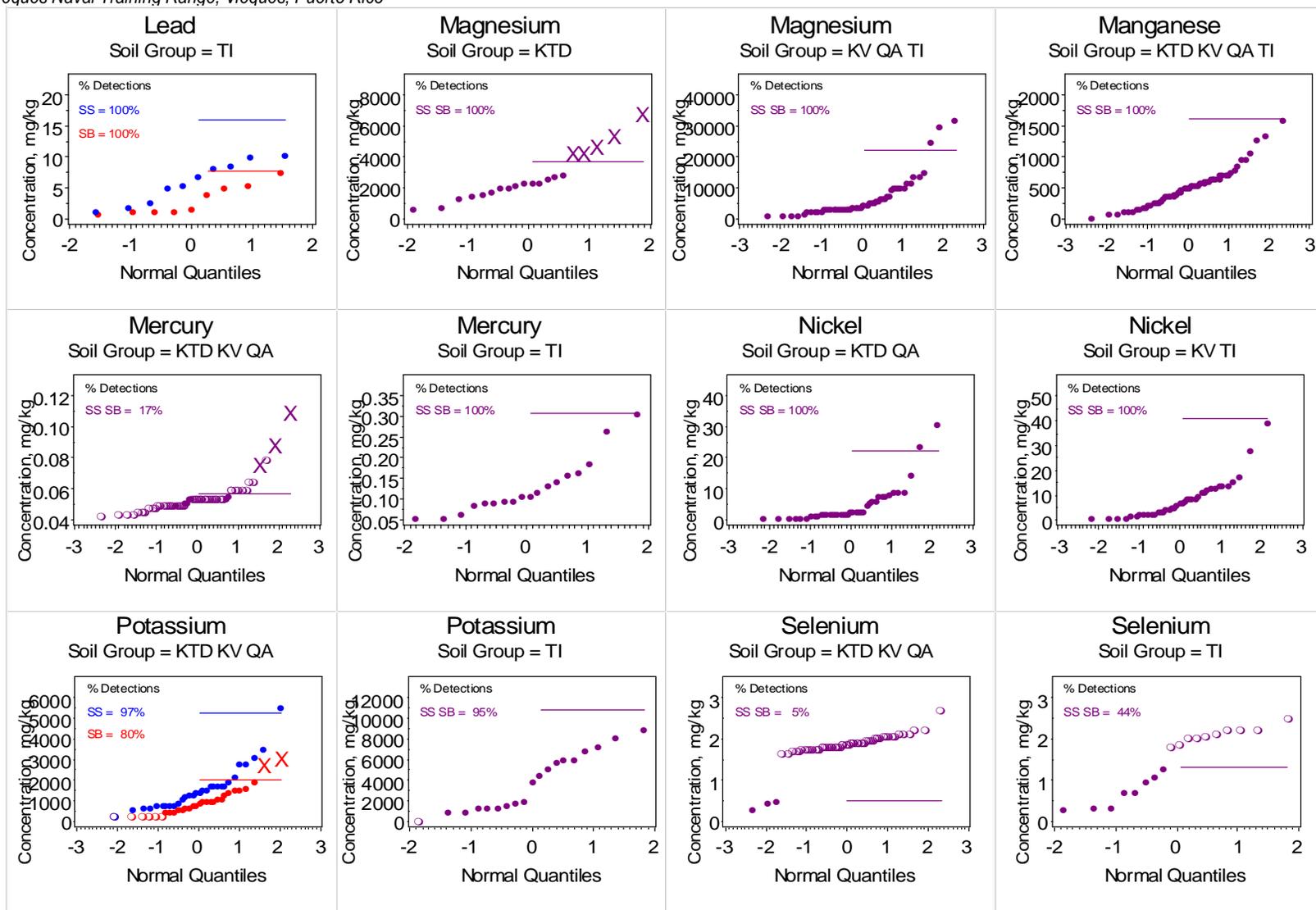
FIGURE 3-2
 Probability Plots for Inorganics Concentrations
 East Vieques Background Soil Inorganics Investigation
 Former Vieques Naval Training Range, Vieques, Puerto Rico



Open Symbol Represents Nondetected Value; X Represents Elevated Value Excluded from Background Data Set
 Horizontal Line at Recommended Background Threshold Value

The UTLs are shown as horizontal lines in the probability plots which enable the reader to visually note the position of the background threshold values relative to the available data.

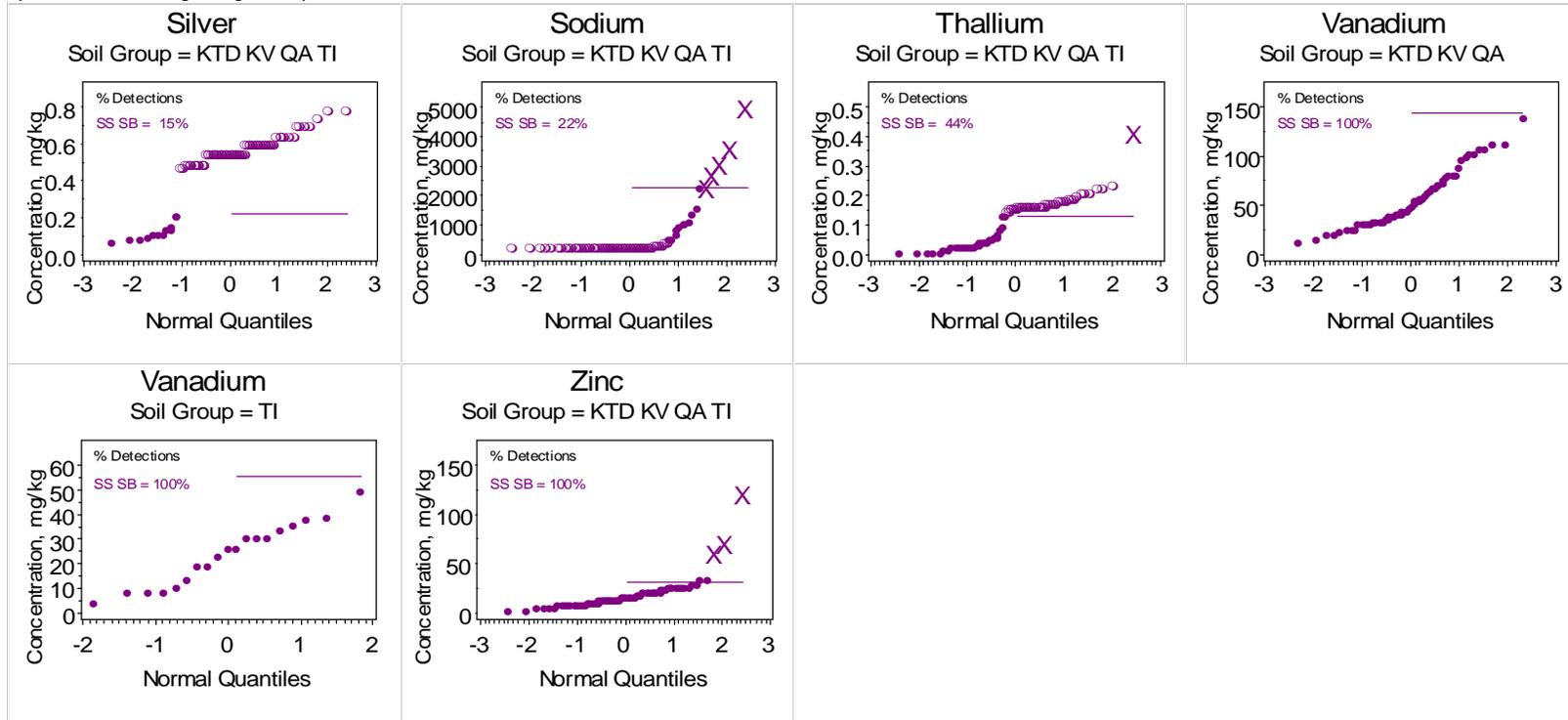
FIGURE 3-2
 Probability Plots for Inorganics Concentrations
 East Vieques Background Soil Inorganics Investigation
 Former Vieques Naval Training Range, Vieques, Puerto Rico



Open Symbol Represents Nondetected Value; X Represents Elevated Value Excluded from Background Data Set
 Horizontal Line at Recommended Background Threshold Value

The UTLs are shown as horizontal lines in the probability plots which enable the reader to visually note the position of the background threshold values relative to the available data.

FIGURE 3-2
 Probability Plots for Inorganics Concentrations
East Vieques Background Soil Inorganics Investigation
Former Vieques Naval Training Range, Vieques, Puerto Rico



Open Symbol Represents Nondetected Value; X Represents Elevated Value Excluded from Background Data Set
 Horizontal Line at Recommended Background Threshold Value

The UTLs are shown as horizontal lines in the probability plots which enable the reader to visually note the position of the background threshold values relative to the available data.

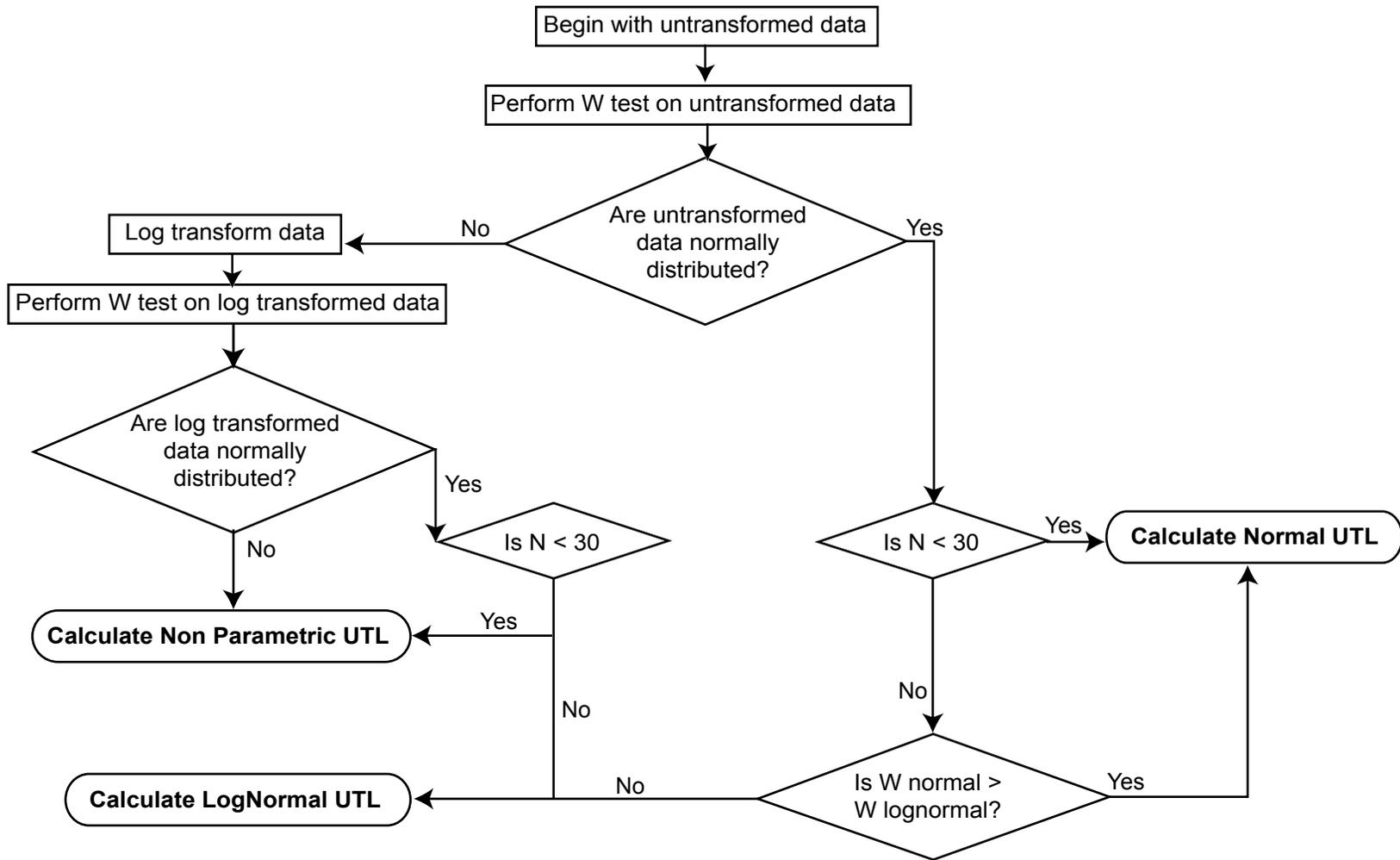


FIGURE 3-3
 Decision Flowchart for UTL Calculations
East Vieques Background Soil Inorganics Investigation
Former Vieques Naval Training Range, Vieques, Puerto Rico

SECTION 4

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APPENDIX A

Soil Boring Logs

Boring Log List of Acronyms

°F	Fahrenheit
AH	Above Hole
bls	Below land surface
BZ	Breathing Zone
Color	Munsell Color System – This system was used to describe soil colors based off of three color dimensions: hue, value/lightness, and Lightness
MS/MSD	Matrix spike/matrix spike duplicate
NA	Not Applicable
OVM	Organic Vapor Monitor
PPM	Parts Per Million
SS	Stainless Steel
USCS	Unified Soil Classification System – This system was used to describe soils on site. A description of the USCS is described in Attachment 1, A-9 Standard Practice for Description and Identification of Soils in the CH2M HILL, Inc. 2006. <i>Draft Master Quality Assurance Project Plan Environmental Restoration Program</i> , Vieques Puerto Rico. May. All grain size terminology can be found in this section.



PROJECT NUMBER
183719.FI.02

BORING NUMBERS
EBGKTD-SS01-06-06B
EBGKTD-SB01-46-06B

SHEET 1 OF 1

SOIL BORING LOG

PROJECT: East Vieques Background Soil Inorganics Investigation LOCATION: KTd-1 DATE: 07/03/2006

WEATHER: Partly cloudy 95°F DRILLING CONTRACTOR: CH2M HILL

DRILLING METHOD AND EQUIPMENT USED: Stainless Steel (SS) Hand auger, SS Bowl, and SS Spoon

WATER LEVELS: NA START: 1430 END: 1515 LOGGER: Kenji Butler

DEPTH BELOW SURFACE (FT)				SAMPLING EQUIPMENT USED	CORE DESCRIPTION	COMMENTS
INTERVAL (FT)	RECOVERY (IN)	#/TYPE				
6"	All 6"			Hand Auger	0-6" <u>ORGANIC SOIL (OL)</u> , dark brown 7.5YR 3/3, moist, low plasticity, cohesive, some organic matter (roots), few snail shells	OVM: BZ=0 ppm AH=0 ppm 0-6" sample taken at 1500 EBGKTD-SS01-06-06B
1					6"-6" <u>WELL GRADED SAND WITH CLAY (SW-SC)</u> , reddish yellow, (7.5YR 7/6), dry, noncohesive, non-plastic, sand fine to medium in size, and angular.	OVM: BZ=0 ppm AH=0 ppm 4-6' sample taken at 1505 EBGKTD-SB01-46-06B
2	2'	All 18"				
3						
4						
5						
6	6'	48"			End of boring @ 6 ft bls	

Sampler Signature: Kenji Butler

Date: 07/03/2006



PROJECT NUMBER
183719.FI.02

BORING NUMBERS
EBGKTD-SS02-06-06B
EBGKTD-SB02-46-06B

SHEET 1 OF 1

SOIL BORING LOG

PROJECT: East Vieques Background Soil Inorganics Investigation LOCATION: KTd-2 DATE: 07/02/2006

WEATHER: Partly Cloudy 95°F DRILLING CONTRACTOR: CH2M HILL

DRILLING METHOD AND EQUIPMENT USED: SS Hand auger, SS Bowl, and SS Spoon

WATER LEVELS: NA START: 1430 END: 1510 LOGGER: Kenji Butler

DEPTH BELOW SURFACE (FT)				SAMPLING EQUIPMENT USED	CORE DESCRIPTION	COMMENTS
INTERVAL (FT)	RECOVERY (IN)	#/TYPE		HAND AUGER OR SLIDE HAMMER	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	SAMPLE TIME, SAMPLE DEPTH, FIELD DUPLICATE OR MS/MSD TAKEN, ADDITIONAL SAMPLE INFO, ODORS, DISCOLORATION, AND OVM READINGS
-	6"	All 6"		Hand Auger	0-3' <u>SANDY LEAN CLAY</u> (CL), Brown (7.5YR 4/3), moist, low plasticity, cohesive, small amount of gravel.	OVM: BZ=0 ppm AH=0 ppm 0-6" sample taken at 1440 EBGKTD-SS02-06-06B
1						
2	2'	All 18"				
3	3'	All 12"			3'-6' <u>SANDY LEAN CLAY</u> (CL), Brown (7.5YR 4/3), dry, low plasticity, cohesive, with an increase of gravel.	OVM: BZ=0 ppm AH=0 ppm 4-6' sample taken at 1500 EBGKTD-SB02-46-06B
4						
5						
6	6'	All 36"			End of boring @ 6 ft bls	

Sampler Signature: Kenji Butler

Date: 07/02/2006



PROJECT NUMBER
183719.FI.02

BORING NUMBERS
EBGKTD-SS03-06-06B
EBGKTD-SB03-46-06B

SHEET 1 OF 1

SOIL BORING LOG

PROJECT: East Vieques Background Soil Inorganics Investigation LOCATION: KTd-3 DATE: 06/24/2006

WEATHER: Partly cloudy, High of 85 °F slight breeze DRILLING CONTRACTOR: CH2M HILL

DRILLING METHOD AND EQUIPMENT USED: SS Hand auger, SS Bowl, SS Spoon, Slide hammer w/ sampling sleeve

WATER LEVELS: NA START: 0700 END: 0745 LOGGER: Kenji Butler

DEPTH BELOW SURFACE (FT)				SAMPLING EQUIPMENT USED	CORE DESCRIPTION	COMMENTS
INTERVAL (FT)	RECOVERY (IN)	#/TYPE				
6"	All 6"			Hand Auger	0-5' <u>SANDY LEAN CLAY</u> (CL), strong brown (7.5YR, 4/6), moist, low plasticity, cohesive, some root fragments, sand is fine to medium.	OVM: BZ=0 ppm AH=0 ppm 0-6" sample taken at 0710 EBGKTD-SS03-06-06B
1						
2	All 18"					
3	30"of48"			Slide Hammer		
4						
5						
6	6'				5-6 ft <u>SANDY LEAN CLAY</u> (CL), strong brown (7.5YR, 4/6), less moist, stiff, low plasticity, cohesive, sand is fine to medium. End of boring @ 6 ft bls	OVM: BZ=0 ppm AH=0 ppm sample taken at 0730 EBGKTD-SB03-46-06B SB Field Dup taken EBGKTD-SB03P-46-06B

Sampler Signature: Kenji Butler

Date: 06/24/2006



PROJECT NUMBER
183719.FI.02

BORING NUMBERS
EBGKTD-SS04-06-06B
EBGKTD-SB04-46-06B

SHEET 1 OF 1

SOIL BORING LOG

PROJECT: East Vieques Background Soil Inorganics Investigation LOCATION: KTd-4 DATE: 06/26/2006

WEATHER: Sunny, Slight Breeze, 90°F DRILLING CONTRACTOR: CH2M HILL

DRILLING METHOD AND EQUIPMENT USED: SS Hand auger, SS Bowl, SS Spoon, Slide hammer w/ sampling sleeve

WATER LEVELS: NA START: 0825 END: 1000 LOGGER: Wade Trevathan

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)		RECOVERY (IN)	#/TYPE	SAMPLING EQUIPMENT USED	CORE DESCRIPTION	COMMENTS
	INTERVAL (FT)						
	RECOVERY (IN)						
	6"	All 6"			Hand Auger	0-6" <u>ORGANIC SOIL WITH SAND (OL)</u> , dusky red (2.5YR 3/2), moist, cohesive, low plasticity, some root material	OVM: BZ=0 ppm AH=0 ppm 0-6" sample taken at 0910 EBGKTD-SS10-06-06B
1						6"-12" <u>ORGANIC SOIL WITH SAND (OL)</u> , dark reddish brown (5YR 3/3), dry, cohesive, low plasticity, some gravel	
2						1'-2' <u>SANDY SILT WITH GRAVEL (ML)</u> , reddish brown (5YR 4/4), dry, cohesive, non-plastic	
			36" of 48"		Slide Hammer	2'-6" <u>SANDY SILT WITH GRAVEL (ML)</u> , strong brown (7.5YR 5/6), dry, noncohesive, non-plastic	OVM: BZ=0 ppm AH=0 ppm sample taken at 0945 EBGKTD-SB10-46-06B
3							
4							
5							
6						End of boring @ 6 ft bls	

Sampler Signature: Wade Trevathan Reviewed by Kenji Butler

Date: 06/26/2006



PROJECT NUMBER
183719.FI.02

BORING NUMBERS
EBGKTD-SS05-06-06B
EBGKTD-SB05-46-06B

SHEET 1 OF 1

SOIL BORING LOG

PROJECT: East Vieques Background Soil Inorganics Investigation LOCATION: KTd-5 DATE: 06/21/2006

WEATHER: Cloudy w/ intermittent rain DRILLING CONTRACTOR: CH2M HILL

DRILLING METHOD AND EQUIPMENT USED: Stainless Steel (SS) Hand auger, SS Bowl, SS Spoon, Slide hammer w/ acetate sleeve

WATER LEVELS: NA START: 0700 END: 0925 LOGGER: Kenji Butler

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)		RECOVERY (IN)	#/TYPE	SAMPLING EQUIPMENT USED	CORE DESCRIPTION	COMMENTS
	INTERVAL (FT)						
	RECOVERY (IN)						
					HAND AUGER OR SLIDE HAMMER	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	SAMPLE TIME, SAMPLE DEPTH, FIELD DUPLICATE OR MS/MSD TAKEN, ADDITIONAL SAMPLE INFO, ODORS, DISCOLORATION, AND OVM READINGS OVM (ppm): Breathing Zone (BZ) Above Hole (AH)
0	6"	All 6"			Hand Auger	0-6" <u>LEAN CLAY WITH SAND</u> (CL), Brown 7.5YR 4/4, moist, soft, medium plasticity, cohesive, some organic matter (roots)	OVM: BZ=0 ppm AH=0 ppm 0-6" sample taken at 0711 EBGKTD-SS05-06-06B
1						6"-12" <u>LEAN CLAY WITH SAND</u> (CL), Brown 7.5YR 4/3, moist, soft, medium plasticity, cohesive	
						1'-6" <u>SANDY LEAN CLAY</u> (CL), Brown 7.5YR 5/4, dry, medium, medium plasticity, cohesive, ~30% is sand medium to course grained, angular	OVM: BZ=0 ppm AH=0 ppm 4-6" sample taken at 0905 EBGKTD-SB05-46-06B
2	2'	All 18"			Slide Hammer		
3							
4							
5							
6	6'					End of boring @ 6 ft bls	

Sampler Signature: Kenji Butler

Date: 06/21/2006



PROJECT NUMBER
183719.FI.02

BORING NUMBERS
EBGKTD-SS06-06-06B
EBGKTD-SB06-46-06B

SHEET 1 OF 1

SOIL BORING LOG

PROJECT: East Vieques Background Soil Inorganics Investigation LOCATION: KTd-06 DATE: 06/21/2006

WEATHER: Partly cloudy, 90°F DRILLING CONTRACTOR: CH2M HILL

DRILLING METHOD AND EQUIPMENT USED: SS Hand auger, SS Bowl, SS Spoon, Slide hammer w/ sampling sleeve

WATER LEVELS: NA START: 0950 END: 1105 LOGGER: Kenji Butler

DEPTH BELOW SURFACE (FT)		RECOVERY (IN)		SAMPLING EQUIPMENT USED	CORE DESCRIPTION	COMMENTS
INTERVAL (FT)		#/TYPE				
	6"	All 6"		Hand Auger	0-1' <u>LEAN CLAY (CL)</u> , Dark Brown (7.5YR, 3/2), moist, medium plasticity, cohesive, organic pieces - roots	OVM: BZ=0 ppm AH=0 ppm 0-6" sample taken at 1004 EBGKTD-SS06-06-06B
1					1'-2' <u>LEAN CLAY WITH SAND (CL)</u> , Brown (7.5YR 4/4), moist, medium plasticity, cohesive, moist but drier then before, sand is medium to coarse grained, angular, 15% of sample	
2	2'	All 18"		Slide Hammer	2-6 ft <u>SANDY LEAN CLAY (CL)</u> , very dry, hard, medium plasticity, cohesive, sand is fine to coarse, weathered granite.	OVM: BZ=0 ppm AH=0 ppm sample taken at 1055 EBGKTD-SB06-46-06B
3		37" of 48"				
4						
5						
6	6'				End of boring @ 6 ft bls	

Sampler Signature: Kenji Butler

Date: 06/21/2006



PROJECT NUMBER
183719.FI.02

BORING NUMBERS
EBGKTD-SS07-06-06B
EBGKTD-SB07-46-06B

SHEET 1 OF 1

SOIL BORING LOG

PROJECT: East Vieques Background Soil Inorganics Investigation LOCATION: KTd-7 DATE: 06/24/2006

WEATHER: Humid, overcast, 85°F DRILLING CONTRACTOR: CH2M HILL

DRILLING METHOD AND EQUIPMENT USED: SS Hand auger, SS Bowl, SS Spoon, Slide hammer w/ sampling sleeve

WATER LEVELS: NA START: 0810 END: 1000 LOGGER: Wade Trevathan

DEPTH BELOW SURFACE (FT)				SAMPLING EQUIPMENT USED	CORE DESCRIPTION	COMMENTS
	INTERVAL (FT)	RECOVERY (IN)	#/TYPE			
1	6"	All 6"		Hand Auger	0-2' <u>SANDY LEAN CLAY (CL)</u> , dark brown (7.5YR, 3/3), moist, medium plasticity, cohesive, sand is fine to medium in size	SAMPLE TIME, SAMPLE DEPTH, FIELD DUPLICATE OR MS/MSD TAKEN, ADDITIONAL SAMPLE INFO, ODORS, DISCOLORATION, AND OVM READINGS OVM (ppm): Breathing Zone (BZ) Above Hole (AH) OVM: BZ=0 ppm AH=0 ppm 0-6" sample taken at 0815 EBGKTD-SS07-06-06B * Wades Trevathan characterized & sampled 4-6ft interval
2		46" of 48"		Slide Hammer	2'-6' <u>SANDY LEAN CLAY (CL)</u> , strong brown (7.5YR 4/6), dry, medium plasticity, cohesive, sand is fine.	OVM: BZ=0 ppm AH=0 ppm sample taken at 0950 EBGKTD-SB07-46-06B
3						
4						
5						
6					End of boring @ 6 ft bls	

Sampler Signature: Wade Trevathan Reviewed by Kenji Butler

Date: 06/24/2006



PROJECT NUMBER
183719.FI.02

BORING NUMBERS
EBGKTD-SS08-06-06B
EBGKTD-SB08-46-06B

SHEET 1 OF 1

SOIL BORING LOG

PROJECT: East Vieques Background Soil Inorganics Investigation LOCATION: KTd-8 DATE: 06/26/2006

WEATHER: Partly cloudy, High of 95°F DRILLING CONTRACTOR: CH2M HILL

DRILLING METHOD AND EQUIPMENT USED: SS Hand auger, SS Bowl, SS Spoon, Slide hammer w/ sampling sleeve

WATER LEVELS: NA START: 0635 END: 0803 LOGGER: Kenji Butler

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)		RECOVERY (IN)	#/TYPE	SAMPLING EQUIPMENT USED	CORE DESCRIPTION	COMMENTS
	INTERVAL (FT)						
	RECOVERY (IN)						
					HAND AUGER OR SLIDE HAMMER	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	SAMPLE TIME, SAMPLE DEPTH, FIELD DUPLICATE OR MS/MSD TAKEN, ADDITIONAL SAMPLE INFO, ODORS, DISCOLORATION, AND OVM READINGS OVM (ppm): Breathing Zone (BZ) Above Hole (AH)
0	6"	All 6"			Hand Auger	0'-1' <u>ORGANIC SILT</u> (OL), dark brown (5YR, 3/3), moist, low plasticity, cohesive, some root material in sample.	OVM: BZ=0 ppm AH=0 ppm 0-6" sample taken at 0715 EBGKTD-SS08-06-06B
1						1'-2' <u>CLAYEY SAND</u> (SC) dark brown (5YR 3/3) dry, noncohesive, low plasticity	
2							
3					Slide Hammer	2'-6' <u>POORLY GRADED SAND WITH GRAVEL</u> (SP), light brown (7.5YR 5/4), dry, noncohesive, non-plastic	OVM: BZ=0 ppm AH=0 ppm sample taken at 0750 EBGKTD-SB08-46-06B
4							
5							
6	6'		All of 48"			End of boring @ 6 ft bls	

Sampler Signature: Kenji Butler

Date: 06/26/2006



PROJECT NUMBER
183719.FI.02

BORING NUMBERS
EBGKTD-SS09-06-06B
EBGKTD-SB09-24-06B

SHEET 1 OF 1

SOIL BORING LOG

PROJECT: East Vieques Background Soil Inorganics Investigation LOCATION: KTd-9 DATE: 07/06/2006

WEATHER: Partly cloudy, High of 95°F DRILLING CONTRACTOR: CH2M HILL

DRILLING METHOD AND EQUIPMENT USED: SS Hand auger, SS Bowl, SS Spoon, Slide hammer w/ sampling sleeve

WATER LEVELS: NA START: 1000 END: 1045 LOGGER: Kenji Butler

DEPTH BELOW SURFACE (FT)		RECOVERY (IN)		SAMPLING EQUIPMENT USED	CORE DESCRIPTION	COMMENTS
INTERVAL (FT)		#/TYPE				
	6"	All 6"		Hand Auger	0-3 ft <u>LEAN CLAY WITH SAND</u> (CL), very dark brown (7.5YR, 2.5/3), moist, low plasticity, cohesive, some organic material, roots and snail shells.	OVM: BZ=0 ppm AH=0 ppm 0-6" sample taken at 1020 EBGKTD-SS09-06-06B
1						
2						
3					3-4 ft <u>LEAN CLAY WITH GRAVEL</u> (CL) very dark brown (7.5YR, 2.5/3), moist, low plasticity, hit rock and could not continue, moved to second location and hit rock at 3 1/2 ft. First attempt was to 4'. Hit weathered bedrock	OVM: BZ=0 ppm AH=0 ppm sample taken at 1040 EBGKTD-SB09-24-06B
4	48"	All 42"			End of boring @ 4 ft bls	
5						
6						

Sampler Signature: Kenji Butler

Date: 07/06/2006



PROJECT NUMBER
183719.FI.02

BORING NUMBERS
EBGKTD-SS10-06-06B
EBGKTD-SB10-13-06B

SHEET 1 OF 1

SOIL BORING LOG

PROJECT: East Vieques Background Soil Inorganics Investigation LOCATION: KTd-10 DATE: 07/04/2006

WEATHER: Partly cloudy, High of 85°F DRILLING CONTRACTOR: CH2M HILL

DRILLING METHOD AND EQUIPMENT USED: SS Hand auger, SS Bowl, SS Spoon, Slide hammer w/ sampling sleeve

WATER LEVELS: NA START: 0840 END: 0900 LOGGER: Kenji Butler

DEPTH BELOW SURFACE (FT)		RECOVERY (IN)		SAMPLING EQUIPMENT USED	CORE DESCRIPTION	COMMENTS
INTERVAL (FT)		#/TYPE				
	6"	All 6"		Hand Auger	0-6" <u>LEAN CLAY WITH GRAVEL (CL)</u> , dark brown (10YR, 3/3), moist, stiff, medium plasticity, cohesive, some organic material, roots and snail shells.	OVM: BZ=0 ppm AH=0 ppm 0-6" sample taken at 0845 EBGKTD-SS10-06-06B
1					6" - 3" <u>LEAN CLAY WITH GRAVEL (CL)</u> , dark brown (10YR, 3/3), dry, low plasticity, hit rock and could not continue	OVM: BZ=0 ppm AH=0 ppm sample taken at 0850 EBGKTD-SB10-13-06B Field Duplicate taken at 0855 EBGKTD-SB10P-13-06B
3	36"	All 30"			End of boring @ 3 ft bls	
4						
5						
6						

Sampler Signature: Kenji Butler

Date: 07/04/2006



PROJECT NUMBER
183719.FI.02

BORING NUMBERS
EBGKV-SS01-06-06B
EBGKV-SB01-24-06B

SHEET 1 OF 1

SOIL BORING LOG

PROJECT: East Vieques Background Soil Inorganics Investigation LOCATION: Kv-1 DATE: 06/28/2006

WEATHER: Partly cloudy, 90°F DRILLING CONTRACTOR: CH2M HILL

DRILLING METHOD AND EQUIPMENT USED: SS Hand auger, SS Bowl, SS Spoon, Slide hammer w/ sampling sleeve

WATER LEVELS: NA START: 1020 END: 1130 LOGGER: Kenji Butler

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)		RECOVERY (IN)	#/TYPE	SAMPLING EQUIPMENT USED	CORE DESCRIPTION	COMMENTS
	INTERVAL (FT)						
	RECOVERY (IN)						
					HAND AUGER OR SLIDE HAMMER	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	SAMPLE TIME, SAMPLE DEPTH, FIELD DUPLICATE OR MS/MSD TAKEN, ADDITIONAL SAMPLE INFO, ODORS, DISCOLORATION, AND OVM READINGS OVM (ppm): Breathing Zone (BZ) Above Hole (AH)
0-6"	All 6"			Hand Auger	0-6" <u>LEAN CLAY WITH GRAVEL</u> (CL), brown (7.5YR, 4/4), slightly moist, loose, low plasticity, cohesive, gravel up to 50mm	OVM: BZ=0 ppm AH=0 ppm 0-6" sample taken at 1030	
6"-12"					6"-12" <u>LEAN CLAY WITH GRAVEL</u> (CL), brown (7.5YR, 4/4), dry, loose, low plasticity, cohesive, fine to coarse gravel not exceeding 30mm	EBGKV-SS01-06-06B	
12"-2'					12"-2' <u>SANDY LEAN CLAY WITH GRAVEL</u> (CL), very pale brown (10YR 7/4), dry, low plasticity, cohesive, sand is fine to coarse, gravel is fine to coarse		
2'-4'				Slide Hammer	2'-4' <u>SANDY LEAN CLAY WITH GRAVEL</u> (CL), very pale brown (10YR 7/4), dry, low plasticity, cohesive, sand is fine to coarse, gravel is fine to coarse with and increase in amount of weathered granodiorite. Refusal at 4'	OVM: BZ=0 ppm AH=0 ppm sample taken at 1120 EBGKV-SB01-24-06B	
4'					End of boring @ 4 ft bls		
4'-6"							
6'-6"							
6'-12"							
12'-0"							
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100'-6"							

Sampler Signature: Kenji Butler

Date: 06/28/2006



PROJECT NUMBER
183719.FI.02

BORING NUMBERS
EBGKV-SS02-06-06B
EBGKV-SB02-35-06B

SHEET 1 OF 1

SOIL BORING LOG

PROJECT: East Vieques Background Soil Inorganics Investigation LOCATION: Kv-02 DATE: 06/28/2006

WEATHER: Partly cloudy, 90°F DRILLING CONTRACTOR: CH2M HILL

DRILLING METHOD AND EQUIPMENT USED: SS Hand auger, SS Bowl, SS Spoon, Slide hammer w/ sampling sleeve

WATER LEVELS: NA START: 1540 END: 1650 LOGGER: Kenji Butler

DEPTH BELOW SURFACE (FT)		RECOVERY (IN)		SAMPLING EQUIPMENT USED	CORE DESCRIPTION	COMMENTS
INTERVAL (FT)		#/TYPE				
	6"	All 6"		Hand Auger	0-1' <u>LEAN CLAY WITH GRAVEL</u> (CL), dark reddish brown (5YR, 3/4), moist, Loose, medium plasticity, cohesive, gravel up to 50mm	OVM: BZ=0 ppm AH=0 ppm 0-6" sample taken at 1550 EBGKV-SS02-06-06B
1					1'-3' <u>LEAN CLAY WITH GRAVEL</u> (CL), Dark Reddish Brown (5YR 3/4), dry, medium plasticity, cohesive, slightly stiffer than previous interval	
2	2'	All 18"		Slide Hammer	3'-5' <u>SANDY LEAN CLAY WITH GRAVEL</u> (CL), Pink (7.5YR 7/4), dry, stiff, low plasticity, cohesive, sand is fine to coarse. Refusal at 5'	OVM: BZ=0 ppm AH=0 ppm sample taken at 1645 EBGKV-SB01-35-06B
3		30" of 36"				
4						
5					End of boring @ 5 ft bls	
6						

Sampler Signature: Kenji Butler

Date: 06/28/2006



PROJECT NUMBER
183719.FI.02

BORING NUMBERS
EBGKV-SS03-06-06B
EBGKV-SB03-46-06B

SHEET 1 OF 1

SOIL BORING LOG

PROJECT: East Vieques Background Soil Inorganics Investigation LOCATION: Kv-3 DATE: 06/29/2006

WEATHER: Partly cloudy, 90°F DRILLING CONTRACTOR: CH2M HILL

DRILLING METHOD AND EQUIPMENT USED: SS Hand auger, SS Bowl, SS Spoon, Slide hammer w/ sampling sleeve

WATER LEVELS: NA START: 0815 END: 0925 LOGGER: Kenji Butler

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)		RECOVERY (IN)	#/TYPE	SAMPLING EQUIPMENT USED	CORE DESCRIPTION	COMMENTS
	INTERVAL (FT)						
	RECOVERY (IN)						
					HAND AUGER OR SLIDE HAMMER	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	SAMPLE TIME, SAMPLE DEPTH, FIELD DUPLICATE OR MS/MSD TAKEN, ADDITIONAL SAMPLE INFO, ODORS, DISCOLORATION, AND OVM READINGS OVM (ppm): Breathing Zone (BZ) Above Hole (AH)
0	6"	All 6"			Hand Auger	0-6" <u>LEAN CLAY</u> (CL), dark brown (7.5YR, 3/4), moist, loose, medium plasticity, cohesive, some sand, fine to medium grained, some foot fragments	OVM: BZ=0 ppm AH=0 ppm 0-6" sample taken at 0830 EBGKV-SS03-06-06B
1						6"-3' <u>LEAN CLAY</u> (CL), brown (7.5 4/4) moist, loose, medium plasticity, cohesive, some root fragments, few gravel pieces <10mm.	
2	2'	All 18"			Slide Hammer		
3			45" of 48"				
4						3'-6" <u>SANDY LEAN CLAY</u> (CL), dry, stiff, medium plasticity, cohesive, sand is fine to coarse.	OVM: BZ=0 ppm AH=0 ppm sample taken at 0910 EBGKV-SB03-46-06B
5							
6	6'					End of boring @ 6 ft bls	

Sampler Signature: Kenji Butler

Date: 06/29/2006



PROJECT NUMBER
183719.FI.02

BORING NUMBERS
EBGKV-SS04-06-06B
EBGKV-SB04-35-06B

SHEET 1 OF 1

SOIL BORING LOG

PROJECT: East Vieques Background Soil Inorganics Investigation LOCATION: Kv-4 DATE: 06/22/2006

WEATHER: Cloudy, slight drizzle, 90°F DRILLING CONTRACTOR: CH2M HILL

DRILLING METHOD AND EQUIPMENT USED: SS Hand auger, SS Bowl, SS Spoon, Slide hammer w/ sampling sleeve

WATER LEVELS: NA START: 1740 END: 1845 LOGGER: Kenji Butler

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)		RECOVERY (IN)	#/TYPE	SAMPLING EQUIPMENT USED	CORE DESCRIPTION	COMMENTS
	INTERVAL (FT)						
	RECOVERY (IN)						
					HAND AUGER OR SLIDE HAMMER	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	SAMPLE TIME, SAMPLE DEPTH, FIELD DUPLICATE OR MS/MSD TAKEN, ADDITIONAL SAMPLE INFO, ODORS, DISCOLORATION, AND OVM READINGS OVM (ppm): Breathing Zone (BZ) Above Hole (AH)
1	6"	All 6"			Hand Auger	0-1" <u>LEAN CLAY WITH GRAVEL</u> (CL), dark brown (10YR, 3/3), slightly moist to dry, low plasticity, cohesive, some sand 6"-12" <u>LEAN CLAY WITH GRAVEL</u> (CL), brown (7.5YR 4/4), dry, medium plasticity, cohesive, more sand than previous 1'-5' <u>LEAN CLAY WITH SAND</u> (CL), light yellowish Brown (10TR6/4), dry, low plasticity, cohesive, fine to coarse sand	OVM: BZ=0 ppm AH=0 ppm 0-6" sample taken at 1750 EBGKV-SS04-06-06B
2	2'	All 18"			Slide Hammer		
3			31" of 34"				OVM: BZ=0 ppm AH=0 ppm sample taken at 1840 EBGKV-SB04-35-06B
4							
5	4' 10"					End of boring @ 4 ft 10 inches bls	
6							

Sampler Signature: Kenji Butler

Date: 06/22/2006



PROJECT NUMBER
183719.FI.02

BORING NUMBERS
EBGKV-SS05-06-06B
EBGKV-SB05-13-06B

SHEET 1 OF 1

SOIL BORING LOG

PROJECT: East Vieques Background Soil Inorganics Investigation LOCATION: Kv-5 DATE: 06/28/2006

WEATHER: Partly cloudy, 90°F DRILLING CONTRACTOR: CH2M HILL

DRILLING METHOD AND EQUIPMENT USED: SS Hand auger, SS Bowl, SS Spoon, Slide hammer w/ sampling sleeve

WATER LEVELS: NA START: 0815 END: 0925 LOGGER: Kenji Butler

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)		RECOVERY (IN)	#/TYPE	SAMPLING EQUIPMENT USED	CORE DESCRIPTION	COMMENTS
	RECOVERY (IN)						
1	6"	All 6"			Hand Auger	0-6" <u>LEAN CLAY WITH GRAVEL</u> (CL), brown (7.5YR, 4/4), slightly moist, loose, low plasticity, cohesive, gravel up to 50mm	OVM: BZ=0 ppm AH=0 ppm 0-6" sample taken at 0825
	19"					6"-12" <u>LEAN CLAY WITH GRAVEL</u> (CL), brown (7.5YR, 4/4), dry, loose, low plasticity, cohesive, fine to coarse gravel not exceeding 30mm 12"-19" <u>SANDY LEAN CLAY WITH GRAVEL</u> (CL), very pale brown (10YR 7/4), dry, low plasticity, cohesive, sand is fine to coarse, gravel is fine to course	EBGKV-SS05-06-06B EBGKV-SS05P-06-06B
2		16" of 17"			Slide Hammer	19"-36" <u>SANDY LEAN CLAY WITH GRAVEL</u> (CL), very pale brown (10YR 7/4), dry, low plasticity, cohesive, sand is fine to coarse, gravel is fine to course with and increase in amount of weathered granodiorite. Refusal at 36"	OVM: BZ=0 ppm AH=0 ppm sample taken at 0915 EBGKV-SB05P-13-06B
3	36"					End of boring @ 3 ft bls	
4							
5							
6							

Sampler Signature: Kenji Butler

Date: 06/28/2006



PROJECT NUMBER
183719.FI.02

BORING NUMBERS
EBGKV-SS06-06-06B
EBGKV-SB06-46-06B

SHEET 1 OF 1

SOIL BORING LOG

PROJECT: East Vieques Background Soil Inorganics Investigation LOCATION: Kv-6 DATE: 06/22/2006

WEATHER: Partly cloudy, High of 85°F DRILLING CONTRACTOR: CH2M HILL

DRILLING METHOD AND EQUIPMENT USED: SS Hand auger, SS Bowl, SS Spoon, Slide hammer w/ sampling sleeve

WATER LEVELS: NA START: 1445 END: 1610 LOGGER: Kenji Butler

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)		RECOVERY (IN)	#/TYPE	SAMPLING EQUIPMENT USED	CORE DESCRIPTION	COMMENTS
	INTERVAL (FT)						
	RECOVERY (IN)						
					HAND AUGER OR SLIDE HAMMER	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	SAMPLE TIME, SAMPLE DEPTH, FIELD DUPLICATE OR MS/MSD TAKEN, ADDITIONAL SAMPLE INFO, ODORS, DISCOLORATION, AND OVM READINGS OVM (ppm): Breathing Zone (BZ) Above Hole (AH)
1	6"	All 6"			Hand Auger	0-6" <u>SANDY LEAN CLAY WITH GRAVEL</u> (CL), dark reddish brown (5YR, 3/2), moist, stiff, medium to low plasticity, cohesive, some organic material (roots), ~40% sand 6" - 2' <u>SANDY LEAN CLAY WITH GRAVEL</u> (CL), dark yellowish brown (10YR, 4/6), slightly moist, medium to low plasticity, cohesive.	OVM: BZ=0 ppm AH=0 ppm 0-6" sample taken at 1510 EBGKV-SS06-06-06B
2	24"	All 18"			Slide Hammer	2'-6" <u>SANDY LEAN CLAY</u> (CL), dark yellowish brown (10YR, 4/6), dry, low plasticity, cohesive, sand is fine to coarse grained.	OVM: BZ=0 ppm AH=0 ppm sample taken at 1555 EBGKV-SB06-46-06B
3							
4							
5							
6	72"					End of boring @ 6 ft bls	

Sampler Signature: Kenji Butler

Date: 06/22/2006



PROJECT NUMBER
183719.FI.02

BORING NUMBERS
EBGKV-SS07-06-06B
EBGKV-SB07-46-06B

SHEET 1 OF 1

SOIL BORING LOG

PROJECT: East Vieques Background Soil Inorganics Investigation LOCATION: Kv-07 DATE: 06/29/2006

WEATHER: Overcast, 80°F DRILLING CONTRACTOR: CH2M HILL

DRILLING METHOD AND EQUIPMENT USED: SS Hand auger, SS Bowl, SS Spoon, Slide hammer w/ sampling sleeve

WATER LEVELS: NA START: 0655 END: 0800 LOGGER: Kenji Butler

DEPTH BELOW SURFACE (FT)		RECOVERY (IN)		SAMPLING EQUIPMENT USED	CORE DESCRIPTION	COMMENTS
INTERVAL (FT)		#/TYPE				
	6"	All 6"		Hand Auger	0-6" FAT CLAY (CH), dark brown (7.5YR, 3/3) moist, stiff, high plasticity, cohesive, organic pieces - roots	OVM: BZ=0 ppm AH=0 ppm 0-6" sample taken at 0705
1					6"-12" FAT CLAY (CH), very dark brown (7.5YR, 2.5/3) moist, stiff, high plasticity, cohesive, few gravel pieces <30mm	EBGKV-SS07-06-06B
					1'-4' FAT CLAY WITH SAND (CL) light brown (7.5YR, 6/4) dry, high plasticity, cohesive, few gravel pieces <30mm	
2	2'	All 18"		Slide Hammer		
			42" of 48"			
3						
4						
					4-6 ft SANDY FAT CLAY (CL), light brown (7.5YR 6/3) dry, stiff, high plasticity, cohesive, sand is fine to coarse, angular.	OVM: BZ=0 ppm AH=0 ppm sample taken at 0740
5						EBGKV-SB07-46-06B
6	6'				End of boring @ 6 ft bls	

Sampler Signature: Kenji Butler

Date: 06/29/2006



PROJECT NUMBER
183719.FI.02

BORING NUMBERS
EBGKV-SS08-06-06B
EBGKV-SB08-23-06B

SHEET 1 OF 1

SOIL BORING LOG

PROJECT: East Vieques Background Soil Inorganics Investigation LOCATION: Kv-8 DATE: 06/27/2006

WEATHER: Sunny, overcast, humid, 90°F DRILLING CONTRACTOR: CH2M HILL

DRILLING METHOD AND EQUIPMENT USED: SS Hand auger, SS Bowl, SS Spoon, Slide hammer w/ sampling sleeve

WATER LEVELS: NA START: 0740 END: 0835 LOGGER: Wade Trevathan

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)		RECOVERY (IN)	#/TYPE	SAMPLING EQUIPMENT USED	CORE DESCRIPTION	COMMENTS
	INTERVAL (FT)						
	RECOVERY (IN)						
					HAND AUGER OR SLIDE HAMMER	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	SAMPLE TIME, SAMPLE DEPTH, FIELD DUPLICATE OR MS/MSD TAKEN, ADDITIONAL SAMPLE INFO, ODORS, DISCOLORATION, AND OVM READINGS OVM (ppm): Breathing Zone (BZ) Above Hole (AH)
0-6"	6"	All 6"			Hand Auger	0-6" <u>LEAN CLAY WITH SAND</u> (CL), dark reddish brown (5YR, 3/3), moist, low plasticity, cohesive, some root material in sample. Infrequent gravel to 20mm.	OVM: BZ=0 ppm AH=0 ppm 0-6" sample taken at 0800 EBGKV-SS08-06-06B
6"-12"						6"-12" <u>ORGANIC SOIL WITH SAND</u> (OL), dark reddish brown (5YR 3/3), cohesive, high plasticity.	
12"-18"						1'-2' <u>CLAYEY SAND</u> (SC), strong brown (7.5YR 4/6), moist, cohesive, high plasticity.	
18"-24"	2'	All 18"			Slide Hammer	2'-3' <u>POORLY GRADED SAND WITH SILT & GRAVEL</u> (SP-SM), strong brown (7.5YR 4/6) dry, gravel to 10mm. Slide hammer refused at 3'.	OVM: BZ=0 ppm AH=0 ppm sample taken at 0830 EBGKV-SB08-23-06B
24"-30"	3'					End of boring @ 3 ft bls	
30"-36"							
36"-42"							
42"-48"							
48"-54"							
54"-60"							
60"-66"							
66"-72"							
72"-78"							
78"-84"							
84"-90"							
90"-96"							
96"-102"							
102"-108"							
108"-114"							
114"-120"							

Sampler Signature: Wade Trevathan Reviewed by Kenji Butler

Date: 06/27/2006



PROJECT NUMBER
183719.FI.02

BORING NUMBERS
EBGKV-SS09-06-06B
EBGKV-SB09-24-06B

SHEET 1 OF 1

SOIL BORING LOG

PROJECT: East Vieques Background Soil Inorganics Investigation

LOCATION: Kv-9

DATE: 06/29/2006

WEATHER: Partly cloudy, 90°F

DRILLING CONTRACTOR: CH2M HILL

DRILLING METHOD AND EQUIPMENT USED: SS Hand auger, SS Bowl, SS Spoon, Slide hammer w/ sampling sleeve

WATER LEVELS: NA

START: 1010

END: 1100

LOGGER: Kenji Butler

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)		RECOVERY (IN)	#/TYPE	SAMPLING EQUIPMENT USED	CORE DESCRIPTION	COMMENTS
	INTERVAL (FT)	RECOVERY (IN)					
0	6"	All 6"			Hand Auger	0-6" <u>LEAN CLAY (CL)</u> , dark brown (7.5YR, 3/4), moist, medium plasticity, cohesive, some sand and gravel up to 30mm	OVM: BZ=0 ppm AH=0 ppm 0-6" sample taken at 1020 EBGKV-SS09-06-06B
1	18"					6"-18" <u>SANDY LEAN CLAY WITH GRAVEL (CL)</u> , dark brown (7.5YR, s/4), moist, medium plasticity, cohesive, fine to coarse sand, gravel not exceeding 40mm	
2		24" of 30"			Slide Hammer	18"-48" <u>POORLY GRADED SAND WITH CLAY & GRAVEL (CL)</u> , pink (7.5YR 7/4), dry, non-plastic, noncohesive, sand is fine to medium, gravel is no larger than 15 mm. Refusal at 4'	OVM: BZ=0 ppm AH=0 ppm sample taken at 1055 EBGKV-SB09-24-06B FD Taken EBGKV-SB09P-24-06B
3							
4	4'					End of boring @ 4 ft bls	
5							
6							

Sampler Signature: Kenji Butler

Date: 06/29/2006



PROJECT NUMBER
183719.FI.02

BORING NUMBERS
EBGKV-SS10-06-06B
EBGKV-SB10-46-06B

SHEET 1 OF 1

SOIL BORING LOG

PROJECT: East Vieques Background Soil Inorganics Investigation

LOCATION: Kv-10

DATE: 06/29/2006

WEATHER: Overcast, 90°F

DRILLING CONTRACTOR: CH2M HILL

DRILLING METHOD AND EQUIPMENT USED: SS Hand auger, SS Bowl, and SS Spoon

WATER LEVELS: NA

START: 1410

END: 1500

LOGGER: Kenji Butler

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)		RECOVERY (IN)	#/TYPE	SAMPLING EQUIPMENT USED	CORE DESCRIPTION	COMMENTS
	INTERVAL (FT)						
	RECOVERY (IN)						
	6"	All 6"			Hand Auger	0-1' LEAN CLAY (CL) , dark brown (7.5YR, 3/4), moist, loose, low plasticity, cohesive, some organic material (roots)	OVM: BZ=0 ppm AH=0 ppm 0-6" sample taken at 1420 EBGKV-SS10-06-06B
1						1'-2' LEAN CLAY (CL) , brown (7.5YR, 5/4), moist, loose, low plasticity, cohesive, some coarse grained sand and gravel pieces.	
2	24"	All 18"			Slide Hammer	2'-6' SANDY LEAN CLAY (CL) , very pale brown (10YR, 7/3), dry, loose, low plasticity, cohesive, sand is fine grained sand.	OVM: BZ=0 ppm AH=0 ppm sample taken at 1450 EBGKV-SB10-46-06B
3							
4							
5							
6						End of boring @ 6 ft bls	

Sampler Signature: Kenji Butler

Date: 06/29/2006



PROJECT NUMBER
183719.FI.02

BORING NUMBERS
EBGQA-SS01-06-06B
EBGQA-SB01-24-06B

SHEET 1 OF 1

SOIL BORING LOG

PROJECT: East Vieques Background Soil Inorganics Investigation LOCATION: Qa-01 DATE: 07/04/2006

WEATHER: Partly Cloudy 90°F DRILLING CONTRACTOR: CH2M HILL

DRILLING METHOD AND EQUIPMENT USED: SS Hand auger, SS Bowl, and SS Spoon

WATER LEVELS: 4ft START: 1150 END: 1210 LOGGER: Kenji Butler

DEPTH BELOW SURFACE (FT)				SAMPLING EQUIPMENT USED	CORE DESCRIPTION	COMMENTS
INTERVAL (FT)	RECOVERY (IN)	#/TYPE		HAND AUGER OR SLIDE HAMMER	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	SAMPLE TIME, SAMPLE DEPTH, FIELD DUPLICATE OR MS/MSD TAKEN, ADDITIONAL SAMPLE INFO, ODORS, DISCOLORATION, AND OVM READINGS
-	6"	All 6"		Hand Auger	0'-4' POORLY GRADED SAND WITH CLAY (SP-SC), dark grey (10YR 4/1) wet, cohesive, medium to high plasticity, sand fine to medium grained. some organics at top 2 inches. Hit water at 4'.	OVM: BZ=0 ppm AH=0 ppm 0-6" sample taken at 1200 EBGKTD-SS1-06-06B OVM: BZ=0 ppm AH=0 ppm sample taken at 1205 EBGKTD-SB01-24-06B
1						
2	2'	All 18"				
3						
4	4'	All 24"			End of boring @ 4 ft bls	
5						
6						

Sampler Signature: _____ Kenji Butler _____

Date: _____ 07/04/2006 _____



PROJECT NUMBER
183719.FI.02

BORING NUMBERS
EBGQA-SS02-06-06B
EBGQA-SB02-46-06B

SHEET 1 OF 1

SOIL BORING LOG

PROJECT: East Vieques Background Soil Inorganics Investigation LOCATION: Qa-02 DATE: 06/23/2006

WEATHER: Partly Cloudy DRILLING CONTRACTOR: CH2M HILL

DRILLING METHOD AND EQUIPMENT USED: SS Hand auger, SS Bowl, SS Spoon, Slide hammer w/ sampling sleeve

WATER LEVELS: NA START: 900 END: 0945 LOGGER: Kenji Butler

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)		RECOVERY (IN)	#/TYPE	SAMPLING EQUIPMENT USED	CORE DESCRIPTION	COMMENTS
	INTERVAL (FT)						
	RECOVERY (IN)						
					HAND AUGER OR SLIDE HAMMER	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	SAMPLE TIME, SAMPLE DEPTH, FIELD DUPLICATE OR MS/MSD TAKEN, ADDITIONAL SAMPLE INFO, ODORS, DISCOLORATION, AND OVM READINGS OVM (ppm): Breathing Zone (BZ) Above Hole (AH)
0	6"	All 6"			Hand Auger	0-1' <u>WELL GRADED SAND WITH CLAY</u> (SW-SC), dark brown (7.5YR 3/2) moist, noncohesive, non-plasticity, few gravel pieces	OVM: BZ=0 ppm AH=0 ppm 0-6" sample taken at 0910 EBGQA-SS02-06-06B
1							
2			All 18"			1'-4' <u>WELL GRADED SAND WITH CLAY</u> (SW-SC), dark brown (7.5YR 3/2) moist, noncohesive, non-plasticity, with more gravel pieces	
3			32" of 48"		Slide Hammer		
4						4'-6' <u>WELL GRADED SAND WITH CLAY & GRAVEL</u> (SW-SC), brown (10YR 5/3) slightly moist, noncohesive, non-plasticity	OVM: BZ=0 ppm AH=0 ppm sample taken at 0935 EBGQA-SB02-46-06B
5							
6						End of boring @ 6 ft bls	

Sampler Signature: _____ Kenji Butler

Date: _____ 06/23/2006



PROJECT NUMBER
183719.FI.02

BORING NUMBERS
EBGQA-SS03-06-06B
EBGQA-SB03-24-06B

SHEET 1 OF 1

SOIL BORING LOG

PROJECT: East Vieques Background Soil Inorganics Investigation LOCATION: Qa-03 DATE: 07/04/2006

WEATHER: Partly Cloudy 90°F DRILLING CONTRACTOR: CH2M HILL

DRILLING METHOD AND EQUIPMENT USED: SS Hand auger, SS Bowl, and SS Spoon

WATER LEVELS: 4ft START: 1055 END: 1130 LOGGER: Kenji Butler

DEPTH BELOW SURFACE (FT)				SAMPLING EQUIPMENT USED	CORE DESCRIPTION	COMMENTS
INTERVAL (FT)	RECOVERY (IN)	#/TYPE		HAND AUGER OR SLIDE HAMMER	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	SAMPLE TIME, SAMPLE DEPTH, FIELD DUPLICATE OR MS/MSD TAKEN, ADDITIONAL SAMPLE INFO, ODORS, DISCOLORATION, AND OVM READINGS
-	6"	All 6"		Hand Auger	0'-4' <u>POORLY GRADED SAND WITH CLAY</u> SP-SC, dark grey (10YR 4/1) wet, cohesive, medium plasticity, sand medium to fine grained. Hit water at 4'.	OVM: BZ=0 ppm AH=0 ppm
1						0-6" sample taken at 1120 EBGKTD-SS3-06-06B
2						OVM: BZ=0 ppm AH=0 ppm
3						sample taken at 1125 EBGKTD-SB03-24-06B
4	2'	All 18"			End of boring @ 4 ft bls	
5						
6	4'	All 24"				

Sampler Signature: _____ Kenji Butler _____

Date: _____ 07/04/2006 _____



PROJECT NUMBER
183719.FI.02

BORING NUMBERS
EBGQA-SS04-06-06B
EBGQA-SB04-46-06B

SHEET 1 OF 1

SOIL BORING LOG

PROJECT: East Vieques Background Soil Inorganics Investigation LOCATION: Qa-4 DATE: 06/21/2006

WEATHER: Overcast, 90°F, slight breeze from East DRILLING CONTRACTOR: CH2M HILL

DRILLING METHOD AND EQUIPMENT USED: SS Hand auger, SS Bowl, SS Spoon, Slide hammer w/ sampling sleeve

WATER LEVELS: NA START: 1310 END: 1430 LOGGER: Kenji Butler

DEPTH BELOW SURFACE (FT)				SAMPLING EQUIPMENT USED	CORE DESCRIPTION	COMMENTS
INTERVAL (FT)	RECOVERY (IN)	#/TYPE				
6"	All 6"			Hand Auger	0-6" ORGANIC SOIL (OL) , dark brown (7.5YR, 3/2), moist, medium plasticity, cohesive, some root fragments, snail found in sample bowl	OVM: BZ=0 ppm AH=0 ppm 0-6" sample taken at 1325 EBGQA-SS04-06-06B
1					6"-12" ORGANIC SOIL (OL) , dark brown (7.5YR, 3/2), moist, medium plasticity, cohesive, root fragments, few gravel	
2					1'-2' ORGANIC SOIL WITH SAND (OL) , brown (7.5YR 4/2), moist, cohesive, low plasticity, sand is quartz, fine to coarse, angular some root fragments.	
3		All 18"		Slide Hammer	2-6 ft SANDY ORGANIC SOIL WITH GRAVEL (OL) , strong brown (7.5YR, 4/6), moist, stiff, low plasticity, cohesive, sand is fine to coarse.	OVM: BZ=0 ppm AH=0 ppm sample taken at 1415 EBGQA-SB04-46-06B
4						
5						
6	6'				End of boring @ 6 ft bls	

Sampler Signature: Kenji Butler

Date: 06/21/2006



PROJECT NUMBER
183719.FI.02

BORING NUMBERS
EBGQA-SS05-06-06B
EBGQA-SB05-13-06B

SHEET 1 OF 1

SOIL BORING LOG

PROJECT: East Vieques Background Soil Inorganics Investigation LOCATION: Qa-05 DATE: 06/27/2006

WEATHER: Clear, Hot 95°F + DRILLING CONTRACTOR: CH2M HILL

DRILLING METHOD AND EQUIPMENT USED: SS Hand auger, SS Bowl, and SS Spoon

WATER LEVELS: NA START: 1515 END: 1605 LOGGER: Wade Trevathan

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)		RECOVERY (IN)	#/TYPE	SAMPLING EQUIPMENT USED	CORE DESCRIPTION	COMMENTS
1	6"	All 6"			Hand Auger	0'-1' <u>SANDY SILT WITH GRAVEL</u> (ML), dark red brown (5YR 3/4) dry, cohesive, low plasticity, some root matter, gravel to 30 mm with more gravel from 6"-12"	OVM: BZ=0 ppm AH=0 ppm 0-6" sample taken at 1545 EBGKTD-SS10-06-06B
	12"	All 6"					
2						1'-3' <u>SANDY SILT WITH GRAVEL</u> (ML), yellowish brown (10YR 5/4) dry, non cohesive, non plastic, large gravel, hang auguring thru to limestone deposits.	OVM: BZ=0 ppm AH=0 ppm sample taken at 1605 EBGKTD-SB05-13-06B
3						End of boring @ 3 ft bls	
4							
5							
6							

Sampler Signature: Wade Trevathan Reviewed by Kenji Butler

Date: 06/27/2006



PROJECT NUMBER
183719.FI.02

BORING NUMBERS
EBGQA-SS06-06-06B
EBGQA-SB06-24-06B

SHEET 1 OF 1

SOIL BORING LOG

PROJECT: East Vieques Background Soil Inorganics Investigation LOCATION: Qa-06 DATE: 07/04/2006

WEATHER: Clear, Hot 95°F + DRILLING CONTRACTOR: CH2M HILL

DRILLING METHOD AND EQUIPMENT USED: SS Hand auger, SS Bowl, and SS Spoon

WATER LEVELS: NA START: 1240 END: 1305 LOGGER: Kenji Butler

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)		RECOVERY (IN)	#/TYPE	SAMPLING EQUIPMENT USED	CORE DESCRIPTION	COMMENTS
	RECOVERY (IN)						
					Hand Auger	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	SAMPLE TIME, SAMPLE DEPTH, FIELD DUPLICATE OR MS/MSD TAKEN, ADDITIONAL SAMPLE INFO, ODORS, DISCOLORATION, AND OVM READINGS OVM (ppm): Breathing Zone (BZ) Above Hole (AH)
	6"	All 6"			Hand Auger	0'-6' <u>LEAN CLAY WITH SAND</u> (CL), brown (7.5YR 4/3) moist, cohesive, low plasticity, sand medium to course grained. Organic matter (roots)	OVM: BZ=0 ppm AH=0 ppm 0-6" sample taken at 1255 EBGKTD-SS06-06-06B
1						6'-12' <u>LEAN CLAY WITH GRAVEL</u> (CL), brown (7.5YR 4/3), moist, cohesive, low plasticity, sand medium to course grained. Organic matter (roots), Gravel up to 30 mm large	
2	2'	All 18"				1'-4' <u>POORLY GRADED SAND WITH CLAY</u> (SP-SC), white (10YR 8/1) dry, cohesive, low plasticity, refusal at 4 ft by limestone aggregate.	OVM: BZ=0 ppm AH=0 ppm sample taken at 1300 EBGKTD-SB06-24-06B
3							
4	4'	All 24"				End of boring @ 4 ft bls	
5							
6							

Sampler Signature: _____ Kenji Butler _____

Date: _____ 07/04/2006 _____



PROJECT NUMBER
183719.FI.02

BORING NUMBERS
EBGQA-SS07-06-06B
EBGQA-SB07-46-06B

SHEET 1 OF 1

SOIL BORING LOG

PROJECT: East Vieques Background Soil Inorganics Investigation

LOCATION: Qa-7

DATE: 06/27/2006

WEATHER: Clear sky, 90°F +

DRILLING CONTRACTOR: CH2M HILL

DRILLING METHOD AND EQUIPMENT USED: SS Hand auger, SS Bowl, SS Spoon, Slide hammer w/ sampling sleeve

WATER LEVELS: NA

START: 1115

END: 1300

LOGGER: Wade Trevathan

DEPTH BELOW SURFACE (FT)		RECOVERY (IN)		SAMPLING EQUIPMENT USED	CORE DESCRIPTION	COMMENTS
INTERVAL (FT)		#/TYPE				
	6"	All 6"		Hand Auger	0-3" <u>ORGANIC SOIL (OL)</u> , dark reddish brown (5YR 2.5/2), moist, cohesive, low plasticity 3"-6" <u>FAT CLAY (CH)</u> , dark reddish brown (EVD 2/2), moist, cohesive, high plasticity 6"-12" <u>FAT CLAY WITH SAND (CH)</u> , dark reddish brown (5YR 3/2), moist, cohesive, high plasticity 1'-2' <u>FAT CLAY WITH SAND (CH)</u> , dark reddish brown (5YR 3/2), moist, cohesive, high plasticity	OVM: BZ=0 ppm AH=0 ppm 0-6" sample taken at 1155 EBGKTD-SS07-06-06B
		All 18"		Slide Hammer	2'-6" <u>FAT CLAY (CH)</u> , grey (5YR 5/1), moist, cohesive, high plasticity. Uniform fat clay until last 2 inches, rock fragments at cutting tip.	OVM: BZ=0 ppm AH=0 ppm sample taken at 1250 EBGKTD-SB07-46-06B
		24" of 48"				
6	6'				End of boring @ 6 ft bls	

Sampler Signature: Wade Trevathan Reviewed by Kenji Butler

Date: 06/27/2006



PROJECT NUMBER
183719.FI.02

BORING NUMBERS
EBGQA-SS08-06-06B
EBGQA-SB08-13-06B

SHEET 1 OF 1

SOIL BORING LOG

PROJECT: East Vieques Background Soil Inorganics Investigation LOCATION: Qa-8 DATE: 07/06/2006

WEATHER: Partly cloudy, High of 95 °F DRILLING CONTRACTOR: CH2M HILL

DRILLING METHOD AND EQUIPMENT USED: SS Hand auger, SS Bowl, SS Spoon, Slide hammer w/ sampling sleeve

WATER LEVELS: NA START: 0910 END: 1045 LOGGER: Kenji Butler

DEPTH BELOW SURFACE (FT)		RECOVERY (IN)		SAMPLING EQUIPMENT USED	CORE DESCRIPTION	COMMENTS
INTERVAL (FT)		#/TYPE				
	6"	All 6"		Hand Auger	0-12" <u>LEAN CLAY WITH SAND</u> (CL), very dark brown (7.5YR, 2.5/3), moist, low plasticity, cohesive, some organic material (root Fragments)	SAMPLE TIME, SAMPLE DEPTH, FIELD DUPLICATE OR MS/MSD TAKEN, ADDITIONAL SAMPLE INFO, ODORS, DISCOLORATION, AND OVM READINGS OVM (ppm): Breathing Zone (BZ) Above Hole (AH)
1					1'-3 1/2' <u>LEAN CLAY WITH SAND</u> (CL), brownish yellow (10YR 6/6), dry, cohesive, low plasticity, some gravel. Weathered bedrock and refusal at 31/2' Sample taken from 1 1/2' to 3 1/2'. Weathered bedrock at bottom, Refusal at 3 1/2' twice.	OVM: BZ=0 ppm AH=0 ppm 0-6" sample taken at 0925 EBGQA-SS08-06-06B Field Duplicate taken EBGQA-SS08P-06-06B OVM: BZ=0 ppm AH=0 ppm sample taken at 1025 EBGQA-SB08-13-06B
2	24"			Slide Hammer		
3						
	42"	All 18"			End of boring @ 3 ft 6 inches bls	
4						
5						
6						

Sampler Signature: Kenji Butler

Date: 06/22/2006



PROJECT NUMBER
183719.FI.02

BORING NUMBERS
EBGQA-SS09-06-06B
EBGQA-SB09-46-06B

SHEET 1 OF 1

SOIL BORING LOG

PROJECT: East Vieques Background Soil Inorganics Investigation LOCATION: Qa-09 DATE: 06/26/2006

WEATHER: Clear, Hot 95°F + DRILLING CONTRACTOR: CH2M HILL

DRILLING METHOD AND EQUIPMENT USED: SS Hand auger, SS Bowl, SS Spoon, Slide hammer w/ sampling sleeve

WATER LEVELS: NA START: 1355 END: 1620 LOGGER: Wade Trevathan

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)		RECOVERY (IN)	#/TYPE	SAMPLING EQUIPMENT USED	CORE DESCRIPTION	COMMENTS
	INTERVAL (FT)						
	RECOVERY (IN)						
					HAND AUGER OR SLIDE HAMMER	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	SAMPLE TIME, SAMPLE DEPTH, FIELD DUPLICATE OR MS/MSD TAKEN, ADDITIONAL SAMPLE INFO, ODORS, DISCOLORATION, AND OVM READINGS OVM (ppm): Breathing Zone (BZ) Above Hole (AH)
1	6"	All 6"			Hand Auger	0'-1' <u>ORGANIC SOIL (CL)</u> , dark brown (7.5YR 3/3) dry, cohesive, non-plastic, root material, some gravel < 5%, up to 20mm	OVM: BZ=0 ppm AH=0 ppm 0-6" sample taken at 1545 EBGQA-SS09-06-06B
2	2'	All 18"			Slide Hammer	1'-2' <u>ORGANIC SOIL WITH GRAVEL (CL)</u> , dusky red (2.5YR 3/2), dry, noncohesive, non-plastic, gravel up to 10 mm large	
3			39" of 48"		Slide Hammer	2'-6' <u>POORLY GRADED SAND WITH SILT (SP-SC)</u> , yellowish red (5YR 4/6) dry, noncohesive, non-plastic.	OVM: BZ=0 ppm AH=0 ppm sample taken at 1610 EBGQA-SB09-46-06B
4							
5							
6						End of boring @ 6 ft bls	

Sampler Signature: Wade Trevathan Reviewed by Kenji Butler

Date: 06/26/2006



PROJECT NUMBER
183719.FI.02

BORING NUMBERS
EBGQA-SS10-06-06B
EBGQA-SB10-13-06B

SHEET 1 OF 1

SOIL BORING LOG

PROJECT: East Vieques Background Soil Inorganics Investigation LOCATION: Qa-10 DATE: 06/27/2006

WEATHER: Clear, Hot 95°F + DRILLING CONTRACTOR: CH2M HILL

DRILLING METHOD AND EQUIPMENT USED: SS Hand auger, SS Bowl, SS Spoon, Slide hammer w/ sampling sleeve

WATER LEVELS: NA START: 1327 END: 1435 LOGGER: Wade Trevathan

DEPTH BELOW SURFACE (FT)				SAMPLING EQUIPMENT USED	CORE DESCRIPTION	COMMENTS
INTERVAL (FT)	RECOVERY (IN)	#/TYPE				
				HAND AUGER OR SLIDE HAMMER	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	SAMPLE TIME, SAMPLE DEPTH, FIELD DUPLICATE OR MS/MSD TAKEN, ADDITIONAL SAMPLE INFO, ODORS, DISCOLORATION, AND OVM READINGS OVM (ppm): Breathing Zone (BZ) Above Hole (AH)
-	6"	All 6"		Hand Auger	0'-1' SANDY SILT WITH GRAVEL (ML) , dark red brown (5YR 3/4) dry, cohesive, low plasticity, some root matter	OVM: BZ=0 ppm AH=0 ppm 0-6" sample taken at 1350 EBGKTD-SS10-06-06B
1					1'-3' SANDY LEAN CLAY WITH GRAVEL (CL) , dark yellow brown (10YR 3/4), moist, cohesive, medium plasticity, Refusal at 3'	
2		All 18"				OVM: BZ=0 ppm AH=0 ppm sample taken at 1430 EBGKTD-SB10-13-06B EBGKTD-SB10P-13-06B
3		All 12"			End of boring @ 3 ft bls	
4						
5						
6						

Sampler Signature: Wade Trevathan Reviewed by Kenji Butler

Date: 06/27/2006



PROJECT NUMBER
183719.FI.02

BORING NUMBERS
EBGTI-SS01-06-06B

SHEET 1 OF 1

SOIL BORING LOG

PROJECT: East Vieques Background Soil Inorganics Investigation LOCATION: TI-1 DATE: 06/30/2006

WEATHER: Cloudy w/ intermittent rain DRILLING CONTRACTOR: CH2M HILL

DRILLING METHOD AND EQUIPMENT USED: Stainless Steel (SS) Hand auger, SS Bowl, and SS Spoon

WATER LEVELS: NA START: 1000 END: 1030 LOGGER: Kenji Butler

DEPTH BELOW SURFACE (FT)				SAMPLING EQUIPMENT USED	CORE DESCRIPTION	COMMENTS
INTERVAL (FT)	RECOVERY (IN)	#/TYPE				
				HAND AUGER OR SLIDE HAMMER	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	SAMPLE TIME, SAMPLE DEPTH, FIELD DUPLICATE OR MS/MSD TAKEN, ADDITIONAL SAMPLE INFO, ODORS, DISCOLORATION, AND OVM READINGS OVM (ppm): Breathing Zone (BZ) Above Hole (AH)
6"	All 6"			Hand Auger	0-1' <u>ORGANIC SOIL WITH LIMESTONE SAND</u> (OL), dusky red (2.5YR 3/2), moist, low plasticity, cohesive, some organic matter (roots), limestone gravel	OVM: BZ=0 ppm AH=0 ppm 0-6" sample taken at 1020
					End of boring @ 1 ft bls	EBGTI-SS01-06-06B
1					Refusal on limestone bedrock at 6"	No Subsurface sample taken.
2						
3						
4						
5						
6						

Sampler Signature: Kenji Butler

Date: 06/30/2006



PROJECT NUMBER
183719.FI.02

BORING NUMBERS
EBGTI-SS02-06-06B
EBGTI-SB02-12-06B

SHEET 1 OF 1

SOIL BORING LOG

PROJECT: East Vieques Background Soil Inorganics Investigation LOCATION: TI-2 DATE: 06/30/2006

WEATHER: Cloudy 80°F DRILLING CONTRACTOR: CH2M HILL

DRILLING METHOD AND EQUIPMENT USED: Stainless Steel (SS) Hand auger, SS Bowl, and SS Spoon

WATER LEVELS: NA START: 0720 END: 0800 LOGGER: Kenji Butler

DEPTH BELOW SURFACE (FT)				SAMPLING EQUIPMENT USED	CORE DESCRIPTION	COMMENTS
INTERVAL (FT)	RECOVERY (IN)	#/TYPE				
6"	All 6"			Hand Auger	0-6" <u>ORGANIC SOIL WITH LIMESTONE SAND (OL)</u> , dark reddish brown (2.5YR 3/4), moist, medium plasticity, cohesive, some gravel pieces and root matter 0-6" <u>ORGANIC SOIL WITH LIMESTONE SAND (OL)</u> , reddish brown (2.5YR 5/3), moist, medium plasticity, cohesive, more 1'-2' <u>LIMESTONE SAND WITH GRAVEL (SW)</u> , refusal at 2' on limestone bedrock	OVM: BZ=0 ppm AH=0 ppm 0-6" sample taken at 0745 EBGTI-SS02-06-06B OVM: BZ=0 ppm AH=0 ppm 6"-2' sample taken at 0755 EBGTI-SB02-12-06B
2'	All 18"				End of boring @ 2 ft bls	
3						
4						
5						
6						

Sampler Signature: Kenji Butler

Date: 06/30/2006



PROJECT NUMBER
183719.FI.02

BORING NUMBERS
EBGTI-SS03-06-06B
EBGTI-SB03-61-06B

SHEET 1 OF 1

SOIL BORING LOG

PROJECT: East Vieques Background Soil Inorganics Investigation LOCATION: TI-03 DATE: 07/05/2006

WEATHER: Partly cloudy 90°F DRILLING CONTRACTOR: CH2M HILL

DRILLING METHOD AND EQUIPMENT USED: Stainless Steel (SS) Hand auger, SS Bowl, SS Spoon

WATER LEVELS: NA START: 1425 END: 1440 LOGGER: Kenji Butler

DEPTH BELOW SURFACE (FT)				SAMPLING EQUIPMENT USED	CORE DESCRIPTION	COMMENTS
INTERVAL (FT)	RECOVERY (IN)	#/TYPE				
				HAND AUGER OR SLIDE HAMMER	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	SAMPLE TIME, SAMPLE DEPTH, FIELD DUPLICATE OR MS/MSD TAKEN, ADDITIONAL SAMPLE INFO, ODORS, DISCOLORATION, AND OVM READINGS OVM (ppm): Breathing Zone (BZ) Above Hole (AH)
1	6"	All 6"		Hand Auger	0-12" ORGANIC SOIL (OL) , Dusky Red (2.5YR 3/2), moist, low to medium plasticity, cohesive, limestone sand w/ limestone gravel pieces, refusal at 1ft on limestone bedrock, tried and refused 4 times.	OVM: BZ=0 ppm AH=0 ppm 0-6" sample taken at 1430 EBGTI-SS03-06-06B
	12"	All 6"			End of boring @ 1 ft bls	
2						OVM: BZ=0 ppm AH=0 ppm 6"-12" sample taken at 1435 EBGTI-SB03-61-06B
3						
4						
5						
6						

Sampler Signature: Kenji Butler

Date: 07/05/2006



PROJECT NUMBER
183719.FI.02

BORING NUMBERS
EBGTI-SS04-06-06B
EBGTI-SB04-62-06B

SHEET 1 OF 1

SOIL BORING LOG

PROJECT: East Vieques Background Soil Inorganics Investigation LOCATION: TI-4 DATE: 07/02/2006

WEATHER: Partly cloudy 95°F DRILLING CONTRACTOR: CH2M HILL

DRILLING METHOD AND EQUIPMENT USED: Stainless Steel (SS) Hand auger, SS Bowl, SS Spoon

WATER LEVELS: NA START: 1615 END: 1645 LOGGER: Kenji Butler

DEPTH BELOW SURFACE (FT)		RECOVERY (IN)		SAMPLING EQUIPMENT USED	CORE DESCRIPTION	COMMENTS
INTERVAL (FT)		#/TYPE				
	6"	All 6"		Hand Auger	0-6" <u>ORGANIC SOIL WITH LIMESTONE SAND</u> (OL), very dark brown (10YR 2/2), moist, medium plasticity, cohesive	OVM: BZ=0 ppm AH=0 ppm 0-6" sample taken at 1625 EBGTI-SS04-06-06B
1	18"	All 12"			6"-18" <u>ORGANIC SOIL WITH LIMESTONE SAND</u> (OL), very dark brown (10YR 2/2), moist, medium plasticity, cohesive, increase in limestone gravel. Refusal at 18" End of boring @ 1 ft 6 inches bls	OVM: BZ=0 ppm AH=0 ppm 6"-18" sample taken at 1630 EBGTI-SB04-62-06B
2						Field Duplicate taken EBGTI-SB04P-62-06B
3						
4						
5						
6						

Sampler Signature: Kenji Butler

Date: 07/02/2006



PROJECT NUMBER
183719.FI.02

BORING NUMBERS
EBGTI-SS05-06-06B
EBGTI-SB05-61-06B

SHEET 1 OF 1

SOIL BORING LOG

PROJECT: East Vieques Background Soil Inorganics Investigation LOCATION: TI-5 DATE: 06/23/2006

WEATHER: Overcast, 90°F DRILLING CONTRACTOR: CH2M HILL

DRILLING METHOD AND EQUIPMENT USED: SS Hand auger, SS Bowl, SS Spoon, Slide hammer w/ sampling sleeve

WATER LEVELS: NA START: 0700 END: 0750 LOGGER: Kenji Butler

DEPTH BELOW SURFACE (FT)		RECOVERY (IN)		SAMPLING EQUIPMENT USED	CORE DESCRIPTION	COMMENTS
INTERVAL (FT)		#/TYPE				
				Hand Auger	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	SAMPLE TIME, SAMPLE DEPTH, FIELD DUPLICATE OR MS/MSD TAKEN, ADDITIONAL SAMPLE INFO, ODORS, DISCOLORATION, AND OVM READINGS OVM (ppm): Breathing Zone (BZ) Above Hole (AH)
	6"	All 6"			0-1' <u>ORGANIC SOIL WITH GRAVEL</u> (OL), dark reddish brown (5YR, 3/2) moist, medium plasticity, cohesive, some limestone, sand, root material through out, Gravel all limestone. Increase of gravel towards 1'.Refusal at 1' on limestone bedrock, tried 3 locations.	OVM: BZ=0 ppm AH=0 ppm 0-6" sample taken at 0725 EBGTI-SS05-06-06B
1	12"	All 6"			End of boring @ 1 ft bls	OVM: BZ=0 ppm AH=0 ppm 6"-12" sample taken at 0740 EBGTI-SB05-61-06B
2						
3						
4						
5						
6						

Sampler Signature: Kenji Butler

Date: 06/23/2006



PROJECT NUMBER
183719.FI.02

BORING NUMBERS
EBGTI-SS06-06-06B
EBGTI-SB06-12-06B

SHEET 1 OF 1

SOIL BORING LOG

PROJECT: East Vieques Background Soil Inorganics Investigation LOCATION: TI-6 DATE: 06/21/2006

WEATHER: Overcast, 90°F DRILLING CONTRACTOR: CH2M HILL

DRILLING METHOD AND EQUIPMENT USED: SS Hand auger, SS Bowl, SS Spoon, Slide hammer w/ sampling sleeve

WATER LEVELS: NA START: 1145 END: 1245 LOGGER: Kenji Butler

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)		RECOVERY (IN)	#/TYPE	SAMPLING EQUIPMENT USED	CORE DESCRIPTION	COMMENTS
	INTERVAL (FT)						
	RECOVERY (IN)						
					HAND AUGER OR SLIDE HAMMER	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	SAMPLE TIME, SAMPLE DEPTH, FIELD DUPLICATE OR MS/MSD TAKEN, ADDITIONAL SAMPLE INFO, ODORS, DISCOLORATION, AND OVM READINGS OVM (ppm): Breathing Zone (BZ) Above Hole (AH)
1	6"	All 6"			Hand Auger	0-6" <u>ORGANIC SOIL WITH SAND (OL)</u> , very dark brown (7.5YR, 2.5/3) moist, some gravel pieces of limestone.	OVM: BZ=0 ppm AH=0 ppm 0-6" sample taken at 1200
						6"-12" <u>ORGANIC SOIL WITH SAND AND GRAVEL (OL)</u> , brown (7.5YR, 4/2) Fine to gravel Limestone, white (2.5Y, 8/1), Dry	EBGTI-SS06-06-06B OVM: BZ=0 ppm AH=0 ppm
	18"	All 12"				12"-18" <u>WELL GRADED SAND WITH GRAVEL (SW)</u> , brown (2.5Y 6/4), dry, limestone sand, refusal at 18" on limestone rocks. three tries	6"-18"sample taken at 1233 EBGTI-SB06-16-06B
2						End of boring @ 1 ft 6 inches bls	
3							
4							
5							
6							

Sampler Signature: Kenji Butler

Date: 06/21/2006



PROJECT NUMBER
183719.FI.02

BORING NUMBERS
EBGTI-SS07-06-06B
EBGTI-SB07-61-06B

SHEET 1 OF 1

SOIL BORING LOG

PROJECT: East Vieques Background Soil Inorganics Investigation

LOCATION: TI-7

DATE: 06/22/2006

WEATHER: Overcast, some drizzle, 85°F

DRILLING CONTRACTOR: CH2M HILL

DRILLING METHOD AND EQUIPMENT USED: Stainless Steel (SS) Hand auger, SS Bowl, SS Spoon, Slide hammer w/ acetate sleeve

WATER LEVELS: NA

START: 0715

END: 0800

LOGGER: Kenji Butler

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)		RECOVERY (IN)	#/TYPE	SAMPLING EQUIPMENT USED	CORE DESCRIPTION	COMMENTS
	INTERVAL (FT)						
	RECOVERY (IN)						
					HAND AUGER OR SLIDE HAMMER	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	SAMPLE TIME, SAMPLE DEPTH, FIELD DUPLICATE OR MS/MSD TAKEN, ADDITIONAL SAMPLE INFO, ODORS, DISCOLORATION, AND OVM READINGS OVM (ppm): Breathing Zone (BZ) Above Hole (AH)
1	6"	All 6"			Hand Auger	0-6" <u>ORGANIC SOIL WITH LIMESTONE GRAVEL</u> (OL), dark reddish brown (2.5YR 3/3), moist, low plasticity, cohesive, root fragments throughout.	OVM: BZ=0 ppm AH=0 ppm 0-6" sample taken at 0735 EBGTI-SS07-06-06B
	12"	All 6"				6"-12" <u>ORGANIC SOIL WITH LIMESTONE GRAVEL</u> (OL), reddish brown (2.5YR 4/4), moist, low plasticity, cohesive, root fragments throughout.	
						End of boring @ 1 ft bls	OVM: BZ=0 ppm AH=0 ppm 6"-12" sample taken at 0750 EBGTI-SB07-61-06B
2							
3							
4							
5							
6							

Sampler Signature: Kenji Butler

Date: 06/21/2006



PROJECT NUMBER
183719.FI.02

BORING NUMBERS
EBGTI-SS08-06-06B
EBGTI-SB08-62-06B

SHEET 1 OF 1

SOIL BORING LOG

PROJECT: East Vieques Background Soil Inorganics Investigation LOCATION: TI-8 DATE: 07/02/2006

WEATHER: Partly cloudy 95°F DRILLING CONTRACTOR: CH2M HILL

DRILLING METHOD AND EQUIPMENT USED: Stainless Steel (SS) Hand auger, SS Bowl, SS Spoon

WATER LEVELS: NA START: 1145 END: 1200 LOGGER: Kenji Butler

DEPTH BELOW SURFACE (FT)		RECOVERY (IN)		SAMPLING EQUIPMENT USED	CORE DESCRIPTION	COMMENTS
INTERVAL (FT)		#/TYPE				
	6"	All 6"		Hand Auger	0-6" <u>SANDY LEAN CLAY</u> (CL), brown (7.5YR 4/3), moist, medium plasticity, cohesive, sand fine to coarse, few pieces of gravel (limestone)	OVM: BZ=0 ppm AH=0 ppm 0-6" sample taken at 1150 EBGTI-SS08-06-06B
1					6"-24" <u>POORLY GRADED SAND WITH CLAY & GRAVEL</u> (SW-SC), pinkish grey (7.5YR 7/2), dry, non-plastic, noncohesive, Refusal at 2 ft at limestone.	OVM: BZ=0 ppm AH=0 ppm 6"-24" sample taken at 1155 EBGTI-SB08-62-06B Field Duplicate taken
2	18"	All 18"			End of boring @ 2 ft	EBGTI-SB08P-62-06B
3						
4						
5						
6						

Sampler Signature: Kenji Butler

Date: 07/02/2006



PROJECT NUMBER
183719.FI.02

BORING NUMBERS
EBGTI-SS09-06-06B
EBGTI-SB09-61-06B

SHEET 1 OF 1

SOIL BORING LOG

PROJECT: East Vieques Background Soil Inorganics Investigation LOCATION: TI-9 DATE: 06/30/2006

WEATHER: Cloudy w/ intermittent rain DRILLING CONTRACTOR: CH2M HILL

DRILLING METHOD AND EQUIPMENT USED: Stainless Steel (SS) Hand auger, SS Bowl, and SS Spoon

WATER LEVELS: NA START: 0900 END: 1000 LOGGER: Kenji Butler

DEPTH BELOW SURFACE (FT)				SAMPLING EQUIPMENT USED	CORE DESCRIPTION	COMMENTS
INTERVAL (FT)	RECOVERY (IN)			HAND AUGER OR SLIDE HAMMER	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	SAMPLE TIME, SAMPLE DEPTH, FIELD DUPLICATE OR MS/MSD TAKEN, ADDITIONAL SAMPLE INFO, ODORS, DISCOLORATION, AND OVM READINGS
		#/TYPE				
1	6"	All 6"		Hand Auger	0-1' <u>ORGANIC SOIL (OL)</u> , very dark brown (7.5YR 2.5/2), moist, low plasticity, cohesive, some organic matter (roots) Refusal on limestone bedrock	OVM: BZ=0 ppm AH=0 ppm 0-6" sample taken at 0940 EBGKTD-SS09-06-06B
1	12"	All 6"			End of boring @ 1 ft	
2						OVM: BZ=0 ppm AH=0 ppm 6"-1' sample taken at 0945 EBGKTD-SB09-61-06B
3						
4						
5						
6						

Sampler Signature: Kenji Butler

Date: 06/30/2006



PROJECT NUMBER
183719.FI.02

BORING NUMBERS
EBGTI-SS10-06-06B
EBGTI-SB10-62-06B

SHEET 1 OF 1

SOIL BORING LOG

PROJECT: East Vieques Background Soil Inorganics Investigation LOCATION: TI-10 DATE: 07/02/2006

WEATHER: Partly cloudy 90°F DRILLING CONTRACTOR: CH2M HILL

DRILLING METHOD AND EQUIPMENT USED: Stainless Steel (SS) Hand auger, SS Bowl, SS Spoon

WATER LEVELS: NA START: 1645 END: 1720 LOGGER: Kenji Butler

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)		RECOVERY (IN)	#/TYPE	SAMPLING EQUIPMENT USED	CORE DESCRIPTION	COMMENTS
	INTERVAL (FT)						
	RECOVERY (IN)						
					HAND AUGER OR SLIDE HAMMER	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	SAMPLE TIME, SAMPLE DEPTH, FIELD DUPLICATE OR MS/MSD TAKEN, ADDITIONAL SAMPLE INFO, ODORS, DISCOLORATION, AND OVM READINGS OVM (ppm): Breathing Zone (BZ) Above Hole (AH)
1	6"	All 6"			Hand Auger	0-6" <u>ORGANIC SOIL WITH LIMESTONE SAND</u> (OL), very dark brown (10YR 2/2), moist, low plasticity, cohesive 6"-24" <u>ORGANIC SOIL WITH LIMESTONE SAND</u> (OL), very dark brown (10YR 2/2), moist, medium plasticity, cohesive, increase in limestone sand. Refusal at 24" at limestone.	OVM: BZ=0 ppm AH=0 ppm 0-6" sample taken at 1705 EBGTI-SS10-06-06B MS/MSD taken at surface. OVM: BZ=0 ppm AH=0 ppm 6"-24" sample taken at 1710 EBGTI-SB10-62-06B
2	18"	All 18"				End of boring @ 2 ft	
3							
4							
5							
6							

Sampler Signature: Kenji Butler

Date: 07/02/2006

APPENDIX B

Sample Location Photographs



KTD-1 entrance



KTD-1 sample location



KTD-2 entrance



KTD-2 sample location



KTD-3 entrance



KTD-3 sample location



KTd-4 entrance



KTd-4 sample location



KTd-5 entrance



KTd-5 sample location



KTd-6 entrance



KTd-6 sample location



KTd-7 entrance



KTd-7 sample location



KTd-8 entrance



KTd-8 sample location



KTd-9 entrance



KTd-9 sample location



KTd-10 entrance



KTd-10 sample location



Kv-1 entrance



Kv-1 sample location



Kv-2 entrance



Kv-2 sample location



Kv-3 entrance



Kv-3 sample location



Kv-4 entrance



Kv-4 sample location



Kv-5 entrance



Kv-5 sample location



Kv-6 entrance



Kv-6 sample location



Kv-7 entrance



Kv-7 sample location



Kv-8 entrance



Kv-8 sample location



Kv-9 entrance



Kv-9 sample location



Kv-10 entrance



Kv-10 sample location



Qa-1 entrance



Qa-1 sample location



Qa-2 entrance



Qa-2 sample location



Qa-3 entrance



Qa-3 sample location



Qa-4 entrance



Qa-4 sample location



Qa-5 entrance



Qa-5 sample location



Qa-6 entrance



Qa-6 sample location



Qa-7 entrance



Qa-7 sample location



Qa-8 entrance



Qa-8 sample location



Qa-9 entrance



Qa-9 sample location



Qa-10 entrance



Qa-10 sample location



TI-1 entrance



TI-1 sample location



TI-2 entrance



TI-2 sample location

No Photograph of TI-3 entrance



TI-3 sample location



TI-4 entrance



TI-4 sample location



TI-5 entrance



TI-5 sample location



TI-6 entrance



TI-6 sample location



TI-7 entrance



TI-7 sample location



TI-8 entrance



TI-8 sample location



TI-9 entrance



TI-9 sample location



TI-10 entrance



TI-10 sample location

APPENDIX C

Analytical Data

East Vieques
Background Investigation
Surface Soil Raw Analytical Results

Station ID	EBGKTD-SO01	EBGKTD-SO02	EBGKTD-SO03	EBGKTD-SO04	EBGKTD-SO05	EBGKTD-SO06	EBGKTD-SO07	EBGKTD-SO08	EBGKTD-SO09	EBGKTD-SO10	EBGKV-SO01	EBGKV-SO02	EBGKV-SO03
Sample ID	EBGKTD-SS01-06-06B	EBGKTD-SS02-06-06B	EBGKTD-SS03-06-06B	EBGKTD-SS04-06-06B	EBGKTD-SS05-06-06B	EBGKTD-SS06-06-06B	EBGKTD-SS07-06-06B	EBGKTD-SS08-06-06B	EBGKTD-SS09-06-06B	EBGKTD-SS10-06-06B	EBGKV-SS01-06-06B	EBGKV-SS02-06-06B	EBGKV-SS03-06-06B
Sample Date	07/03/06	07/02/06	06/24/06	06/26/06	06/21/06	06/21/06	06/24/06	06/26/06	07/06/06	07/04/06	06/28/06	06/28/06	06/29/06
Chemical Name													
Explosives (UG/KG)													
1,3,5-Trinitrobenzene	620 UJ	620 UJ	620 U	620 U	620 UJ	620 UJ	620 U	620 U	620 UJ	620 UJ	620 U	620 U	620 U
1,3-Dinitrobenzene	620 UJ	620 UJ	620 U	620 U	620 UJ	620 UJ	620 U	620 U	620 UJ	620 UJ	620 U	620 U	620 U
2,4,6-Trinitrotoluene	620 UJ	620 UJ	620 U	620 U	620 UJ	620 UJ	620 U	620 U	620 UJ	620 UJ	620 U	620 U	620 U
2,4-Dinitrotoluene	1,200 UJ	1,200 UJ	1,200 U	1,200 U	1,200 UJ	1,200 UJ	1,200 U	1,200 U	1,200 UJ	1,200 UJ	1,200 U	1,200 UJ	1,200 UJ
2,6-Dinitrotoluene	1,200 UJ	1,200 UJ	1,200 U	1,200 U	1,200 UJ	1,200 UJ	1,200 U	1,200 U	1,200 UJ	1,200 UJ	1,200 U	1,200 UJ	1,200 UJ
2-Amino-4,6-dinitrotoluene	1,200 UJ	1,200 UJ	1,200 U	1,200 U	1,200 UJ	1,200 UJ	1,200 U	1,200 U	1,200 UJ	1,200 UJ	1,200 U	1,200 U	1,200 U
2-Nitrotoluene	1,200 UJ	1,200 UJ	1,200 U	1,200 U	1,200 UJ	1,200 UJ	1,200 U	1,200 U	1,200 UJ	1,200 UJ	1,200 U	1,200 U	1,200 U
3-Nitrotoluene	1,200 UJ	1,200 UJ	1,200 U	1,200 U	1,200 UJ	1,200 UJ	1,200 U	1,200 U	1,200 UJ	1,200 UJ	1,200 U	1,200 U	1,200 U
4-Amino-2,6-dinitrotoluene	1,200 UJ	1,200 UJ	1,200 U	1,200 U	1,200 UJ	1,200 UJ	1,200 U	1,200 U	1,200 UJ	1,200 UJ	1,200 U	1,200 U	1,200 U
4-Nitrotoluene	1,200 UJ	1,200 UJ	1,200 U	1,200 U	1,200 UJ	1,200 UJ	1,200 U	1,200 U	1,200 UJ	1,200 UJ	1,200 U	1,200 U	1,200 U
HMX	620 UJ	620 UJ	620 U	620 U	620 UJ	620 UJ	620 U	620 U	620 UJ	620 UJ	620 U	620 U	620 U
Nitrobenzene	620 UJ	620 UJ	620 U	620 U	620 UJ	620 UJ	620 U	620 U	620 UJ	620 UJ	620 U	620 U	620 U
RDX	620 UJ	620 UJ	620 U	620 U	620 UJ	620 UJ	620 U	620 U	620 UJ	620 UJ	620 U	620 U	620 U
Tetryl	1,200 UJ	1,200 UJ	1,200 U	1,200 U	1,200 UJ	1,200 UJ	1,200 U	1,200 U	1,200 UJ	1,200 UJ	1,200 U	1,200 U	1,200 U
Total Metals (MG/KG)													
Aluminum	10,900	9,810	8,300	5,500	6,370	12,300	5,740	6,150	8,880	19,900	11,500	19,400	9,900
Antimony	6.8 U	6.7 U	7.3 U	6.4 U	6.6 U	7.1 U	6.8 U	6.2 U	6.4 U	9.4 U	6.9 U	7 UJ	7.1 U
Arsenic	1.1 U	1.1 U	0.64 J	1.1 U	1.1 UJ	1.2 UJ	1.1 U	1 U	1.1 U	2.1	0.5 J	0.48 J	0.69 J
Barium	120 J	119 J	100	53	73	64.4	47.7	78.2	48.4	68.8 J	80.4	81.2 J	63.7 J
Beryllium	0.57 U	0.56 U	0.61 U	0.53 U	0.55 U	0.59 U	0.57 U	0.52 U	0.53 U	0.78 U	0.57 U	0.26 J	0.24 J
Cadmium	0.72 J	0.77 J	0.4 J	0.22 J	0.42 J	0.85	0.24 J	0.33 J	0.53 U	1.3 J	0.79	1.6	0.44 J
Calcium	4,530	4,310	3,010	2,230	1,800	3,420	1,740	4,610	4,670	7,270	2,890	3,940 J	2,960 J
Chromium	3.9 J	4.7 J	3.4	2.5	3.3	14.8	3.3	3.2	4.6	53.6 J	18.2	40.7	19
Cobalt	7.2 J	8.1 J	6.7	5 J	6.5	8.5	3.7 J	5.2	6.3	13.4 J	15.3	21	13.8
Copper	35.6 J	61.4 J	37.3	21.8	25.7	37.7	23.9	34	32.7 R	48.7 J	29	102 J	21.9 J
Cyanide	0.2 J	2.8 R	3.2 U	2.8 U	2.9 U	3 U	2.9 U	2.8 U	2.7 U	0.29 J	2.9 U	2.9 U	0.19 J
Iron	16,200 J	16,900 J	14,200 J	7,790 J	11,500 J	18,800 J	9,770 J	9,120 J	12,100	25,200 J	22,400 J	38,400 J	20,500 J
Lead	1.9	1.1 J	2.7	2.1	2	3.3	1.7	2.9	4.5	2.7	2	1.7	2.5
Magnesium	2,060 J	5,440 J	2,800 J	909 J	1,400 J	2,740 J	778 J	1,820 J	2,460 J	4,340 J	4,020 J	7,150 J	2,360 J
Manganese	736 J	498 J	669 J	602 J	795	594	372 J	668 J	419	558 J	1,110 J	1,050 R	513 R
Mercury	0.11 U	0.11 U	0.1 U	0.11 U	0.12 U	0.12 U	0.11 U	0.11 U	0.11 U	0.16 U	0.054 J	0.089 J	0.054 J
Nickel	1.9 J	3.3 J	2.1 J	1.1 J	1.8 J	6.2	1.2 J	1.7 J	2.4 J	24.5 J	12.8	28.4	6.5
Potassium	1,860	1,700	1,380 J	923 J	1,320	2,180	570 U	1,220 J	1,700	1,960	1,820 J	3,540	1,610
Selenium	4 U	3.9 U	4.3 U	3.7 U	3.9 UJ	4.2 UJ	4 U	3.6 U	3.7 UJ	5.5 U	4 U	4.1 UJ	4.1 UJ
Silver	1.1 U	1.1 U	1.2 U	1.1 U	0.091 J	1.2 U	1.1 U	1 U	1.1 U	1.6 U	0.11 J	0.22 J	1.2 U
Sodium	569 U	556 U	610 U	532 U	551 U	594 U	570 U	521 U	530 U	785 U	572 U	580 U	592 U
Thallium	0.037 J	0.017 J	0.032 J	0.027 J	0.34 U	0.36 U	0.026 J	0.028 J	0.32 U	0.061 J	0.063 J	0.35 U	0.36 U
Vanadium	45.6 J	43.1 J	38.2	23.8	36.9	68.5	33.7	26.4	36.2	109 J	69.1	108 J	63.7 J
Zinc	17.2 J	22.4 J	35	9.2	12.4 J	21.3 J	7.5	26.7	30.2	22.2 J	29	20.3 J	14.1 J
Wet Chemistry													
Cation Exchange Capacity (MEQ/100G)	26.8	22.4	6.14	5.68	8.46	18.9	4.5	7.76	19	55.9	13.2	35.6	3.53
Redox (MV)	316	274	448	361	384	435	404	324	307	336	391	331	385
Total organic carbon (TOC)	19,400	7,350	8,650	9,780	11,900	13,300	11,200	15,100	12,800	36,400	15,100	16,700	17,500
pH	7.31	7.79	6.59	7.15	6.19	6.75	6.33	8.16	8.04	7.64	6.16	6.38	5.67

Notes:

UG/KG = Micrograms per kilogram

MG/KG = Milligrams per kilogram

MEQ/100G = Milli-equivalents per 100 grams

MV = Millivolts

J = Analyte present. Reported value may or may not be accurate or precise

R = Unreliable result

UJ = Analyte not detected. Quantitation limit may be inaccurate or imprecise

U = Analyte not detected

Shading indicates a detection

East Vieques
Background Investigation
Surface Soil Raw Analytical Results

Station ID	EBGKV-SO04	EBGKV-SO05		EBGKV-SO06	EBGKV-SO07	EBGKV-SO08	EBGKV-SO09	EBGKV-SO10	EBGQA-SO01	EBGQA-SO02	EBGQA-SO03	EBGQA-SO04	EBGQA-SO05
Sample ID	EBGKV-SS04-06-06B	EBGKV-SS05-06-06B	EBGKV-SS05P-06-06B	EBGKV-SS06-06-06B	EBGKV-SS07-06-06B	EBGKV-SS08-06-06B	EBGKV-SS09-06-06B	EBGKV-SS10-06-06B	EBGQA-SS01-06-06B	EBGQA-SS02-06-06B	EBGQA-SS03-06-06B	EBGQA-SS04-06-06B	EBGQA-SS05-06-06B
Sample Date	06/22/06	06/28/06	06/28/06	06/22/06	06/29/06	06/27/06	06/29/06	06/29/06	07/04/06	06/23/06	07/04/06	06/21/06	06/27/06
Chemical Name													
Explosives (UG/KG)													
1,3,5-Trinitrobenzene	620 UJ	620 U	620 U	620 UJ	620 U	620 U	620 U	620 UJ	620 U				
1,3-Dinitrobenzene	620 UJ	620 U	620 U	620 UJ	620 U	620 U	620 U	620 UJ	620 U				
2,4,6-Trinitrotoluene	620 UJ	620 U	620 U	620 UJ	620 U	620 UJ	620 U	620 UJ	620 U				
2,4-Dinitrotoluene	1,200 UJ	1,200 U	1,200 U	1,200 UJ	1,200 UJ	1,200 U	1,200 UJ						
2,6-Dinitrotoluene	1,200 UJ	1,200 U	1,200 U	1,200 UJ	1,200 UJ	1,200 U	1,200 UJ						
2-Amino-4,6-dinitrotoluene	1,200 UJ	1,200 U	1,200 U	1,200 UJ	1,200 U	1,200 U	1,200 U	1,200 UJ	1,200 U				
2-Nitrotoluene	1,200 UJ	1,200 U	1,200 U	1,200 UJ	1,200 U	1,200 U	1,200 U	1,200 UJ	1,200 U				
3-Nitrotoluene	1,200 UJ	1,200 U	1,200 U	1,200 UJ	1,200 U	1,200 U	1,200 U	1,200 UJ	1,200 U				
4-Amino-2,6-dinitrotoluene	1,200 UJ	1,200 U	1,200 U	1,200 UJ	1,200 U	1,200 U	1,200 U	1,200 UJ	1,200 U				
4-Nitrotoluene	1,200 UJ	1,200 U	1,200 U	1,200 UJ	1,200 U	1,200 U	1,200 U	1,200 UJ	1,200 U				
HMX	620 UJ	620 U	620 U	620 UJ	620 U	620 U	620 U	620 UJ	620 U				
Nitrobenzene	620 UJ	620 U	620 U	620 UJ	620 U	620 U	620 U	620 UJ	620 U				
RDX	620 UJ	620 U	620 U	620 UJ	620 U	620 U	620 U	620 UJ	620 U				
Tetryl	1,200 UJ	1,200 U	1,200 U	1,200 UJ	1,200 U	1,200 U	1,200 U	1,200 UJ	1,200 U				
Total Metals (MG/KG)													
Aluminum	19,900	11,300	12,400	5,300	14,300	7,180	11,400	13,800	7,900	4,600	10,600	6,230	17,800
Antimony	6.5 U	6.8 UJ	6.9 U	6.7 U	7.5 U	6.7 U	6.7 U	6.8 U	7.1 U	6.3 U	7.2 U	6.8 U	6.6 U
Arsenic	1.6 J	1.1 U	0.53 J	1.1 UJ	0.54 J	0.82 J	1.1 J	1.6	1.2 U	1.1 UJ	1.2 U	1.1 UJ	0.52 J
Barium	54.3	43.6	49	31	84.2 J	74.3	43.5 J	75.5 J	44.2 J	29.9	104 J	36.7	133 J
Beryllium	0.54 U	0.56 U	0.57 U	0.56 U	0.27 J	0.56 U	0.24 J	0.56 U	0.59 U	0.53 U	0.6 U	0.57 U	0.55 U
Cadmium	2.2	0.47 J	0.47 J	0.43 J	0.93	0.34 J	0.62	0.64 J	0.33 J	0.64	0.5 J	0.58	0.84
Calcium	1,950	3,060	3,080	1,380	4,120 J	1,330	2,670 J	2,740	881	30,800	11,900	3,340	4,230 J
Chromium	10	4.9	5.4	4.8	42.9	2.4	25.5	9.8 J	2.8 J	6.5	3.3 J	8.9	4.9
Cobalt	12.7	7.6	7.9	2.9 J	18.4	4.3 J	13.6	24 J	2.4 J	4.2 J	5.5 J	5.8	11.8
Copper	20.2	10.2	10.7	6	42.4 J	9.7	43.6 J	18.9 J	21.3 J	18.1	33.5 J	29.7	13.5 J
Cyanide	2.8 U	2.8 U	2.9 U	2.9 U	3.3 U	2.8 U	2.8 U	0.22 J	3 U	2.8 U	3.1 U	2.9 U	2.8 U
Iron	39,500 J	16,800 J	18,100 J	9,860 J	30,600 J	14,800 J	22,900 J	25,500 J	9,230 J	9,020 J	12,400 J	13,300 J	21,200 J
Lead	2.8	0.9 J	0.98 J	1.8	3.1	2	1.1	1.5 J	2.9	1 J	1.6 J	1.7	4.1
Magnesium	7,820 J	3,220 J	3,390 J	1,420 J	3,580 J	1,420 J	4,860 J	2,750 J	1,370 J	3,500 J	3,570 J	1,810 J	6,760 J
Manganese	1,360	519 J	523 J	372	1,040 R	503 J	512 R	308 J	152 J	255	494 J	279	756 R
Mercury	0.099 U	0.11 U	0.1 U	0.11 U	0.077 J	0.05 J	0.052 J	0.11 U	0.12 U	0.094 U	0.12 U	0.1 U	0.057 J
Nickel	5.5	3.3 J	3.9 J	1.2 J	14.7	1 J	14.4	4.2 J	0.87 J	2.5 J	1.8 J	3.2 J	3.1 J
Potassium	1,120	865 J	872 J	871	3,160	805 J	622	934	814	710	814	1,320	2,800
Selenium	3.8 UJ	3.9 U	4 U	0.32 J	4.4 UJ	3.9 U	3.9 UJ	4 U	4.1 U	0.51 J	4.2 U	0.47 J	3.9 UJ
Silver	0.21 J	1.1 U	1.1 U	1.1 U	0.14 J	1.1 U	1.1 U	1.1 U	1.2 U	0.11 J	1.2 U	0.1 J	1.1 U
Sodium	542 U	563 U	574 U	559 U	626 U	559 U	556 U	565 U	987	526 U	1,590	567 U	550 U
Thallium	0.34 U	0.044 J	0.046 J	0.34 U	0.4 U	0.34 U	0.34 U	0.059 J	0.032 J	0.34 U	0.045 J	0.34 U	0.33 U
Vanadium	81.1	53.3	57.6	28.2	105 J	32.5	74.1 J	61 J	46.5 J	39.3	46.7 J	52.7	42.5 J
Zinc	61.5 J	11.2	11.8	11.3 J	25.2 J	16	122 J	7.5 J	9.9 J	11.2 J	14.5 J	13.3 J	29.1 J
Wet Chemistry													
Cation Exchange Capacity (MEQ/100G)	14	6.94	20.5	9.96	27.1	7.31	17.7	25.2	57.2	10.1	7.74	8.47	17.1
Redox (MV)	422	447	417	456	304	380	378	377	358	300	267	453	322
Total organic carbon (TOC)	15,900	15,800	9,030	13,700	16,100	11,800	21,200	21,600	5,080	16,300	6,380	12,800	13,600
pH	6.42	6.34	6.31	6.21	6.82	6.25	6.4	6.35	7.18	8.48	8.16	6.06	6.76

Notes:

- UG/KG = Micrograms per kilogram
- MG/KG = Milligrams per kilogram
- MEQ/100G = Milli-equivalents per 100 grams
- MV = Millivolts
- J = Analyte present. Reported value may or may not be accurate or precise
- R = Unreliable result
- UJ = Analyte not detected. Quantitation limit may be inaccurate or imprecise
- U = Analyte not detected
- Shading indicates a detection

East Vieques
Background Investigation
Surface Soil Raw Analytical Results

Station ID	EBGQA-SO06	EBGQA-SO07	EBGQA-SO08		EBGQA-SO09	EBGQA-SO10	EBGTI-SO01	EBGTI-SO02		EBGTI-SO03	EBGTI-SO04	EBGTI-SO05	EBGTI-SO06	EBGTI-SO07
Sample ID	EBGQA-SS06-06-06B	EBGQA-SS07-06-06B	EBGQA-SS08-06-06B	EBGQA-SS08P-06-06B	EBGQA-SS09-06-06B	EBGQA-SS10-06-06B	EBGTI-SS01-06-06B	EBGTI-SS02-06-06B	EBGTI-SS02P-06-06B	EBGTI-SS03-06-06B	EBGTI-SS04-06-06B	EBGTI-SS05-06-06B	EBGTI-SS06-06-06B	EBGTI-SS07-06-06B
Sample Date	07/04/06	06/27/06	06/22/06	06/22/06	06/26/06	06/27/06	06/30/06	06/30/06	06/30/06	07/05/06	07/02/06	06/23/06	06/21/06	06/22/06
Chemical Name														
Explosives (UG/KG)														
1,3,5-Trinitrobenzene	620 UJ	620 U	620 UJ	620 UJ	620 U	620 UJ								
1,3-Dinitrobenzene	620 UJ	620 U	620 UJ	620 UJ	620 U	620 UJ								
2,4,6-Trinitrotoluene	620 UJ	620 U	620 UJ	620 UJ	620 UJ	620 U	620 U	620 U	620 U	620 UJ				
2,4-Dinitrotoluene	1,200 UJ	1,200 U	1,200 UJ	1,200 UJ	1,200 U	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ
2,6-Dinitrotoluene	1,200 UJ	1,200 U	1,200 UJ	1,200 UJ	1,200 U	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ
2-Amino-4,6-dinitrotoluene	1,200 UJ	1,200 U	1,200 UJ	1,200 UJ	1,200 U	1,200 UJ								
2-Nitrotoluene	1,200 UJ	1,200 U	1,200 UJ	1,200 UJ	1,200 U	1,200 UJ								
3-Nitrotoluene	1,200 UJ	1,200 U	1,200 UJ	1,200 UJ	1,200 U	1,200 UJ								
4-Amino-2,6-dinitrotoluene	1,200 UJ	1,200 U	1,200 UJ	1,200 UJ	1,200 U	1,200 UJ								
4-Nitrotoluene	1,200 UJ	1,200 U	1,200 UJ	1,200 UJ	1,200 U	1,200 UJ								
HMX	620 UJ	620 U	620 UJ	620 UJ	620 U	620 UJ								
Nitrobenzene	620 UJ	620 U	620 UJ	620 UJ	620 U	620 UJ								
RDX	620 UJ	620 U	620 UJ	620 UJ	620 U	620 UJ								
Tetryl	1,200 UJ	1,200 U	1,200 UJ	1,200 UJ	1,200 U	1,200 UJ								
Total Metals (MG/KG)														
Aluminum	19,300	11,300	22,600	23,300	9,370	12,500	26,900	25,800	23,000	41,500	21,700	24,900	10,200	35,300
Antimony	7.3 U	7.1 U	7.2 U	6.7 U	6.4 U	6.5 U	8.6 U	8.7 U	7.6 U	7.6 U	7.8 U	9.2 U	8.2 U	9.7 U
Arsenic	5	1 J	1.1 J	0.95 J	0.8 J	0.71 J	3.3	5.2	4.3	5.1	3.8	5.7 J	3.1 J	5.2 J
Barium	70.5 J	38.4 J	244	245	76.7	55.8 J	82.5 J	72.3 J	63.9 J	114	52.8	65.7	55.1	103
Beryllium	0.6 U	0.59 U	0.6 U	0.56 U	0.53 U	0.6 U	0.72	0.73	0.65	0.95	0.65 U	0.77 U	0.68 U	0.94
Cadmium	1.4 J	0.63	2.2	2.3	0.68	0.68	1.4	1.5	1.3	2	1	1.8	1.2	2.1
Calcium	89,900	5,040 J	3,470	3,620	40,000	4,420 J	67,900 J	76,200 J	70,300 J	23,100	47,700	77,300	210,000	17,800
Chromium	16.1 J	23.3	19.4	20	10.7	20.1	42.7	44.5	39.9	58.8	38.3	29.8	14.2	53.4
Cobalt	6.2 J	10.7	18.9	17.2	8.9	10.3	6.8 J	7.6	6.8	7.6	5.7 J	6.2 J	4.8 J	7.6 J
Copper	25.5 J	28.9 J	33.4	33.1	39.8	26.5 J	15.6 J	17.8 J	16 J	26 R	19.9 R	17.1	14.7	29
Cyanide	0.33 J	2.9 U	3.1 U	3 U	2.7 U	2.8 U	3.9 U	3.7 U	3.3 U	0.24 J	0.37 J	0.45 J	3.4 U	4.1 U
Iron	15,400 J	19,700 J	37,400 J	37,700 J	13,900 J	20,400 J	22,700 J	24,400 J	22,000 J	33,300	13,400	17,800 J	6,910 J	30,200 J
Lead	4.5	2.9	1.1 J	0.99 J	2.2	2.2	8.6	8.4	7.8	10.6	5.2	6.9	2.8	10.4
Magnesium	6,170 J	4,660 J	9,680 J	9,730 J	7,160 J	4,030 J	3,950 J	3,740 J	3,250 J	4,440 J	5,790 J	5,320 J	10,200 J	4,960 J
Manganese	515 J	536 R	617	580	667 J	516 R	832 R	660 R	594 R	895	785	631	563	663
Mercury	0.11 J	0.051 J	0.12 U	0.12 U	0.091 U	0.055 J	0.16	0.15	0.12 J	0.096 J	0.27	0.19	0.097 J	0.11 J
Nickel	8.2 J	9.9	9.5	9.5	5.4	8.6	11.5	12.1	10.9	17.7	9.3	9.7	6	13.8
Potassium	5,520	1,450	2,790	2,750	1,510 J	1,880	6,020	5,910	5,220	8,090	4,140	7,350	1,960	9,050
Selenium	4.2 U	4.1 UJ	4.2 UJ	3.9 UJ	3.7 U	3.8 UJ	5 UJ	5.1 UJ	4.5 UJ	4.5 UJ	4.6 UJ	1.3 J	0.7 J	1.1 J
Silver	1.2 U	1.2 U	0.14 J	0.11 J	1.1 U	1.1 U	1.4 U	1.5 U	1.3 U	1.3 U	0.12 J	1.5 U	1.4 U	1.6 U
Sodium	600 U	898 J	600 U	559 U	532 U	544 U	716 U	727 U	637 U	637 U	654 U	765 U	683 U	812 U
Thallium	0.092 J	0.35 U	0.37 U	0.33 U	0.34 U	0.46 U	0.5	0.4 U	0.41	0.42 U	0.42 U	0.46 U	0.41 U	0.49 U
Vanadium	26 J	71.6 J	112	113	60.7	71.2 J	32 J	36.1 J	32.5 J	50.3	27.2	27.5	14.7	40
Zinc	26.3 J	26.4 J	13.2 J	12.9 J	15.4	24.1 J	22.7 J	19.8 J	17.2 J	34.6	23.6	22.1 J	13.5 J	27.1 J
Wet Chemistry														
Cation Exchange Capacity (MEQ/100G)	111	12.9	21.2	18.8	11.2	12.6	65.7	64.3	45	19.6	11	44.6	2.23	3.42
Redox (MV)	271	320	394	403	287	274	280	281	264	279	207	276	315	336
Total organic carbon (TOC)	67,200	38,200	21,100	19,100	8,150	12,500	45,500	44,200	41,800	40,500	86,800	47,800	58,200	49,000
pH	7.63	7.79	6.48	6.35	8.35	7.75	7.61	8.12	7.87	7.77	8	7.95	7.87	7.79

Notes:
 UG/KG = Micrograms per kilogram
 MG/KG = Milligrams per kilogram
 MEQ/100G = Milli-equivalents per 100 grams
 MV = Millivolts
 J = Analyte present. Reported value may or may not be accurate or precise
 R = Unreliable result
 UJ = Analyte not detected. Quantitation limit may be inaccurate or imprecise
 U = Analyte not detected
 Shading indicates a detection

East Vieques
Background Investigation
Surface Soil Raw Analytical Results

Station ID	EBGTI-SO08	EBGTI-SO09	EBGTI-SO10
Sample ID	EBGTI-SS08-06-06B	EBGTI-SS09-06-06B	EBGTI-SS10-06-06B
Sample Date	07/02/06	06/30/06	07/02/06
Chemical Name			
Explosives (UG/KG)			
1,3,5-Trinitrobenzene	620 UJ	620 UJ	620 U
1,3-Dinitrobenzene	620 UJ	620 UJ	620 U
2,4,6-Trinitrotoluene	620 UJ	620 UJ	620 UJ
2,4-Dinitrotoluene	1,200 UJ	1,200 UJ	1,200 U
2,6-Dinitrotoluene	1,200 UJ	1,200 UJ	1,200 U
2-Amino-4,6-dinitrotoluene	1,200 UJ	1,200 UJ	1,200 U
2-Nitrotoluene	1,200 UJ	1,200 UJ	1,200 U
3-Nitrotoluene	1,200 UJ	1,200 UJ	1,200 U
4-Amino-2,6-dinitrotoluene	1,200 UJ	1,200 R	1,200 U
4-Nitrotoluene	1,200 UJ	1,200 UJ	1,200 U
HMX	620 UJ	620 UJ	620 U
Nitrobenzene	620 UJ	620 UJ	620 U
RDX	620 UJ	620 UJ	620 U
Tetryl	1,200 UJ	1,200 UJ	1,200 U
Total Metals (MG/KG)			
Aluminum	5,510	12,000	4,600
Antimony	7.1 U	7.6 U	6.6 U
Arsenic	2	9.6	2.5
Barium	38.2	29.1 J	39.7
Beryllium	0.59 U	0.64 U	0.55 U
Cadmium	1.1	1.4 J	0.96
Calcium	261,000	219,000	204,000
Chromium	6.8	25.9 J	7.3
Cobalt	3.7 J	5 J	3.2 J
Copper	9.7 R	16.2 J	11.6
Cyanide	0.24 J	0.28 J	2.7 U
Iron	3,950	9,980 J	4,280 J
Lead	5.6	2 J	1.3
Magnesium	13,800 J	30,200 J	9,970 J
Manganese	137	287 J	218 J
Mercury	0.087 J	0.1 J	0.091 J
Nickel	2.8 J	9.5 J	3 J
Potassium	1,400	1,760	1,020 J
Selenium	4.2 UJ	0.36 J	3.8 U
Silver	1.2 U	1.3 U	1.1 U
Sodium	593 U	636 U	546 U
Thallium	0.38 U	0.13 J	0.046 J
Vanadium	9	34.5 J	11.2
Zinc	18.9	15.3 J	14
Wet Chemistry			
Cation Exchange Capacity (MEQ/100G)	48.1	59.2	30.7
Redox (MV)	217	235	249
Total organic carbon (TOC)	61,200	68,200	54,900
pH	8.13	8.05	7.89

East Vieques
Background Investigation
Subsurface Soil Raw Analytical Results

Station ID	EBGKTD-SO01		EBGKTD-SO02		EBGKTD-SO03		EBGKTD-SO04	EBGKTD-SO05	EBGKTD-SO06	EBGKTD-SO07	EBGKTD-SO08	EBGKTD-SO09	EBGKTD-SO10	
Sample ID	EBGKTD-SB01-46-06B	EBGKTD-SB01P-46-06B	EBGKTD-SB02-46-06B	EBGKTD-SB03-46-06B	EBGKTD-SB03P-46-06B	EBGKTD-SB04-46-06B	EBGKTD-SB05-46-06B	EBGKTD-SB06-46-06B	EBGKTD-SB07-46-06B	EBGKTD-SB08-46-06B	EBGKTD-SB09-24-06B	EBGKTD-SB10-13-06B	EBGKTD-SB10P-13-06B	
Sample Date	07/03/06	07/03/06	07/02/06	06/24/06	06/24/06	06/26/06	06/21/06	06/21/06	06/24/06	06/26/06	07/06/06	07/04/06	07/04/06	
Chemical Name														
Explosives (UG/KG)														
1,3,5-Trinitrobenzene	620 UJ	620 UJ	620 UJ	620 U	620 U	620 U	620 UJ	620 UJ	620 U	620 U	620 UJ	620 UJ	620 UJ	
1,3-Dinitrobenzene	620 UJ	620 UJ	620 UJ	620 U	620 U	620 U	620 UJ	620 UJ	620 U	620 U	620 UJ	620 UJ	620 UJ	
2,4,6-Trinitrotoluene	620 UJ	620 UJ	620 UJ	620 U	620 U	620 U	620 UJ	620 UJ	620 U	620 U	620 UJ	620 UJ	620 UJ	
2,4-Dinitrotoluene	1,200 UJ	1,200 UJ	1,200 UJ	1,200 U	1,200 U	1,200 U	1,200 UJ	1,200 UJ	1,200 U	1,200 U	1,200 UJ	1,200 UJ	1,200 UJ	
2,6-Dinitrotoluene	1,200 UJ	1,200 UJ	1,200 UJ	1,200 U	1,200 U	1,200 U	1,200 UJ	1,200 UJ	1,200 U	1,200 U	1,200 UJ	1,200 UJ	1,200 UJ	
2-Amino-4,6-dinitrotoluene	1,200 UJ	1,200 UJ	1,200 UJ	1,200 U	1,200 U	1,200 U	1,200 UJ	1,200 UJ	1,200 U	1,200 U	1,200 UJ	1,200 UJ	1,200 UJ	
2-Nitrotoluene	1,200 UJ	1,200 UJ	1,200 UJ	1,200 U	1,200 U	1,200 U	1,200 UJ	1,200 UJ	1,200 U	1,200 U	1,200 UJ	1,200 UJ	1,200 UJ	
3-Nitrotoluene	1,200 UJ	1,200 UJ	1,200 UJ	1,200 U	1,200 U	1,200 U	1,200 UJ	1,200 UJ	1,200 U	1,200 U	1,200 UJ	1,200 UJ	1,200 UJ	
4-Amino-2,6-dinitrotoluene	1,200 UJ	1,200 UJ	1,200 UJ	1,200 U	1,200 U	1,200 U	1,200 UJ	1,200 UJ	1,200 U	1,200 U	1,200 UJ	1,200 UJ	1,200 UJ	
4-Nitrotoluene	1,200 UJ	1,200 UJ	1,200 UJ	1,200 U	1,200 U	1,200 U	1,200 UJ	1,200 UJ	1,200 U	1,200 U	1,200 UJ	1,200 UJ	1,200 UJ	
HMX	620 UJ	620 UJ	620 UJ	620 U	620 U	620 U	620 UJ	620 UJ	620 U	620 U	620 UJ	620 UJ	620 UJ	
Nitrobenzene	620 UJ	620 UJ	620 UJ	620 U	620 U	620 U	620 UJ	620 UJ	620 U	620 U	620 UJ	620 UJ	620 UJ	
RDX	620 UJ	620 UJ	620 UJ	620 U	620 U	620 U	620 UJ	620 UJ	620 U	620 U	620 UJ	620 UJ	620 UJ	
Tetryl	1,200 UJ	1,200 UJ	1,200 UJ	1,200 U	1,200 U	1,200 U	1,200 UJ	1,200 UJ	1,200 U	1,200 U	1,200 UJ	1,200 UJ	1,200 R	
Total Metals (MG/KG)														
Aluminum	8,310	9,610	14,700	7,240	8,910	4,540	7,200	12,300	9,380	5,380	8,320	24,200	21,300	
Antimony	6.2 U	6.2 U	6.5 UJ	6.3 U	7.3 U	6 U	5.9 U	6.7 U	7.2 U	5.8 U	6.3 U	7.2 U	8.7 U	
Arsenic	1 U	1 U	1.1 U	1 U	1.2 U	1 U	0.99 UJ	1.1 UJ	1.2 U	0.96 U	1.1 U	2	2	
Barium	75.7 J	83.8 J	107 J	72.3	96.3	102	74.6	118	292	90.9	51.1 J	121 J	77 J	
Beryllium	0.51 U	0.52 U	0.54 U	0.52 U	0.6 U	0.5 U	0.5 U	0.56 U	0.6 U	0.48 U	0.52 U	0.6 U	0.72 U	
Cadmium	0.52 J	0.59 J	0.8 J	0.28 J	0.38 J	0.17 J	0.43 J	1.2	0.45 J	0.27 J	0.33 J	1.8 J	1.5 J	
Calcium	3,130	3,290	3,860	2,080	2,720	1,360	2,000	43,600	4,090	1,730	3,950	7,740	6,100	
Chromium	2.8 J	2.9 J	4 J	3.2	3.7	2.3	2.9	16.5	5.5	2.5	4.9 J	72 J	65.2 J	
Cobalt	5.6 J	6.2 J	7.9 J	5.1 J	5.8 J	4.6 J	5.4	10.2	12.9	4 J	5.9 J	19.4 J	16.3 J	
Copper	19.6 J	22.8 J	47.8 J	25.1 J	36.7 J	35	35.5	50.2	40.5	50.1	29.5 J	53.8 J	49.5 J	
Cyanide	2.6 R	2.6 R	2.7 R	2.9 U	3 U	2.6 U	2.6 U	2.8 U	3.1 U	2.6 U	2.6 U	3 U	3.6 U	
Iron	12,000 J	13,600 J	17,200 J	10,300 J	13,600 J	7,490 J	10,600 J	18,800 J	16,900 J	8,860 J	12,200 J	32,400 J	30,400 J	
Lead	0.72 J	0.84 J	1.1	1.7	2.7	0.73 J	1	1.7	3	0.57 J	1.8 J	1.4	1.7	
Magnesium	3,880 J	4,310 J	2,930 J	1,560 J	2,380 J	1,490 J	2,120 J	6,800 J	2,480 J	1,690 J	2,170 J	4,830 J	4,270 J	
Manganese	429 J	470 J	732 J	539 J	576 J	496 J	556	685	1,630 J	435 J	407 J	964 J	693 J	
Mercury	0.1 U	0.1 U	0.11 U	0.097 U	0.12 U	0.1 U	0.1 U	0.11 U	0.11 U	0.099 U	0.1 U	0.053 J	0.14 U	
Nickel	2.6 J	2.6 J	2.8 J	1.4 J	1.9 J	1 J	2 J	8.2	2.4 J	1.2 J	2.6 J	31.2 J	27.8 J	
Potassium	515 U	516 U	1,640	762 J	1,070 J	641 J	907	1,060	604 U	571 J	1,180	1,440	1,430	
Selenium	3.6 U	3.6 U	3.8 U	3.7 U	4.2 U	3.5 U	3.5 UJ	3.9 UJ	4.2 U	3.4 U	3.7 U	4.2 U	5.1 U	
Silver	1 U	1 U	1.1 U	1 U	1.2 U	1 U	0.99 U	1.1 U	1.2 U	0.96 U	1.1 U	1.2 U	1.4 U	
Sodium	515 U	516 U	538 U	524 U	604 U	504 U	495 U	2,320 J	1,140	479 U	525 U	603 U	724 U	
Thallium	0.012 J	0.013 J	0.026 J	0.032 J	0.036 J	0.024 J	0.32 U	0.33 U	0.056 J	0.023 J	0.014 J	0.038 J	0.046 J	
Vanadium	30.1 J	33.3 J	47.8 J	28.6	37	24.3	32.7	80.6	61.7	27.2	40.8 J	142 J	138 J	
Zinc	23.9 J	26.6 J	27.3 J	15.2	22.3	10.2	16.2 J	22.1 J	15.2	11.8	17.2 J	19.5 J	19.2 J	
Wet Chemistry														
Cation Exchange Capacity (MEQ/100G)	19.4	18.9	30	3.91	5.99	0.72	9.05	18.3	7.48	5.43	14.6	53.6	48.5	
Redox (MV)	356	359	330	409	408	378	411	293	297	352	297	262	285	
Total organic carbon (TOC)	2,130	2,250	3,530	5,900	6,560	1,460	2,640	3,480	2,770	1,690	5,530	28,100	24,900	
pH	7.93	7.69	8.01	6.82	6.82	7.18	7.39	9.17	9.08	8.12	8.06	8.06	8.11	

Notes:

- UG/KG = Micrograms per kilogram
- MG/KG = Milligrams per kilogram
- MEQ/100G = Milli-equivalents per 100 grams
- MV = Millivolts
- J = Analyte present. Reported value may or may not be accurate or precise
- R = Unreliable result
- UJ = Analyte not detected. Quantitation limit may be inaccurate or imprecise
- U = Analyte not detected
- Shading indicates a detection

East Vieques
Background Investigation
Subsurface Soil Raw Analytical Results

Station ID	EBGKV-SO01	EBGKV-SO02	EBGKV-SO03	EBGKV-SO04	EBGKV-SO05	EBGKV-SO06	EBGKV-SO07	EBGKV-SO08	EBGKV-SO09		EBGKV-SO10	EBGQA-SO01	EBGQA-SO02	EBGQA-SO03
Sample ID	EBGKV-SB01-24-06B	EBGKV-SB02-35-06B	EBGKV-SB03-46-06B	EBGKV-SB04-35-06B	EBGKV-SB05-13-06B	EBGKV-SB06-46-06B	EBGKV-SB07-46-06B	EBGKV-SB08-23-06B	EBGKV-SB09-24-06B	EBGKV-SB09P-24-06B	EBGKV-SB10-46-06B	EBGQA-SB01-24-06B	EBGQA-SB02-46-06B	EBGQA-SB03-24-06B
Sample Date	06/28/06	06/28/06	06/29/06	06/22/06	06/28/06	06/22/06	06/29/06	06/27/06	06/29/06	06/29/06	06/29/06	07/04/06	06/23/06	07/04/06
Chemical Name														
Explosives (UG/KG)														
1,3,5-Trinitrobenzene	620 U	620 U	620 U	620 UJ	620 U	620 UJ	620 U	620 U	620 U	620 U	620 UJ	620 UJ	620 U	620 U
1,3-Dinitrobenzene	620 U	620 U	620 U	620 UJ	620 U	620 UJ	620 U	620 U	620 U	620 U	620 UJ	620 UJ	620 U	620 U
2,4,6-Trinitrotoluene	620 UJ	620 U	620 U	620 UJ	620 U	620 UJ	620 U	620 UJ	620 U	620 U	620 UJ	620 UJ	620 U	620 U
2,4-Dinitrotoluene	1,200 U	1,200 UJ	1,200 UJ	1,200 UJ	1,200 U	1,200 UJ	1,200 U	1,200 U	1,200 U	1,200 UJ	1,200 UJ	1,200 UJ	1,200 U	1,200 UJ
2,6-Dinitrotoluene	1,200 U	1,200 UJ	1,200 UJ	1,200 UJ	1,200 U	1,200 UJ	1,200 U	1,200 U	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ	1,200 U	1,200 UJ
2-Amino-4,6-dinitrotoluene	1,200 U	1,200 U	1,200 U	1,200 UJ	1,200 U	1,200 UJ	1,200 U	1,200 U	1,200 U	1,200 U	1,200 UJ	1,200 UJ	1,200 U	1,200 U
2-Nitrotoluene	1,200 U	1,200 U	1,200 U	1,200 UJ	1,200 U	1,200 UJ	1,200 U	1,200 U	1,200 U	1,200 U	1,200 UJ	1,200 UJ	1,200 U	1,200 U
3-Nitrotoluene	1,200 U	1,200 U	1,200 U	1,200 UJ	1,200 U	1,200 UJ	1,200 U	1,200 U	1,200 U	1,200 U	1,200 UJ	1,200 UJ	1,200 U	1,200 U
4-Amino-2,6-dinitrotoluene	1,200 U	1,200 U	1,200 U	1,200 UJ	1,200 U	1,200 UJ	1,200 U	1,200 U	1,200 U	1,200 U	1,200 UJ	1,200 UJ	1,200 U	1,200 U
4-Nitrotoluene	1,200 U	1,200 U	1,200 U	1,200 UJ	1,200 U	1,200 UJ	1,200 U	1,200 U	1,200 U	1,200 U	1,200 UJ	1,200 UJ	1,200 U	1,200 U
HMX	620 U	620 U	620 U	620 UJ	620 U	620 UJ	620 U	620 U	620 U	620 U	620 UJ	620 UJ	620 U	620 U
Nitrobenzene	620 U	620 U	620 U	620 UJ	620 U	620 UJ	620 U	620 U	620 U	620 U	620 UJ	620 UJ	620 U	620 U
RDX	620 U	620 U	620 U	620 UJ	620 U	620 UJ	620 U	620 U	620 U	620 U	620 UJ	620 UJ	620 U	620 U
Tetryl	1,200 U	1,200 U	1,200 U	1,200 UJ	1,200 U	1,200 UJ	1,200 U	1,200 U	1,200 U	1,200 U	1,200 UJ	1,200 UJ	1,200 U	1,200 U
Total Metals (MG/KG)														
Aluminum	14,600	15,600	8,610	17,600	9,420	10,600	13,000	7,920	3,700	3,740	16,400	16,100	4,660	9,550
Antimony	5.9 UJ	6.2 UJ	6.4 U	6.3 U	6.1 U	6.6 U	6.1 U	6.2 U	6.2 U	6.2 U	6.4 U	7.4 U	6.2 U	7.7 U
Arsenic	0.62 J	1 U	0.48 J	0.47 J	0.52 J	1.1 UJ	0.57 J	1 U	1.5	1.4	0.67 J	1.2 U	1 U	1.3 U
Barium	75.3	61.6 J	74.3 J	67.9	23.7	117	60.9 J	69.7	20.5 U	20.5 U	209 J	108 J	21	53.4 J
Beryllium	0.49 U	0.19 J	0.54 U	0.52 U	0.51 U	0.55 U	0.21 J	0.52 U	0.51 U	0.51 U	0.53 U	0.61 U	0.52 U	0.64 U
Cadmium	1.2	1.1	0.61	1.5	0.33 J	0.7	1	0.23 J	0.51 U	0.51 U	0.89 J	0.45 J	0.59	0.37 J
Calcium	5,440	20,500 J	4,120 J	1,480	3,890	5,330	18,000 J	931	1,610 J	1,370 J	4,900	4,230	40,000	11,600 J
Chromium	24.9	42.2	23.5	3.1	3.9	10.6	36.5	2.9	2.9	2.8	4.8 J	4.6 J	8.3	3.4
Cobalt	12.6	8.3	12.5	6.6	3.5 J	10	15.8	5.5	3.5 J	3.4 J	6.7 J	6.4 J	4.6 J	4.6 J
Copper	76	68.6 J	21.3 J	28.1	4.4	15.4	53 J	11.3	4.9 J	4.6 J	12.3 J	34.6 J	25.1	25.9 J
Cyanide	2.6 U	2.6 U	2.7 U	2.6 U	2.6 U	2.8 U	2.7 U	2.7 U	2.6 U	2.6 U	2.7 R	3.1 U	2.7 U	3.2 U
Iron	28,700 J	23,400 J	24,700 J	27,700 J	11,000 J	18,600 J	26,100 J	14,500 J	5,140 J	5,100 J	21,400 J	15,200 J	10,200 J	12,100 J
Lead	0.84 J	1 U	1.6	1.2	1 U	1.5	1.4	0.85 J	1 U	1 U	1.1 UJ	2 J	0.73 J	1.8
Magnesium	9,920 J	15,400 J	3,560 J	10,600 J	3,950 J	4,680 J	6,270 J	2,710 J	1,180 J	1,080 J	7,410 J	3,000 J	3,940 J	3,940 J
Manganese	639 J	242 R	311 R	1,320	159 J	747	742 R	379 J	136 R	114 R	305 J	738 J	123 J	464 R
Mercury	0.088 U	0.1 U	0.11 U	0.092 U	0.1 U	0.11 U	0.11 U	0.089 U	0.1 U	0.1 U	0.11 U	0.12 U	0.089 U	0.13 U
Nickel	14	40	7.6	1.9 J	2.2 J	4.8	16.4	1.6 J	4.1	3.7 J	2.9 J	2.6 J	2.7 J	1.4 J
Potassium	490 U	966	547	1,110	506 U	1,560	3,130	759 J	512 U	513 U	2,010	1,620	521 U	840
Selenium	3.4 U	3.6 UJ	3.8 UJ	3.7 UJ	3.5 U	3.9 UJ	3.6 UJ	3.6 U	3.6 UJ	3.6 UJ	3.7 U	4.3 U	3.6 U	4.5 UJ
Silver	0.078 J	1 U	1.1 U	0.16 J	1 U	1.1 U	1 U	1 U	1 U	1 U	1.1 U	1.2 U	1 U	1.3 U
Sodium	490 U	567 J	1,110 J	522 U	506 U	1,420 J	2,250 J	592	512 U	513 U	2,700	4,990	771	3,600 J
Thallium	0.016 J	0.32 U	0.33 U	0.32 U	0.022 J	0.33 U	0.33 U	0.033 J	0.31 U	0.31 U	0.064 J	0.049 J	0.017 J	0.38 U
Vanadium	79.5	92.7 J	103 J	34.8	35.9	56	99.3 J	31.9	13.4 J	12.9 J	49.4 J	42 J	54.7	38.3 J
Zinc	31.8	13.5 J	9.1 J	71.3 J	9.2	19.4 J	21.5 J	16.2	9.9 J	9.9 J	10.5 J	20.7 J	12.2	15.1 J
Wet Chemistry														
Cation Exchange Capacity (MEQ/100G)	15.7	22.8	21	13.2	7.98	16.2	22	5.66	9.59	10.5	18.3	35.5	4.04	25.3
Redox (MV)	359	282	260	390	396	286	222	324	330	346	269	266	297	327
Total organic carbon (TOC)	1,900	2,820	4,550	1,470	5,940	2,880	4,660	2,190	5,170	8,300	1,930	2,080	2,640	3,630
pH	7.23	8.62	9.14	7.62	7.42	9.27	9.65	7.01	7.36	7.29	8.53	8.09	8.7	8.02

Notes:

- UG/KG = Micrograms per kilogram
- MG/KG = Milligrams per kilogram
- MEQ/100G = Milli-equivalents per 100 grams
- MV = Millivolts
- J = Analyte present. Reported value may or may not be accurate or precise
- R = Unreliable result
- UJ = Analyte not detected. Quantitation limit may be inaccurate or imprecise
- U = Analyte not detected
- Shading indicates a detection

East Vieques
Background Investigation
Subsurface Soil Raw Analytical Results

Station ID	EBGQA-SO04	EBGQA-SO05	EBGQA-SO06	EBGQA-SO07	EBGQA-SO08	EBGQA-SO09	EBGQA-SO10		EBGTI-SO02	EBGTI-SO03	EBGTI-SO04		EBGTI-SO05	EBGTI-SO06
Sample ID	EBGQA-SB04-46-06B	EBGQA-SB05-13-06B	EBGQA-SB06-24-06B	EBGQA-SB07-46-06B	EBGQA-SB08-13-06B	EBGQA-SB09-46-06B	EBGQA-SB10-13-06B	EBGQA-SB10P-13-06B	EBGTI-SB02-12-06B	EBGTI-SB03-61-06B	EBGTI-SB04P-62-06B	EBGTI-SB04-62-06B	EBGTI-SB05-61-06B	EBGTI-SB06-12-06B
Sample Date	06/21/06	06/27/06	07/04/06	06/27/06	06/22/06	06/26/06	06/27/06	06/27/06	06/30/06	07/05/06	07/02/06	07/02/06	06/23/06	06/21/06
Chemical Name														
Explosives (UG/KG)														
1,3,5-Trinitrobenzene	620 UJ	620 U	620 UJ	620 U	620 UJ	620 U	620 U	620 U	620 UJ	620 UJ	620 UJ	620 UJ	620 UJ	620 UJ
1,3-Dinitrobenzene	620 UJ	620 U	620 UJ	620 U	620 UJ	620 U	620 U	620 U	620 UJ	620 UJ	620 UJ	620 UJ	620 UJ	620 UJ
2,4,6-Trinitrotoluene	620 UJ	620 U	620 UJ	620 U	620 UJ	620 U	620 U	620 U	620 UJ	620 UJ	620 UJ	620 UJ	620 UJ	620 UJ
2,4-Dinitrotoluene	1,200 UJ	1,200 U	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ				
2,6-Dinitrotoluene	1,200 UJ	1,200 U	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ				
2-Amino-4,6-dinitrotoluene	1,200 UJ	1,200 U	1,200 UJ	1,200 U	1,200 UJ	1,200 U	1,200 U	1,200 U	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ
2-Nitrotoluene	1,200 UJ	1,200 U	1,200 UJ	1,200 U	1,200 UJ	1,200 U	1,200 U	1,200 U	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ
3-Nitrotoluene	1,200 UJ	1,200 U	1,200 UJ	1,200 U	1,200 UJ	1,200 U	1,200 U	1,200 U	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ
4-Amino-2,6-dinitrotoluene	1,200 UJ	1,200 U	1,200 UJ	1,200 U	1,200 UJ	1,200 U	1,200 U	1,200 U	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ
4-Nitrotoluene	1,200 UJ	1,200 U	1,200 UJ	1,200 U	1,200 UJ	1,200 U	1,200 U	1,200 U	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ
HMX	620 UJ	620 U	620 UJ	620 U	620 UJ	620 U	620 U	620 U	620 UJ	620 UJ	620 UJ	620 UJ	620 UJ	620 UJ
Nitrobenzene	620 UJ	620 U	620 UJ	620 U	620 UJ	620 U	620 U	620 U	620 UJ	620 UJ	620 UJ	620 UJ	620 UJ	620 UJ
RDX	620 UJ	620 U	620 UJ	620 U	620 UJ	620 U	620 U	620 U	620 UJ	620 UJ	620 UJ	620 UJ	620 UJ	620 UJ
Tetryl	1,200 UJ	1,200 U	1,200 UJ	1,200 U	1,200 UJ	1,200 U	1,200 U	1,200 U	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ
Total Metals (MG/KG)														
Aluminum	8,090	22,000	4,310	12,900	29,900	9,640	14,200	14,900	6,500	34,000	25,000	25,300	17,400	5,470
Antimony	6.2 U	6.4 U	6.4 U	7.9 U	6.4 UJ	6.4 U	6.4 U	6.8 U	7 U	7 U	9.2 U	8.4 U	7.9 U	7 U
Arsenic	1 UJ	1.1 U	4.5	0.56 J	1.1 UJ	1.1 U	0.58 J	1.1 U	1.6	4.4	4.4	4.2	3.8 J	1.8 J
Barium	34.8	114 J	35.1 J	51.6 J	344	175	98.6 J	75.7 J	30.1 J	88.8	60.4	58.2	46	28.6
Beryllium	0.52 U	0.53 U	0.53 U	0.66 U	0.53 U	0.54 U	0.53 U	0.56 U	0.58 U	0.77	0.77 U	0.7 U	0.66 U	0.58 U
Cadmium	0.84	0.91	1.2 J	0.77	3.1	0.49 J	0.7	0.71	1.2 J	2	1.1	1.1	1.6	0.85
Calcium	3,050	3,400 J	361,000	6,720 J	4,170	5,060	3,140 J	3,280 J	354,000	76,900	52,900 J	33,800 J	199,000	222,000
Chromium	15.1	4.6	5.6 J	23	30.5	11.4	22.6	23.7	9.1 J	46.3	45.3	45.5	20.2	7.9
Cobalt	5.8	8.3	5.3 U	10.2	12.5	9.2	13.2	11.3	4.1 J	6.9	6.7 J	6.5 J	5.2 J	3.2 J
Copper	43.7	3.3 J	5.6 J	21.2 J	7.3	42.5	24.6 J	24.1 J	7.4 J	19.2 R	20.7 R	20.3 R	9.9	7.4
Cyanide	2.6 U	2.7 U	0.89 J	3.3 U	2.7 U	2.7 U	2.8 U	2.8 U	0.25 J	0.52 J	0.32 J	3.5 U	3.3 U	2.9 U
Iron	22,100 J	21,200 J	4,840 J	21,700 J	38,100 J	15,000 J	22,400 J	22,700 J	4,310 J	25,500	15,600	15,900	11,400 J	3,640 J
Lead	0.94 J	0.71 J	1.1 U	1.4	1.1 U	1.1	1.5	1.5	1.2 J	7.7	5.5	5.1	4.3	1.1 J
Magnesium	3,360 J	10,400 J	5,080 J	5,500 J	25,200 J	3,040 J	4,820 J	4,880 J	3,210 J	3,780 J	5,850 J	5,340 J	4,140 J	14,300 J
Manganese	189	468 R	86 J	237 R	428	555 J	619 R	450 R	86.9 J	631	972	916	369	245
Mercury	0.1 U	0.11 U	0.1 U	0.13 U	0.11 U	0.087 U	0.11 U	0.11 U	0.056 J	0.12	0.31	0.2	0.17	0.07 J
Nickel	5.2	3.1 J	2.9 J	9.4	15.4	6.3	9.1	8.8	2.9 J	14.3	10.8	10.8	6.9	3.2 J
Potassium	424 J	1,370	630	1,160	2,760	793 J	1,000	1,090	1,500	7,020	4,620	4,610	5,180	951
Selenium	3.6 UJ	3.7 UJ	3.7 U	4.6 UJ	3.7 UJ	3.8 U	3.7 UJ	3.9 UJ	4.1 U	4.1 UJ	0.41 J	4.9 UJ	0.71 J	0.38 J
Silver	1 U	1.1 U	1.1 U	1.3 U	0.094 J	1.1 U	1.1 U	1.1 U	1.2 U	1.2 U	1.5 U	1.4 U	1.3 U	1.2 U
Sodium	550 J	532 U	533 U	3,120 J	530 U	538 U	1,070 J	1,100 J	583 U	582 U	765 U	701 U	660 U	583 U
Thallium	0.31 U	0.32 U	0.024 J	0.4 U	0.32 U	0.33 U	0.34 U	0.34 U	0.1 J	0.37 U	0.46 U	0.42 U	0.4 U	0.35 U
Vanadium	114	40.1 J	15.3 J	67.3 J	97.6	81.1	76.7 J	74.3 J	8.7 J	39	30.7	31.5	20.1	9.5
Zinc	18 J	21.4 J	6.7 J	22.7 J	18.9 J	14.6	18.2 J	19.4 J	4 J	25.7	25.1	25.2	13.4 J	6.8 J
Wet Chemistry														
Cation Exchange Capacity (MEQ/100G)	9.14	15	18	17	24	9.12	18	19	13.5	49.5	6.09	10.8	29.7	11.4
Redox (MV)	328	341	235	240	394	283	245	252	248	300	234	248	294	309
Total organic carbon (TOC)	2,870	8,390	25,200	7,890	6,310	3,380	6,880	8,320	37,300	27,900	56,600	73,400	54,200	64,200
pH	8.7	7.09	8.85	8.02	7.75	8.48	8.32	8.36	8.27	7.29	7.8	7.8	8	8.31

Notes:

UG/KG = Micrograms per kilogram

MG/KG = Milligrams per kilogram

MEQ/100G = Milli-equivalents per 100 grams

MV = Millivolts

J = Analyte present. Reported value may or may not be accurate or precise

R = Unreliable result

UJ = Analyte not detected. Quantitation limit may be inaccurate or imprecise

U = Analyte not detected

Shading indicates a detection

East Vieques
Background Investigation
Subsurface Soil Raw Analytical Results

Station ID	EBGTI-SO07	EBGTI-SO08		EBGTI-SO09	EBGTI-SO10
Sample ID	EBGTI-SB07-61-06B	EBGTI-SB08-62-06B	EBGTI-SB08P-62-06B	EBGTI-SB09-61-06B	EBGTI-SB10-62-06B
Sample Date	06/22/06	07/02/06	07/02/06	06/30/06	07/02/06
Chemical Name					
Explosives (UG/KG)					
1,3,5-Trinitrobenzene	620 UJ	620 UJ	620 UJ	620 UJ	620 UJ
1,3-Dinitrobenzene	620 UJ	620 UJ	620 UJ	620 UJ	620 UJ
2,4,6-Trinitrotoluene	620 UJ	620 UJ	620 UJ	620 UJ	620 UJ
2,4-Dinitrotoluene	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ
2,6-Dinitrotoluene	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ
2-Amino-4,6-dinitrotoluene	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ
2-Nitrotoluene	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ
3-Nitrotoluene	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ
4-Amino-2,6-dinitrotoluene	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ
4-Nitrotoluene	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ
HMX	620 UJ	620 UJ	620 UJ	620 UJ	620 UJ
Nitrobenzene	620 UJ	620 UJ	620 UJ	620 UJ	620 UJ
RDX	620 UJ	620 UJ	620 UJ	620 UJ	620 UJ
Tetryl	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ	1,200 UJ
Total Metals (MG/KG)					
Aluminum	21,600	2,340	2,280	10,400	8,460
Antimony	8.4 U	6.4 U	6.8 U	7.4 U	7 U
Arsenic	3.9 J	1.1	1.3	7.8	3.4
Barium	63.9	36.8	37.6	25.7 J	48.2 J
Beryllium	0.7 U	0.54 U	0.56 U	0.62 U	0.58 U
Cadmium	1.9	0.98	0.98	1.4 J	1.2 J
Calcium	190,000	362,000	360,000	222,000	193,000
Chromium	30.3	3.4	3.4	22.7 J	11.6 J
Cobalt	6.2 J	3.3 J	3.3 J	5.1 J	4 J
Copper	21.2	2.4 R	2.7 R	13.7 J	15.1 J
Cyanide	3.5 U	0.97 J	1 J	0.71 J	0.48 J
Iron	16,400 J	1,480	1,500	8,360 J	7,410 J
Lead	5.3	0.78 J	1.2	1.8 J	1.4
Magnesium	3,930 J	11,000 J	12,300 J	32,300 J	12,200 J
Manganese	327	32.2	31.9	234 J	285 J
Mercury	0.14	0.039 J	0.088 U	0.11 J	0.059 J
Nickel	8.8	1.5 J	1.5 J	8.3 J	4.5 J
Potassium	6,120	535 U	564 U	1,490	2,190
Selenium	1 J	3.7 UJ	4 UJ	4.3 U	0.31 J
Silver	1.4 U	1.1 U	1.1 U	1.2 U	1.2 U
Sodium	701 U	535 U	564 U	616 U	584 U
Thallium	0.42 U	0.34 U	0.34 U	0.13 J	0.069 J
Vanadium	23.8	4.8 J	4.9 J	31 J	20.2 J
Zinc	14.7 J	3.2 J	4 J	12.2 J	17.4 J
Wet Chemistry					
Cation Exchange Capacity (MEQ/100G)	21.3	14.7	14	47	47
Redox (MV)	319	208	213	228	283
Total organic carbon (TOC)	58,300	36,500	39,900	45,400	50,900
pH	7.99	8.42	8.47	7.95	7.69

Notes:

- UG/KG = Micrograms per kilogram
- MG/KG = Milligrams per kilogram
- MEQ/100G = Milli-equivalents per 100 grams
- MV = Millivolts
- J = Analyte present. Reported value may or may not be accurate or precise
- R = Unreliable result
- UJ = Analyte not detected. Quantitation limit may be inaccurate or imprecise
- U = Analyte not detected
- Shading indicates a detection

East Vieques
Background Investigation
Field QC Raw Analytical Results

Station ID	FIELDQC															
Sample ID	EB062106	EB062206	EB062306	EB062406	EB062606	EB062706	EB062806	FB062806	EB062906	EB063006	EB070206	EB070306	EB070406	EB070506	FB070506	EB070606
Sample Date	06/21/06	06/22/06	06/23/06	06/24/06	06/26/06	06/27/06	06/28/06	06/28/06	06/29/06	06/30/06	07/02/06	07/03/04	07/04/06	07/05/06	07/05/06	07/06/06
Chemical Name																
Explosives (UG/L)																
1,3,5-Trinitrobenzene	2.5 U															
1,3-Dinitrobenzene	2.5 U	0.64 J	2.5 U													
2,4,6-Trinitrotoluene	2.5 U															
2,4-Dinitrotoluene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 UJ					
2,6-Dinitrotoluene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 UJ					
2-Amino-4,6-dinitrotoluene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 UJ					
2-Nitrotoluene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
3-Nitrotoluene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
4-Amino-2,6-dinitrotoluene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
4-Nitrotoluene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
HMX	2.5 U															
Nitrobenzene	2.5 U															
RDX	2.5 U															
Tetryl	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Total Metals (UG/L)																
Aluminum	200 U	19.9 J	19.4 J	20.6 J	200 U	200 U	200 U									
Antimony	60 U															
Arsenic	10 U															
Barium	0.35 J	200 U	0.5 J	0.35 J	200 U	3.1 J	3.3 J	3.1 J	3 J	3 J	3 J					
Beryllium	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	0.27 J	0.56 J	0.15 J	0.23 J	0.17 J
Cadmium	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Calcium	5,000 U	5,000 U	331 J	5,000 U	136 J	5,000 U	5,000 U	5,000 U	5,000 U							
Chromium	10 U	0.46 J	0.52 J	10 U	0.56 J	10 U	0.74 J	10 U	10 U	10 U	10 U					
Cobalt	50 U															
Copper	25 U	1.2 J	6.6 J	0.98 J	25 U	25 U	25 U									
Cyanide	10 U	10 R	10 U													
Iron	100 U	100 U	107	100 U												
Lead	10 U															
Magnesium	5,000 U	5,000 U	56 J	5,000 U	28.7 J	5,000 U	5,000 U	5,000 U	5,000 U							
Manganese	15 U	15 U	1.6 J	15 U	0.25 J	0.78 J	0.29 J	15 U	15 U	15 U						
Mercury	0.2 U															
Nickel	40 U	40 U	0.86 J	40 U	40 U	40 U	0.73 J	40 U	40 U	0.81 J	40 U					
Potassium	22.1 J	19.2 J	22.1 J	5,000 U	5,000 U	19.7 J	5,000 U	5,000 U	5,000 U	14.8 J	5,000 U	189 J	5,000 U	5,000 U	5,000 U	5,000 U
Selenium	1.7 J	2.6 J	35 U	35 U	2.1 J	35 U	35 U	1.7 J	35 U							
Silver	0.44 J	0.5 J	0.43 J	0.45 J	0.59 J	0.59 J	10 U	0.52 J	10 U	0.87 J	10 U					
Sodium	314 J	280 J	289 J	240 J	262 J	306 J	324 J	325 J	273 J	334 J	5,000 U	1,110 J	5,000 U	5,000 U	5,000 U	5,000 U
Thallium	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.092 J	1 U	1 U	1 U	1 U
Vanadium	50 U	50 U	0.49 J	50 U	0.31 J	50 U										
Zinc	60 U	12.1 J	3.2 J	60 U	60 U	60 U										

Notes:

- UG/L = Micrograms per liter
- J = Analyte present. Reported value may or may not be accurate or precise
- R = Unreliable result
- UJ = Analyte not detected. Quantitation limit may be inaccurate or imprecise
- U = Analyte not detected
- Shading indicates a detection

APPENDIX D

Data Quality Evaluation Results

Surface Soil Data Quality Evaluation

D.1 Data Quality Assessment

The purpose of this data quality evaluation is to assess the effect of the overall analytical process on the usability of the surface soil data. The two major categories of data evaluation are laboratory performance and matrix interferences. Evaluation of laboratory performance is a check for compliance with the method requirements; in other words, a check of whether the laboratory analyzed the samples within the limits of the analytical method. Additionally, an independent, third-party validator conducted a review of the laboratory data to assess whether the analytical methods were within required control limits at the time of analysis. Evaluation of potential matrix interferences involves the review of several areas of results, including surrogate spike recoveries, matrix spike recoveries, and duplicate sample results.

The data evaluation and validation is a multi-tiered approach. The process begins with an internal laboratory review, continues with an independent review by a third-party validator, and ends with an overall review by the Navy contractor project chemistry team. While only the data validator is allowed to apply qualifiers to the data, the process provides a medium for essential communication between the laboratory, validator, and project team to ensure acceptable data quality.

D.1.1 Laboratory Internal Quality Control Review

Prior to releasing the analytical data, the laboratory reviewed both the sample and QC data to verify sample identity, instrument calibration, quantitation limits, dilution factors, numerical computations, accuracy of transcriptions, and chemical interpretations. In addition, the QC data were tabulated and the results reviewed to ascertain whether they were within the contract-required or laboratory-defined limits for accuracy and precision. Any non-conforming data were discussed in the data package cover letter and case narrative.

D.1.2 Data Validation

An independent data validator reviewed all data packages using the validation criteria defined by USEPA Contract Laboratory Program. USEPA Region II checklists were applied to the data to help the validator create a thorough and systematic approach to the validation process. As stated above, the data validation process was independent and separate from the laboratory's internal review. The process was specifically focused on the effects of the laboratory's performance and sample matrix on the analytical results. Areas of review consisted of holding time compliance, surrogate recovery accuracy, matrix spiked sample precision and accuracy, blank contamination, initial and continuing calibration accuracy and precision, laboratory control sample accuracy, internal standard response and retention time accuracy, instrument tune criteria accuracy, and duplicate sample precision (laboratory and field duplicates). Additionally, the analytical spectrum and raw data output were reviewed

and laboratory results selected by the validator were recalculated from the raw data to verify final laboratory quantitation.

When multiple analyses were performed, the analytical run with the lowest quantitation limits was selected by the validator, if the QC criteria were met for that analysis. If a sample was analyzed more than once as a result of concentrations exceeding the calibration range, the data validator selected results from the appropriate dilution. When multiple analyses were performed and QC criteria were outside of control limits for all analyses, the data validator selected results from the analytical run with the least number of exceptions or best possible QC.

D.1.2.1 Primary Data Validation Qualifiers

The following data validation qualifiers were applied to one or more analytical results:

- **U** - Not detected. Sample was analyzed for this parameter, but it was not detected above the reported quantitation limit. The data validator may also apply this qualifier to indicate that a concentration is attributed to blank contamination, but this qualifier does not necessarily indicate a quality control problem.
- **UJ** - Not detected, quantitation limit estimated. Sample was analyzed for this parameter, but it was not detected above the reported quantitation limit. The quantitation limit for this parameter is estimated.
- **UN** - Tentatively not detected. Matrix interference prevented the accurate recovery of an associated parameter in a spiked sample.
- **J** - Concentration estimated. The parameter was positively identified and the associated numerical value is the approximate concentration of the parameter in the sample.
- **R** - Rejected. The result was rejected because quality control limits were exceeded. The presence or absence of the parameter cannot be verified and the result is not usable as detected or not detected. R is also used to indicate an analytical result that is redundant because of reanalysis or dilution, in which case, there is no effect on the quality or usability of data.
- **(No qualifier present)** - Detected. Qualification was not warranted.

D.1.3 Data Quality Evaluation

The data quality evaluation consisted of an overall review by the Navy contractor project chemistry team of the analytical data for systematic errors. The distribution of data qualifiers and systematic errors is discussed below. The data quality is evaluated based on the number of, severity of, and distribution of these data qualifiers. The data qualifiers were compiled and the individual data validation reports were reviewed if clarification on a data quality issue was necessary.

D.1.3.1 Vieques Island Background Surface Soil Study Data

The purpose of this data quality evaluation is to summarize the findings of the data validation and any effects on the usability of the surface soil data as part of the Vieques

Island background soil sampling effort. This evaluation assesses the analytical results of the samples collected between June 19 and July 7, 2006.

D.1.3.1.1 Explosive Compounds

Explosives were analyzed by SW-846 8330. Excluding field quality control samples, 602 distinct data points were generated. The validation process resulted in the following qualifier summaries:

- 53.3 percent of explosives results were UJ-qualified as not detected, estimated quantitation limit because of low spike recovery in the laboratory control sample (LCS)
- 2.2 percent of explosives results were UJ-qualified as not detected, estimated quantitation limit because of continuing calibration percent difference exceedances
- 1.7 percent of explosives results were UJ-qualified as not detected, estimated quantitation limit because of low response in the continuing calibration
- 0.3 percent of explosives results were UN-qualified as tentatively not detected because of low recovery in the matrix spike.
- 0.3 percent of explosives results were R-qualified as rejected because of large differences in quantitation between the primary and secondary analytical columns

D.1.3.1.1.1 Laboratory Control Sample Spike Recovery

The majority of data validation qualifiers for explosives were the result of low spike recoveries in the LCS. The non-detect results for 23 samples were UJ-qualified as not detected, estimated quantitation limit because of low spike recoveries for 14 parameters. Affected parameters consist of 1,3,5-trinitrobenzene, 1,3-dinitrobenzene, 2,4,6-trinitrotoluene, 2,4-dinitrotoluene, 2,6-dinitrotoluene, 2-amino-4,6-dinitrotoluene, 2-nitrotoluene, 3-nitrotoluene, 4-amino-2,6-dinitrotoluene, 4-nitrobenzene, HMX, nitrobenzene, RDX, and tetryl. No data were rejected as a result of LCS deficiencies, and UJ-qualification does not adversely impact data usability. UJ-qualified results are usable as non-detects.

D.1.3.1.1.2 Calibration

A total of 23 results were UJ-qualified because of continuing calibration deficiencies. Of this total, 13 results were UJ-qualified because of percent difference exceedances in the continuing calibration for 2,6-dinitrotoluene and 2,4,6-trinitrotoluene. The remaining 10 results were UJ-qualified because of a decrease in the response factor for 2,4-dinitrotoluene. No data were rejected as a result of calibration deficiencies, and UJ-qualification does not adversely impact data usability. UJ-qualified results are usable as non-detects.

D.1.3.1.1.3 Matrix Spike

Two results were UN-qualified to indicate that they are tentatively not detected in the native sample as a result of low matrix spike recoveries. Affected parameters consist of nitrobenzene and tetryl. No data were rejected as a result of matrix spike deficiencies, and UN-qualification does not adversely affect data usability. UN-qualified results are usable as non-detects.

D.1.3.1.1.4 Dual-Column Reproducibility

One 4-amino-2,6-dinitrotoluene and one tetryl result were R-qualified as rejected because of large percent differences between the primary and secondary analytical columns. Rejected results are not usable as detects or non-detects, and are not used to make project decisions.

D.1.3.1.2 Total Metals

Total metals (inorganics) were analyzed by CLP ILM05.3. Excluding field quality control samples, 1,032 distinct data points were generated. The validation process resulted in the following qualifier summaries:

- 36.1 percent of metals results were detected and did not require qualification
- 35.3 percent of metals results were J-qualified as estimated
 - 10.9 percent of metals results were J-qualified because of serial dilution
 - 10.9 percent of metals results were J-qualified because of high matrix spike recoveries
 - 10.7 percent of metals results were J-qualified because they were below the quantitation limit
 - 1.2 percent of metals results were J-qualified because of low matrix spike recoveries
 - 1.0 percent of metals results were J-qualified because laboratory duplicate precision was outside control limits
 - 0.3 percent of metals results were J-qualified because of low continuing calibration response
 - 0.3 percent of metals results were J-qualified because of holding time exceedances
- 13.8 percent of metals results were U-qualified as not detected and attributable to blank contamination
-
- 2.5 percent of metals results were UJ-qualified as not detected, estimated quantitation limit because of low matrix spike recoveries
- 1.4 percent of metals results were R-qualified as rejected because of high matrix spike recovery
- 0.1 percent of metals results were R-qualified as rejected because of holding time exceedances

D.1.3.1.2.1 Matrix Spike

One hundred twenty four results were J-qualified as estimated because of low or high matrix spike recoveries. Parameters associated with high matrix spike recoveries consisted of barium, cadmium, chromium, cobalt, copper, manganese, nickel, vanadium, and zinc. Parameters associated with low matrix spike recoveries consisted of arsenic and selenium. Fourteen additional results were R-qualified as rejected because of spike recoveries exceeding 200 percent. Affected parameters consisted of manganese and copper. Manganese was rejected in 10 samples, copper was rejected in 2 samples, and manganese and copper were rejected in 2 additional samples. Rejected results are not usable as detects or non-detects, and project decisions are not based upon them. However, the rejection of results does not affect the usability of non-rejected results in the same data set. Some rejected data is common for analytical data sets. Further, if there are sufficient non-rejected results, as is the case for the background surface soil data, several rejected results are inconsequential to the data usability. J-qualified results are usable as detects, and should be considered estimated by the data user without adversely affecting data usability.

D.1.3.1.2.2 Blank Contamination

One hundred forty two results from the metals fraction, corresponding to 13.8 percent, were U-qualified as attributable to blank contamination because of beryllium, cadmium, antimony, potassium, sodium, and thallium detections in associated blank samples. The U-

qualification of results because of blank contamination does not adversely affect the usability of data because the results are usable as non-detects.

D.1.3.1.2.3 Serial Dilution

One hundred thirteen results were J-qualified as estimated because of serial dilution reproducibility exceedances. Affected parameters consisted of iron, magnesium, potassium, sodium, and zinc. No data were rejected due to serial dilution exceedances. J-qualification of data does not adversely affect usability because the estimated results are usable as detects.

D.1.3.1.2.4 Quantitation Limits

One hundred ten results were J-qualified as estimated because the result was lower than the quantitation limit. These results should be considered estimated by the data user, but data usability is not adversely affected because J-qualified results are usable as detects.

D.1.3.1.2.5 Laboratory Duplicate

Ten results were J-qualified as estimated because of laboratory duplicate precision exceeding CLP limits. These results should be considered estimated by the data user, but the J-qualification of results does not adversely affect the usability of data because the estimated results are usable as detects.

D.1.3.1.2.6 Holding Time

Three cyanide results were J-qualified as estimated because of holding time exceedances. One additional cyanide result was R-qualified as rejected because of a holding time exceedance. This rejected result is not usable as a detect or a non-detect, and project decisions are not based upon it. However, the rejection of this cyanide result does not affect the usability of non-rejected cyanide results in the same data set. The three J-qualified results are usable as detects, and should be considered estimated by the data user without adversely affecting data usability.

D.1.3.1.2.7 Calibration

Three metals results were J-qualified as a result of Contract Required Detection Limit (CRDL) standard response below limits. No data were rejected based on CRDL standards, and J-qualified data should be considered estimated by the data user. However, these results may be used as detects without adversely affecting data usability.

D.1.3.1.3 Wet Chemistry

Samples were analyzed by SW-846 9060 for Total Organic Carbon (TOC) and by SW-846 9045C for pH. Excluding field quality control samples, 86 distinct data points were generated. The validation process resulted in the following qualifier summaries:

- 100 percent of wet chemistry results did not require qualification as a result of the data validation process

D.2 Impact of Data Quality on Project Data Quality Objectives and Data Usability

The laboratory analyzed the samples in accordance with SW-846 and EPA CLP methods. The data packages were reviewed by an independent data validator using USEPA Region II validation checklists.

The “J” and “UJ” qualifiers indicate that some data values are estimated. These qualifiers do not indicate a problem that adversely affects the usability of the data. J-qualified data points are usable for evaluating the nature and extent of contamination and estimating potentially associated human health and ecological risks.

Several sample results were U-qualified to indicate associated blank contamination as a result of field and/or laboratory techniques or procedures. U-qualified sample results do not adversely affect data usability. Blank contamination was associated only with the metals fraction. Some of these metals, such as potassium and sodium, are essential human nutrients and not contaminants. Other metals found in this sampling event, such as antimony, beryllium, cadmium, and thallium, occur at low concentrations (with respect to analytical reporting limits) in the environment. Data points U-qualified because of blank contamination are usable as non-detects for evaluating the nature and extent of contamination and estimating potentially associated human health and ecological risks.

Two results were UN-qualified, which indicates that matrix interference affected the final quantitation of spiked samples. The result of this interference was the recovery of parameters below their respective control limits in matrix spike samples. This was reflected in the native sample by UN-qualification of the associated parameters. UN-qualification of data points does not adversely affect data usability because the results are usable as non-detects. Further only two results were UN-qualified.

The R-qualification of data indicates that a quality control issue has resulted in the rejection of a result. R-qualified results are not usable as detects or non-detects. R-qualification of results does not affect the data usability of other non-rejected results in the same analytical fraction or field sample. It is not uncommon that some data are rejected in large environmental sampling datasets. However, as stated previously, if there are sufficient non-rejected results, as is the case for the background surface soil data, several rejected results are inconsequential to the data usability.

D.2.1 PARCC

D.2.1.1 Precision

Precision is defined as the agreement between duplicate results, and was characterized by comparing duplicate matrix spike recoveries, native duplicates, and field duplicate sample results. Because no results were R-qualified based on MS/MSD precision, laboratory duplicates, or field duplicates, the sample matrix did not interfere with the analytical process or adversely affect precision.

D.2.1.2 Accuracy

Accuracy is a measure of the agreement between an experimental determination and the true value of the parameter being measured. For organic analyses, each sample was spiked with surrogate compounds; and for organic and inorganic analyses, an MS/MSD and LCS were spiked with a known parameter concentration before preparation. Surrogates and MS/MSD provide a measure of the matrix effects on the analytical accuracy. LCS demonstrates accuracy of the method and the laboratory’s ability to meet the method criteria. In some cases, the LCS was characterized by slight exceedances, which resulted in the J- or UJ-qualification of data. J- or UJ-qualification of data points does not affect the

usability of data because the qualified points are usable as detects and non-detects, respectively. However, in some cases, the MS/MSD was characterized by recovery high enough to warrant the R-qualification of results as rejected. Results R-qualified because of MS/MSD are not usable as detects or non-detects, but they represent only a small portion of the background data (manganese and/or copper in 14 samples). All non-rejected data, including results from the same samples and analytical fractions, are still usable as qualified with no adverse effect on data usability.

D.2.1.3 Representativeness

Representativeness is a qualitative measure of the degree to which sample data accurately and precisely represent a characteristic environmental condition (in this case, background). Representativeness is a subjective parameter and is used to evaluate the efficacy of the sample planning design. In terms of data quality, representativeness was assured because the sampling team following approved standard operating procedures for sample collection and handling, and the laboratory followed approved standard operating procedures for sample handling, preparation, and analysis.

D.2.1.4 Completeness

Completeness is defined as the percentage of measurements that are judged to be valid compared to the total number of measurements made. USEPA National Functional Guidelines for Organic and Inorganic Data Review and Region II RCRA and CERCLA Data Validation SOPs designate all results except those R-qualified as rejected to be usable. The compilation of data demonstrates that 99.1 percent of the data are usable as qualified.

D.2.1.5 Comparability

Comparability is a qualitative measure designed to express the confidence with which one data set may be compared to another. Factors that affect comparability are sample collection and handling techniques, sample matrix, and analytical methods. In this case, because approved standard operating procedures were used for sample collection and handling, a common sample matrix was evaluated (surface soil), and SW-846 and CLP methods were utilized, the data user may express confidence in the fact that this data set is comparable to others of high data quality. In addition, comparability is controlled by the other PARCC parameters because data sets can be compared with confidence only when precision and accuracy are known. Because precision and accuracy were demonstrated to be acceptable for the surface soil data, with the exception of the few rejected results, the data user may be confident that this data set is comparable to others of high data quality.

D.2.2 Validation Qualifier Summary

The data evaluation showed that the laboratory U-qualified 29.8 percent (512 results) of the data as non-detect and further qualification was not warranted. Another 26.7 percent (459 results) were detected and no further qualification was warranted. The percentage of non-detects UJ-qualified as estimated amounted to 21.4 percent (368 results). The majority of UJ-qualified results (321 results) were attributed the low LCS recoveries in the explosives fraction. The remaining UJ-qualifiers were distributed among calibration and matrix spike recovery values in both the metals and explosives fractions. A total of 8.3 percent (142 results) were U-qualified as non-detect as a result of blank contamination. The percentage of

detected results J-qualified as estimated was 21.1 percent (363 results), and consisted of qualifiers for serial dilution, sample duplicate reproducibility, method holding times, continuing calibration, and matrix spike recoveries. The majority of rejected data, 15 out of 1,032 results, occurred in the metals fraction. Fourteen results were R-qualified as a result of high matrix spike recoveries. One cyanide result was R-qualified because of a holding time exceedance. A single explosive result (out of 602 results) was R-qualified as rejected because of the difference in quantitation between the primary and secondary analytical columns in the explosives fraction.

The overall conclusion is that the dataset generated is acceptable and appropriate for its intended use with the removal of the rejected data, which constitute less than 1 percent of the data.

Subsurface Soil Data Quality Evaluation

D.1 Data Quality Assessment

The purpose of this data quality evaluation is to assess the effect of the overall analytical process on the usability of the subsurface soil data. The two major categories of data evaluation are laboratory performance and matrix interferences. Evaluation of laboratory performance is a check for compliance with the method requirements; in other words, a check of whether the laboratory analyzed the samples within the limits of the analytical method. Additionally, an independent, third-party validator conducted a review of the laboratory data to assess whether the analytical methods were within required control limits at the time of analysis. Evaluation of potential matrix interferences involves the review of several areas of results, including surrogate spike recoveries, matrix spike recoveries, and duplicate sample results.

The data evaluation and validation is a multi-tiered approach. The process begins with an internal laboratory review, continues with an independent review by a third-party validator, and ends with an overall review by the Navy contractor project chemistry team. While only the data validator is allowed to apply qualifiers to the data, the process provides a medium for essential communication between the laboratory, validator, and project team to ensure acceptable data quality.

D.1.1 Laboratory Internal Quality Control Review

Prior to releasing the analytical data, the laboratory reviewed both the sample and QC data to verify sample identity, instrument calibration, quantitation limits, dilution factors, numerical computations, accuracy of transcriptions, and chemical interpretations. In addition, the QC data were tabulated and the results reviewed to ascertain whether they were within the contract-required or laboratory-defined limits for accuracy and precision. Any non-conforming data were discussed in the data package cover letter and case narrative.

D.1.2 Data Validation

An independent data validator reviewed all data packages using the validation criteria defined by USEPA Contract Laboratory Program. USEPA Region II checklists were applied to the data to help the validator create a thorough and systematic approach to the validation process. As stated above, the data validation process was independent and separate from the laboratory's internal review. The process was specifically focused on the effects of the laboratory's performance and sample matrix on the analytical results. Areas of review consisted of holding time compliance, surrogate recovery accuracy, matrix spiked sample precision and accuracy, blank contamination, initial and continuing calibration accuracy and precision, laboratory control sample accuracy, internal standard response and retention time accuracy, instrument tune criteria accuracy, and duplicate sample precision (laboratory and field duplicates). Additionally, the analytical spectrum and raw data output were reviewed

and laboratory results selected by the validator were recalculated from the raw data to verify final laboratory quantitation.

When multiple analyses were performed, the analytical run with the lowest quantitation limits was selected by the validator, if the QC criteria were met for that analysis. If a sample was analyzed more than once as a result of concentrations exceeding the calibration range, the data validator selected results from the appropriate dilution. When multiple analyses were performed and QC criteria were outside of control limits for all analyses, the data validator selected results from the analytical run with the least number of exceptions or best possible QC.

D.1.2.1 Primary Data Validation Qualifiers

The following data validation qualifiers were applied to one or more analytical results:

- **U** - Not detected. Sample was analyzed for this parameter, but it was not detected above the reported quantitation limit. The data validator may also apply this qualifier to indicate that a concentration is attributed to blank contamination, but this qualifier does not necessarily indicate a quality control problem.
- **UJ** - Not detected, quantitation limit estimated. Sample was analyzed for this parameter, but it was not detected above the reported quantitation limit. The quantitation limit for this parameter is estimated.
- **UN** - Tentatively not detected. Matrix interference prevented the accurate recovery of an associated parameter in a spiked sample.
- **J** - Concentration estimated. The parameter was positively identified and the associated numerical value is the approximate concentration of the parameter in the sample.
- **R** - Rejected. The result was rejected because quality control limits were exceeded. The presence or absence of the parameter cannot be verified and the result is not usable as detected or not detected. R is also used to indicate an analytical result that is redundant because of reanalysis or dilution, in which case, there is no effect on the quality or usability of data.
- **(No qualifier present)** - Detected. Qualification was not warranted.

D.1.3 Data Quality Evaluation

The data quality evaluation consisted of an overall review by the Navy contractor project chemistry team of the analytical data for systematic errors. The distribution of data qualifiers and systematic errors is discussed below. The data quality is evaluated based on the number of, severity of, and distribution of these data qualifiers. The data qualifiers were compiled and the individual data validation reports were reviewed if clarification on a data quality issue was necessary.

D.1.3.1 Vieques Island Background Subsurface Soil Study Data

The purpose of this data quality evaluation is to summarize the findings of the data validation and any effects on the usability of the subsurface soil data as part of the Vieques

Island background soil sampling effort. This evaluation assesses the analytical results of the samples collected between June 19 and July 7, 2006.

D.1.3.1.1 Explosive Compounds

Explosives were analyzed by SW-846 8330. Excluding field quality control samples, 644 distinct data points were generated. The validation process resulted in the following qualifier summaries:

- 56.4 percent of explosives results were UJ-qualified as not detected, estimated quantitation limit because of low spike recovery in the laboratory control sample (LCS)
-
- 2.0 percent of explosives results were UJ-qualified as not detected, estimated quantitation limit because of continuing calibration percent difference exceedances
- 1.6 percent of explosives results were UJ-qualified as not detected, estimated quantitation limit because of low response in the continuing calibration
- 0.2 percent of explosives results were UN-qualified as tentatively not detected because of low recovery in the matrix spike.
- 0.2 percent of explosives results were UN-qualified as tentatively not detected because of laboratory duplicate precision
- 0.2 percent of explosives results were R-qualified as rejected because of large differences in quantitation between the primary and secondary analytical columns

D.1.3.1.1.1 Laboratory Control Sample Spike Recovery

The majority of data validation qualifiers for explosives were the result of low spike recoveries in the LCS. The non-detect results for 23 samples were UJ-qualified as not detected, estimated quantitation limit because of low spike recoveries for 14 parameters. Affected parameters consist of 1,3,5-trinitrobenzene, 1,3-dinitrobenzene, 2,4,6-trinitrotoluene, 2,4-dinitrotoluene, 2,6-dinitrotoluene, 2-amino-4,6-dinitrotoluene, 2-nitrotoluene, 3-nitrotoluene, 4-amino-2,6-dinitrotoluene, 4-nitrobenzene, HMX, nitrobenzene, RDX, and tetryl. No data were rejected as a result of LCS deficiencies, and UJ-qualification does not adversely impact data usability. UJ-qualified results are usable as non-detects.

D.1.3.1.1.2 Calibration

A total of 23 results were UJ-qualified because of continuing calibration deficiencies. Of this total, 13 results were UJ-qualified because of percent difference exceedances in the continuing calibration for 2,6-dinitrotoluene and 2,4,6-trinitrotoluene. The remaining 10 results were UJ-qualified because of a decrease in the response factor for 2,4-dinitrotoluene. No data were rejected as a result of calibration deficiencies, and UJ-qualification does not adversely impact data usability. UJ-qualified results are usable as non-detects.

D.1.3.1.1.3 Matrix Spike

One result was UN-qualified to indicate that it was tentatively not detected in the native sample as a result of low matrix spike recoveries. The only affected parameter was 2,4,6-trinitrotoluene. No data were rejected as a result of matrix spike deficiencies, and UN-qualification does not adversely affect data usability. UN-qualified results are usable as non-detects.

D.1.3.1.1.4 Laboratory Duplicate

One result was UN-qualified to indicate that it was tentatively not detected in the native sample but was detected in the laboratory duplicate. The only affected parameter was RDX. No data were rejected as a result of laboratory duplicate difference, and UN-qualification does not adversely affect data usability. UN-qualified results are usable as non-detects.

D.1.3.1.1.5 Dual-Column Reproducibility

One tetryl result was R-qualified as rejected because of a large percent difference between the primary and secondary analytical columns. This rejected result is not usable as a detect or non-detect, and are not used to make project decisions.

D.1.3.1.2 Total Metals

Total metals (inorganics) were analyzed by CLP ILM05.3. Excluding field quality control samples, 1,104 distinct data points were generated. The validation process resulted in the following qualifier summaries:

- 31.2 percent of metals results were detected and did not require qualification
- 36.2 percent of metals results were J-qualified as estimated
 - 13.1 percent of metals results were J-qualified because of high matrix spike recoveries
 - 11.1 percent of metals results were J-qualified because of serial dilution
 - 9.3 percent of metals results were J-qualified because they were below the quantitation limit
 - 0.9 percent of metals results were J-qualified because laboratory duplicate precision was outside control limits
 - 0.7 percent of metals results were J-qualified because of low matrix spike recoveries
 - 0.4 percent of metals results were J-qualified because field duplicate precision was outside control limits
 - 0.4 percent of metals results were J-qualified because of low continuing calibration response
 - 0.3 percent of metals results were J-qualified because of holding time exceedances
-
- 13.9 percent of metals results were U-qualified as not detected and attributable to blank contamination
- 2.6 percent of metals results were UJ-qualified as not detected, estimated quantitation limit because of low matrix spike recoveries
- 0.1 percent of metals results were UJ-qualified as not detected, estimated quantitation limit because of low continuing calibration response
- 1.4 percent of metals results were R-qualified as rejected because of high matrix spike recovery
- 0.4 percent of metals results were R-qualified as rejected because of holding time exceedances

D.1.3.1.2.1 Blank Contamination

One hundred fifty four results from the metals fraction, corresponding to 13.9 percent, were U-qualified as attributable to blank contamination because of beryllium, barium, cobalt, antimony, potassium, sodium, and thallium detections in associated blank samples. The U-

qualification of results because of blank contamination does not adversely affect the usability of data because the results are usable as non-detects.

D.1.3.1.2.2 Matrix Spike

One hundred eighty two results were J-qualified as estimated because of low or high matrix spike recoveries. Parameters associated with high matrix spike recoveries consisted of barium, cadmium, chromium, cobalt, copper, manganese, nickel, vanadium, and zinc. Parameters associated with low matrix spike recoveries consisted of arsenic and selenium. Fifteen additional results were R-qualified as rejected because of spike recoveries exceeding 200 percent. Affected parameters consisted of manganese and copper. Manganese was rejected in 10 samples and copper was rejected in 5 samples. Rejected results are not usable as detects or non-detects, and project decisions are not based upon them. However, the rejection of results does not affect the usability of non-rejected results in the same data set. Some rejected data is common for analytical data sets. Further, if there are sufficient non-rejected results, as is the case for the background subsurface soil data, several rejected results are inconsequential to the data usability. J-qualified results are usable as detects, and should be considered estimated by the data user without adversely affecting data usability.

D.1.3.1.2.3 Serial Dilution

One hundred twenty two results were J-qualified as estimated because of serial dilution reproducibility exceedances. Affected parameters consisted of iron, magnesium, potassium, sodium, and zinc. No data were rejected due to serial dilution exceedances. J-qualification of data does not adversely affect usability because the estimated results are usable as detects.

D.1.3.1.2.4 Quantitation Limits

One hundred three were J-qualified as estimated because the result was lower than the quantitation limit. These results should be considered estimated by the data user, but data usability is not adversely affected because J-qualified results are usable as detects.

D.1.3.1.2.5 Laboratory/Field Duplicate

Ten results were J-qualified as estimated because of laboratory duplicate precision exceeding CLP limits. Four results were J-qualified as estimated because of field duplicate precision exceeding data validation limits. These results should be considered estimated by the data user, but the J-qualification of results does not adversely affect the usability of data because the estimated results are usable as detects.

D.1.3.1.2.6 Holding Time

Three cyanide results were J-qualified as estimated because of holding time exceedances. Four additional cyanide results were R-qualified as rejected because of a holding time exceedance. These rejected results are not usable as detects or non-detects, and project decisions are not based upon them. However, the rejection of this cyanide results does not affect the usability of non-rejected cyanide results in the same data set. The three J-qualified results are usable as detects, and should be considered estimated by the data user without adversely affecting data usability.

D.1.3.1.2.7 Calibration

Four lead results were J-qualified as a result of Contract Required Detection Limit (CRDL) standard response below limits. One additional lead result was UJ-qualified as a result of CRDL standard response below limits. No data were rejected based on CRDL standards, and J- and UJ-qualified data should be considered estimated and non-detect, estimated

quantitation limit, respectively, by the data user. However, these results may be used as detects without adversely affecting data usability.

D.1.3.1.3 Wet Chemistry

Samples were analyzed by SW-846 9060 for Total Organic Carbon (TOC) and by SW-846 9045C for pH. Excluding field quality control samples, 92 distinct data points were generated. The validation process resulted in the following qualifier summaries:

- 100 percent of wet chemistry results did not require qualification as a result of the data validation process

D.2 Impact of Data Quality on Project Data Quality Objectives and Data Usability

The laboratory analyzed the samples in accordance with SW-846 and EPA CLP methods. The data packages were reviewed by an independent data validator using USEPA Region II validation checklists.

The “J” and “UJ” qualifiers indicate that some data values are estimated. These qualifiers do not indicate a problem that adversely affects the usability of the data. J-qualified data points are usable for evaluating the nature and extent of contamination and estimating potentially associated human health and ecological risks.

Several sample results were U-qualified to indicate associated blank contamination as a result of field and/or laboratory techniques or procedures. U-qualified sample results do not adversely affect data usability. Blank contamination was associated only with the metals fraction. Some of these metals, such as potassium and sodium, are essential human nutrients and not contaminants. Other metals found in this sampling event, such as antimony, beryllium, cadmium, and thallium, occur at low concentrations (with respect to analytical reporting limits) in the environment. Data points U-qualified because of blank contamination are usable as non-detects for evaluating the nature and extent of contamination and estimating potentially associated human health and ecological risks.

Two results were UN-qualified, which indicates that matrix interference affected the final quantitation of spiked samples. The result of this interference was the recovery of parameters below their respective control limits in matrix spike samples. This was reflected in the native sample by UN-qualification of the associated parameters. UN-qualification of data points does not adversely affect data usability because the results are usable as non-detects. Further only two results were UN-qualified.

The R-qualification of data indicates that a quality control issue has resulted in the rejection of a result. R-qualified results are not usable as detects or non-detects. R-qualification of results does not affect the data usability of other non-rejected results in the same analytical fraction or field sample. It is not uncommon that some data are rejected in large environmental sampling datasets. However, as stated previously, if there are sufficient non-rejected results, as is the case for the background subsurface soil data, several rejected results are inconsequential to the data usability.

D.2.1 PARCC

D.2.1.1 Precision

Precision is defined as the agreement between duplicate results, and was characterized by comparing duplicate matrix spike recoveries, native duplicates, and field duplicate sample results. Because no results were R-qualified based on MS/MSD precision, laboratory duplicates, or field duplicates, the sample matrix did not interfere with the analytical process or adversely affect precision.

D.2.1.2 Accuracy

Accuracy is a measure of the agreement between an experimental determination and the true value of the parameter being measured. For organic analyses, each sample was spiked with surrogate compounds; and for organic and inorganic analyses, an MS/MSD and LCS were spiked with a known parameter concentration before preparation. Surrogates and MS/MSD provide a measure of the matrix effects on the analytical accuracy. LCS demonstrates accuracy of the method and the laboratory's ability to meet the method criteria. In some cases, the LCS was characterized by slight exceedances, which resulted in the J- or UJ-qualification of data. J- or UJ-qualification of data points does not affect the usability of data because the qualified points are usable as detects and non-detects, respectively. However, in some cases, the MS/MSD was characterized by recovery high enough to warrant the R-qualification of results as rejected. Results R-qualified because of MS/MSD are not usable as detects or nondetects, but they represent only a small portion of the background data (manganese or copper in 15 samples). All non-rejected data, including results from the same samples and analytical fractions, are still usable as qualified with no adverse effect on data usability.

D.2.1.3 Representativeness

Representativeness is a qualitative measure of the degree to which sample data accurately and precisely represent a characteristic environmental condition (in this case, background). Representativeness is a subjective parameter and is used to evaluate the efficacy of the sample planning design. In terms of data quality, representativeness was assured because the sampling team following approved standard operating procedures for sample collection and handling, and the laboratory followed approved standard operating procedures for sample handling, preparation, and analysis.

D.2.1.4 Completeness

Completeness is defined as the percentage of measurements that are judged to be valid compared to the total number of measurements made. USEPA National Functional Guidelines for Organic and Inorganic Data Review and Region II RCRA and CERCLA Data Validation SOPs designate all results except those R-qualified as rejected to be usable. The compilation of data demonstrates that 98.9 percent of the data are usable as qualified.

D.2.1.5 Comparability

Comparability is a qualitative measure designed to express the confidence with which one data set may be compared to another. Factors that affect comparability are sample collection and handling techniques, sample matrix, and analytical methods. In this case, because

approved standard operating procedures were used for sample collection and handling, a common sample matrix was evaluated (subsurface soil), and SW-846 and CLP methods were utilized, the data user may express confidence in the fact that this data set is comparable to others of high data quality. In addition, comparability is controlled by the other PARCC parameters because data sets can be compared with confidence only when precision and accuracy are known. Because precision and accuracy were demonstrated to be acceptable for the subsurface soil data, with the exception of the few rejected results, the data user may be confident that this data set is comparable to others of high data quality.

D.2.2 Validation Qualifier Summary

The data evaluation showed that the laboratory U-qualified 30.8 percent (567 results) of the data as non-detect and further qualification was not warranted. Another 23.7 percent (436 results) were detected and no further qualification was warranted. The percentage of non-detects UJ-qualified as estimated amounted to 22.6 percent (416 results). The majority of UJ-qualified results (363 results) were attributed the low LCS recoveries in the explosives fraction. The remaining UJ-qualifiers were distributed among calibration and matrix spike recovery values in both the metals and explosives fractions. A total of 8.4 percent (154 results) were U-qualified as non-detect as a result of blank contamination. The percentage of detected results J-qualified as estimated was 21.7 percent (399 results), and consisted of qualifiers for serial dilution, sample duplicate reproducibility, method holding times, continuing calibration, and matrix spike recoveries. The majority of rejected data, 19 out of 1,104 results, occurred in the metals fraction. Fifteen results were R-qualified as a result of high matrix spike recoveries. Four cyanide results were R-qualified because of a holding time exceedance. A single explosive result (out of 644 results) was R-qualified as rejected because of the difference in quantitation between the primary and secondary analytical columns in the explosives fraction.

The overall conclusion is that the dataset generated is acceptable and appropriate for its intended use with the removal of the rejected data, which constitute less than 1 percent of the data.

APPENDIX E

Final Responses to EPA and PREQB Comments

**Environmental Protection Agency
Technical Evaluation**

***Draft East Vieques Background Soil Inorganics Investigation Report
Former Vieques Naval Training Range, Vieques Island, Puerto Rico
January 2007***

The comments presented herein are a combination of comments verbally provided to the Navy during the April 24, 2007 Vieques Environmental Restoration Program Technical Subcommittee Meeting at EPA Region II headquarters in New York and those provide through EPA by the National Exposure Research Laboratory (NERL).

Comments from April 24, 2007 Meeting

1. Add a sentence that outlier analysis was done on all inorganics.

Navy Response: The following sentence was added as the second sentence of the first paragraph in Section 3.2.2: “Outlier analysis was performed for all inorganics detected in each soil type.”

2. Add a section with an inorganic-by-inorganic discussion, including the statistical results, surface versus subsurface results, and outliers, as applicable.

Navy Response: A section with the above information has been added to the report. See Section 3.4 of the revised report.

3. Discuss outliers in the context of potential contaminants.

Navy Response: As discussed in the meeting, the outliers are most likely part of the true background, representing the “upper tail” of the actual background concentrations, and are not indicative of isolated releases of contaminants. This information is in the third paragraph of Section 3.2.2.1 and is part of the inorganic constituent-by-constituent discussion in Section 3.4.

4. Add text that explains why outliers are eliminated from the background UTL calculations.

Navy Response: As concurred upon during the meeting, text has been added to clearly state that a widely accepted, conservative threshold value was set for outlier identification and that it is very likely that true background levels are higher than that level. In other words, these values may very well be part of the actual background dataset, but to be conservative, the outliers are eliminated from the background UTL calculations to ensure the UTLs are not inappropriately elevated. The third paragraph of Section 3.2.2.1 has been modified as follows: “It is important to note that the outliers may actually be part of the normal background population of data. Outlier identification was performed by

establishing a widely accepted, conservative significance value of 0.05 and eliminating any constituent concentration that exceeded this significance value (via the outlier test) from the background UTL calculation. While this process likely eliminates true background “upper tail” concentrations from the background UTL calculations, it does provide a conservative measure to avoid elevating the background UTLs in case outlier concentrations are not representative of background. In addition to eliminating outliers from the background UTL calculations, the outliers were compared to EPA Region IX preliminary remediation goals (PRGs) and, as applicable, to the concentrations of the same inorganics in the other soil type groupings. These comparisons are discussed in Section 3.4.”

5. Compare outliers to risk-based numbers.

Navy Response: All outlier concentrations were compared to EPA Region IX PRGs. These comparisons are provided in the inorganic constituent-by-constituent discussion in Section 3.4.

6. Explain that calcium, sodium, potassium, and magnesium variability is likely due to their relatively higher solubility relative to salts of the other inorganics.

Navy Response: The above information has been incorporated into the inorganic constituent-by-constituent discussion in Section 3.4.

7. In Figure 1-4, add the Kv designation to the Kv zone.

Navy Response: The “Kv” designation has been added to the Kv zone in Figure 1-4.

8. The data show that there are not numerous inorganics with surface soil concentrations higher than subsurface soil concentrations; therefore, there is no broad indication of widespread aerial deposition. Add a statement about this and note that the lead in soil is below risk based criteria.

Navy Response: The following text has been added at the end of Section 3.2.1: “Based on the statistical evaluation of soil depths, the surface soil concentrations are statistically similar to the subsurface soil concentrations for all inorganics except cyanide, lead, potassium, and sodium. In reality, the surface soil and subsurface soil cyanide concentrations are also similar (i.e., 1.24 mg/kg [SS] versus 1.36 mg/kg [SB] for the KTd-Kv-Qa soil grouping and 1.03 mg/kg [SS] versus 0.98 mg/kg [SB] for the TI soil type), but are separated into surface soil and subsurface soil for UTL calculations to ensure consistent application of the statistical process for all inorganics. That they were subdivided into SS and SB groupings is simply due to the low concentrations detected, which result in high percent differences between the concentrations.

For sodium and potassium, the differences in mean surface versus subsurface soil concentrations (i.e., 363 mg/kg [SS] versus 484 mg/kg [SB] for sodium, and 1,650 mg/kg [SS] versus 892 mg/kg [SB] for potassium) likely reflect the natural leaching of these generally mobile constituents, as well as differences in depositional and post-depositional environments of the rocks and degree of soil development, especially considering that

sodium and potassium are prevalent cations in seawater and sodium is a common cation in rainfall in this type of environment.

Like potassium, the mean lead concentration in surface soil is higher than that in the subsurface soil (i.e., 2.3 mg/kg [SS] versus 1.2 mg/kg [SB] for the KTd-Kv-Qa soil grouping, and 6.2 mg/kg [SS] versus 3.3 mg/kg [SB] for the TI soil type). Unlike potassium, however, the reason for this is likely natural and anthropogenic. Under natural soil forming processes, lead is one of the least mobile metals in a surface soil environment because it is strongly adsorbed to the ubiquitous iron oxide (the reason for the soil color); it precipitates as the essentially insoluble lead carbonate mineral cerussite; and it also precipitates as a very insoluble lead phosphate suite of minerals called pyromorphite. Lead therefore can be higher in soils than in the natural substrate (i.e., rock) through accumulation in these forms.

Since the 1920s, regional and global use of lead as an additive in gasoline resulted in abnormally high lead levels in the atmosphere. According to a statement on EPA's website, the largest source of lead in the atmosphere has been leaded gasoline combustion. This fact, and the potential health and environmental risks associated with lead, paved the way for the leaded gasoline phase-down provision of the 1970 Clean Air Act. It is important to note, however, that even though the mean lead concentration in background surface soil is higher than in the subsurface soil, even the highest lead concentration detected in all the background samples (10.6 mg/kg) is more than an order of magnitude lower than EPA's lead action level of 400 mg/kg.

Other than lead and potassium, none of the remaining inorganics displays statistically higher concentrations in the surface soil than in the subsurface soil. This indicates that the background sample locations have not been influenced by widespread aerial deposition (other than potentially by lead, as described above)."

9. Consider looking at the reports discussed and referenced in Section 1.3.2 of the NOAA crab study (USGS 2001 soil study on Mainland Puerto Rico, Learned et. al. study in Puerto Rico).

Navy Response: The Learned *et. al.* study was consulted and included in the lead discussion in Section 3.4.

10. Make note that there are some samples that are shown on the map to be in a different geologic zone than the sample type. Make note in the text that the geologic zone lines are not accurate to within that small a scale, but that the soil types collected accurately reflect the soil designations intended.

Navy Response: The following text was added at the end of Section 1.2: "Several of the samples shown in Figures 1-3 and 1-4 are shown to lie within a different geologic zone than their designations indicate. However, the geologic zone boundaries shown on the figures are not accurate to within that small a scale. A site visit was made to each sample location to ensure that the soil types collected accurately reflect the soil designations intended."

Comments from NERL

The full letter report provided by NERL is attached to these responses. Below are the summary and recommendations provided by NERL.

1. Based upon the independent analyses (summarized in this letter report) for some of the inorganic compounds, it is noted that appropriate statistical methods have been used by the Navy to compare two or more populations (concentrations in geological zones and surface and subsurface soils).

2. It is also noted that outlier analyses have been conducted for some of the analytes (e.g., arsenic and lead). Since outliers often distort the statistics of interest (background statistics – UTLs here), it is suggested that outlier analyses be performed for all analytes. The project team and experts familiar with the site and background conditions may decide about the proper disposition of outliers.

Navy Response: Outlier analysis was performed on all analytes. To clarify, the following sentence was added as the second sentence of the first paragraph in Section 3.2.2: “Outlier analysis was performed for all inorganics detected in each soil type.”

3. For analytes with all observations below the detection limit(s), an estimate of the background threshold value (BTV) should also be considered as a nondetect value. It is not advisable to use substitution methods (e.g., replacement by detection limits (DLs), or ½ DLs) to compute summary statistics and background statistics such as UTLs.

Navy Response: Antimony was the only inorganic that was not detected in any of the samples. Therefore, no background value was calculated for this constituent. Any site-specific detection of antimony will be evaluated on a case-by-case basis.

4. For analytes with both detected and nondetected observations (censored data sets), appropriate statistical methods should be used to compute summary and background statistics (e.g., see Singh, Maichle, and Lee, 2006).

Navy Response: The ProUCL Version 4.0 software referred to in the comment has not been released on EPA’s website yet. Only beta testing copies have been released to the public for comment. The 2006 reference provided does not cover background threshold values; rather, it covers calculation of 95% upper confidence limits of the mean (although some of the approaches in handling non-detects, etc. are included in that reference). Further, the statistical methods used to calculate summary statistics for inorganics with both detected and non-detected results were appropriate. They are well-documented, peer-reviewed, widely used methods.

Review of the Draft East Vieques Background Soil Inorganics Investigation Report

Lockheed Martin, 4/12/2007

Mr. M. Sivak of USEPA, Region 2 requested the assistance of Technical Support Center (TSC), NERL Las Vegas, NV in reviewing the statistical methods used by CH2MHILL (for NAVFAC ATLANTIC) to analyze inorganics soil data collected from the Former Vieques Naval Training Range, Vieques Island, Puerto Rico. In order to provide comments on the methods used and conclusions derived by the Navy, the reviewers also performed an independent analysis for some of the inorganic compounds. ProUCL 4.0 (EPA 2007) software was used to perform background comparisons, and to estimate background threshold values (e.g., UTLs, UPLs) for the various soil groups. This letter report describes reviewers' comments *only on the statistical methods* used by CH2MHILL for NAVFAC ATLANTIC, Department of the Navy.

Data

The data for the East Vieques Background Soil was obtained from the website, <http://vieques.lantops-ir.org/>. There are two types of soils, Surface Soil (SS) and Subsurface Soil (SB), divided into 4 geological zones, KTD, KV, QA and TI. Twenty (20) background samples (10 surface and 10 subsurface) from each of the 4 soil zones (a total of 80 samples for the 4 zones combined) were collected for background comparisons and characterization. One sample from zone TI for the soil group SB was not collected (resulting in 79 samples) due to shallow bedrock. Tables 3.1 and 3.2 of the CH2MHILL draft report (dated January, 2007) describe the summary statistics for the various inorganic constituents analyzed for the soil groups SS and SB, respectively. For some locations, duplicate samples were collected. In such cases, higher value was retained and used in the analyses by CH2MHILL.

For this letter report, the reviewers also used the higher duplicate value, even though the use of the average of the duplicate samples is commonly used in practice.

Constituents Compared in this Report

In this letter report, the reviewers considered seven constituents (with nondetects and potential outliers) namely, Aluminum, Antimony, Arsenic, Cyanide, Lead, Silver and Zinc, to verify the assumptions, computations (e.g., Table 3.10 of Navy Report) and analyses described in the Draft Navy Report (January, 2007). For verification, ProUCL 4.0 software has been used for the graphical displays and various computations as given in appendices A and B, respectively.

Comparative study

The concentrations for the 4 geological zones, KTD, KV, QA and TI 4 need to be compared to determine if the soils from the 4 zones can be considered as coming from a single background population. This can be formally done using Analysis of Variance (ANOVA) as used by the Navy. Additionally, informal graphical comparisons can also be used to compare two or more groups. The use of graphical displays often identifies outliers and other abnormalities that might be present in data sets. Therefore, for verification purposes,

reviewers only used side-by-side box plots to compare two or more populations. Some of those graphical displays are given in Appendix A.

Side-by-side boxplots are also used to graphically compare the concentrations of the surface and subsurface soil samples. If no significant differences are found in surface and subsurface concentrations, the concentrations for the 2 depth levels can be merged together to compute and estimate the background threshold values. For verification of the results, reviewers performed two sample comparisons (t-test, Wilcoxon Mann Whitney test). All background statistics have been computed using ProUCL 4.0 for data sets with and without nondetect observations. Some of those results are given in Appendix B.

Background Statistics for Aluminum

The boxplots in Figures 1 and 2 of Appendix A suggest that there are no significant differences between the aluminum concentrations in soils from the four geological zones for each group: surface and subsurface. Table 3.7 of Navy’s draft report suggests the same. This observation leads to the conclusion that the concentration data from the 4 soil zones can be merged together to compute a single background threshold value for surface and subsurface soil.

Table 1 describes a quick comparison of the summary statistics. The first column has the parameter list of the combined background population. The second column gives the statistics from Table 3.10 of the draft Navy report, and the third column shows the ProUCL 4.0 results obtained using the combined background data set of size 79.

TABLE 1

Aluminum		
	Report	ProUCL
Mean	13100	13038
Median	10600	10600
Std.dev	7920	7874
Min. RL	NN*	NN*
Max. RL	NN*	NN*
Min. Det	2340	2340
Max. Det	41500	41500
# of Det	79	79
# of Samples	79	79
% Detects	100	100
Normality p	0	
Lognormal p	0.9253	
Distribution	Lognormal	Lognormal
95% Con UTL	35000	34701

*NN – No Nondetects

NA – Not Available

The minor differences in the statistics summarized in Table 1 are due to rounding of the numbers. It seems like that the Navy has rounded up the values.

For comparisons of aluminum soil concentrations from the 4 geological zones and depth levels (surface and subsurface), the reviewers concur with the results and conclusions derived by the Navy as summarized in the Draft Vieques Background Report.

Background Statistics for Antimony (An)

Surface and subsurface soil data for Antimony from the 4 geological zones consist of only nondetect observations. Therefore, all summary statistics and other statistics such as background statistics (UTLs, UPLs) will also be nondetects. For a rough comparison, substitution method (replacing values by the respective detection limits) has been used to obtain side-by-side boxplots for four zones as given in Figures 3 (surface soil) and 4 (subsurface soil) of Appendix A. These boxplots show the maximum detection limits.

The two boxplots shown in Figures 3 and 4 suggest that for all practical purposes, there are no significant differences between the Antimony concentrations (all are nondetects) in four zones for each soil group. A quick comparison of the statistics based upon the combined data (for 4 zones) is summarized in Table 2 below. The Navy has computed some of the summary statistics using substitution methods. It should be pointed out such fabricated values may not be used in site versus background comparisons.

TABLE 2

Antimony		
	Report	ProUCL
Mean	3.46	Nondetect
Median	3.35	Nondetect
Std.dev	0.397	Nondetect
Min. RL	5.8	5.8
Max. RL	9.7	9.7
Min. Det	NA	NA
Max. Det	NA	NA
# of Det	0	0
# of Samples	79	79
% Detects	0	0
Normality p	0	-
Lognormal p	0.0001	-
Distribution	N P	-
95% Con UTL	NA	Nondetect

Since all values are reported as nondetects, an estimate of the background threshold value (BTV) should also be considered as a nondetect value. The same approach should be used for all other analytes without any detected observations.

For analytes with all observations below the detection limit(s), an estimate of the background threshold value (BTV) should also be considered as a nondetect value.

It is not advisable to use substitution methods (e.g., replacement by detection limits) to compute summary statistics and background statistics such as UTLs.

Note: *For data sets with nondetect observations, ProUCL 4.0 (an upgrade of ProUCL 3.0) software has several methods such as Kaplan-Meier method, ROS methods, and bootstrap methods that may be used to compute the various summary statistics and upper threshold values such as UPLs, UTLs, and also UCLs.*

Background Statistics for Arsenic

From Figures 5 and 6 of Appendix A, it is noted that for surface as well as subsurface soil samples, the arsenic concentrations in TI zone are higher than those found in the other 3 zones: KTD, KV, and QA. Therefore, the analysis (e.g., computing UTL) for the geological zone TI is conducted separately. From Figures 5 and 6, it is noted that one of the observation in QA zone (in both SS and SB soils) may be a statistical outlier. This outlier can also be seen in Figures 7 and 8. The Q-Q plot of the combined data (with nondetects in red) for the three zones is given in Figure 8a of Appendix A. A quick review of Figure 8a suggests the presence of several nondetects. The computations have been performed using data with (Table 3) and without (Table 4) outliers.

The Navy may want to use formal outlier identification tests. The project team should decide about the disposition of outliers: include or not include in computation of UTL.

The side-by-side boxplots for the three zones (KTD, KV, and QA) are given in Figures 7 (Surface soil) and 8 (Subsurface soil) of Appendix A. These figures suggest that the data from these 3 zones may be merged together to compute a single estimate of the BTV for the background population thus obtained (KTD, KV, and QA). The summary statistics and estimates of BTVs for the three zones (KTD, KV, and QA) combined together are given in Table 3 (with outliers). Table 4 shows the corresponding statistics and estimates obtained without the outliers.

TABLE 3 (WITH OUTLIERS)

Arsenic KTD_KV_QA		
	Report	ProUCL With outliers
Mean	0.629	0.865
Median	0.55	1.11
Std.dev	0.231	0.804
Min. RL	0.96	
Max. RL	1.3	
Min. Det	0.47	0.47
Max. Det	1.6	5
# of Det	21	26
# of Samples	53	60
% Detects	40	43.33
Normality p	0	
Lognormal p	0	
Distribution	N P	N P
95% Con UTL	1.6	2.486

TABLE 4 (WITHOUT OUTLIERS)

Arsenic KTD_KV_QA		
	Report	ProUCL without outliers
Mean	0.629	0.635
Median	0.55	0.595
Std.dev	0.231	0.163
Min. RL	0.96	
Max. RL	1.3	
Min. Det	0.47	0.47
Max. Det	1.6	1.1
# of Det	21	20
# of Samples	53	53
% Detects	40	37.74
Normality p	0	
Lognormal p	0	
Distribution	N P	
95% Con UTL	1.6	0.967

Figure 9 of Appendix A suggests that the surface and subsurface arsenic data from TI zone can be combined together to compute the background statistics. The corresponding statistics for TI Zone are given below in Table 5.

TABLE 5

Arsenic TI		
	Report	ProUCL
Mean	4.1	4.066
Median	3.8	3.8
Std.dev	2.09	2.088
Min. RL	NN	
Max. RL	NN	
Min. Det	1.3	1.2
Max. Det	9.6	9.6
# of Det	19	19
# of Samples	19	19
% Detects	100	100
Normality p	0.1153	
Lognormal p	0.8206	
Distribution	Normal	Normal
95% Con UTL	9.17	9.126

It is noted that arsenic data for zones (KTD, KV, and QA) has several nondetect observations. Therefore, summary statistics and UTLs (given in Tables 3 and 4) should be computed using appropriate methods such as the Kaplan-Meier (KM) method. The

background statistics (ProUCL 4.0 output) for arsenic (KTD, KV, and QA) are given in Appendix B. ProUCL 4.0 computes the summary statistics using appropriate statistical methods developed for data sets with nondetect observations.

It is suggested that for data sets with nondetect observations, the Navy computes background statistics using appropriate statistical methods (instead of simple substitution methods) as incorporated in ProUCL 4.0. The details of those methods can be found in Singh, Maichle, and Lee (2006).

Background Statistics for Cyanide

The side-by-side boxplots for Cyanide are given in Figures 10, 11, and 12 in Appendix A. Background statistics for Zone TI are computed separately from the other three zones. Cyanide data from the various zones have several nondetect observations. The background statistics for the combined data set for zones: KTD, KV, and QA are given in Table 6, and background statistics for zone TI are given in Table 7.

TABLE 6

Cyanide KTD_KV_QA		
	Report	ProUCL
Mean	1.3	0.353
Median	1.4	0.255
Std.dev	0.352	0.269
Min. RL	2.6	
Max. RL	3.3	
Min. Det	0.19	0.19
Max. Det	0.89	0.89
# of Det	6	6
# of Samples	56	54
% Detects	11	10
Normality p	0	
Lognormal p	0	
Distribution	N P	N P
95% Con UTL	0.89	0.848

TABLE 7

Cyanide TI		
	Report	ProUCL
Mean	1.01	0.453
Median	0.855	0.41
Std.dev	0.675	0.241
Min. RL	2.7	
Max. RL	4.1	
Min. Det	0.24	0.24
Max. Det	1	0.985
# of Det	10	10
# of Samples	18	19
% Detects	56	52.63
Normality p	0.0135	
Lognormal p	0.0166	
Distribution	N P	N P
95% Con UTL	1	1.007

Background Statistics for Lead

The graphical displays for lead are given in Figures 15, 16, and 17 of Appendix A. The lead concentrations in surface soils seem to be higher than those found in subsurface soils. This can be seen from two sample test results (obtained using ProUCL 4.0) summarized in Appendix B. The background statistics for surface (SS) and subsurface (SB) data for three zones: KTD, KV, and QA are summarized in Tables 8 and 9 below. The background statistics for zone TI are given in Tables 10 (SS) and 11 (SB).

TABLE 8

Lead KTD_KV_QA_SS		
	Report	ProUCL
Mean	2.29	2.283
Median	2.05	2.05
Std.dev	0.964	0.968
Min. RL	NN	
Max. RL	NN	
Min. Det	0.98	0.94
Max. Det	4.5	4.5
# of Det	30	30
# of Samples	30	30
% Detects	100	100
Normality p	0.0401	
Lognormal p	0.335	
Distribution	Lognormal	Lognormal
95% Con UTL	5.4	5.453

TABLE 9

Lead KTD_KV_QA_SB		
	Report	ProUCL
Mean	1.2	1.277
Median	1.05	1.1
Std.dev	0.646	0.525
Min. RL	1	
Max. RL	1.11	
Min. Det	0.57	0.57
Max. Det	3	3
# of Det	24	24
# of Samples	30	30
% Detects	80	80
Normality p	0.0046	
Lognormal p	0.1467	
Distribution	Lognormal	Lognormal
95% Con UTL	3.34	3.206

TABLE 10

Lead_Tl_SS		
	Report	ProUCL
Mean	6.18	6.15
Median	6.25	6.25
Std.dev	3.38	3.357
Min. RL	NN	
Max. RL	NN	
Min. Det	1.3	1.3
Max. Det	10.6	10.6
# of Det	10	10
# of Samples	10	10
% Detects	100	100
Normality p		
Lognormal p		
Distribution	Normal	Normal
95% Con UTL	16	15.92

TABLE 11

Lead_Tl_SB		
	Report	ProUCL
Mean	3.28	3.232
Median	1.8	1.8
Std.dev	2.47	2.469
Min. RL	NN	
Max. RL	NN	
Min. Det	1.1	0.99
Max. Det	7.7	7.7
# of Det	9	9
# of Samples	9	9
% Detects	100	100
Normality p	0.0475	
Lognormal p	0.0614	
Distribution	N P	N P
95% Con UTL	7.7	7.7

Background Statistics for Silver

The boxplots for Silver are given in Figures 13 and 14 of Appendix A. Data from all zones for surface and subsurface soils were combined to compute background statistics for silver. The summary and background statistics for Silver are given in Table 12.

TABLE 12

Silver		
	Report	ProUCL
Mean	0.512	1.008
Median	0.55	1.1
Std.dev	0.176	0.397
Min. RL	0.96	
Max. RL	1.6	
Min. Det	0.078	0.078
Max. Det	0.22	0.22
# of Det	12	12
# of Samples	79	79
% Detects	15	15.19
Normality p	0	
Lognormal p	0	
Distribution	N P	N P
95% Con UTL	0.22	0.22

As can be seen from Table 12, there are some differences in the mean and standard deviation obtained using ProUCL 4.0. ProUCL 4.0 computes the summary statistics using appropriate methods (e.g., KM method) developed for data sets with nondetect observations.

As mentioned before, it is suggested that the Navy computes background statistics using appropriate statistical methods (instead of simple substitution methods) as incorporated in ProUCL 4.0. The details of those methods can be found in Singh, Maichle, and Lee (2006).

Background Statistics for Zinc

The boxplots for zinc data are given in Figures 18 (surface soil) and 19 (subsurface soil) of Appendix A. Outlier analysis was also performed on the combined data set. Three outliers have been found in the combined zinc data set of size 79. This can be easily seen in Figure 20. These three outliers also distorted the normality of the data set. The normality test without the outliers is given in Figure 21. The background statistics are computed without the 3 outliers. The summary statistics including 95%-95% UTL thus obtained (without 3 outliers) match with the Navy report as can be seen in Table 13.

TABLE 13

	Zinc	
	Report	ProUCL
Mean	17.9	17.74
Median	17.2	17.2
Std.dev	7.17	7.143
Min. RL	NN	
Max. RL	NN	
Min. Det	4	3.6
Max. Det	35	122
# of Det	76	79
# of Samples	76	79
% Detects	100	100
Normality p	0.3923	
Lognormal p	0.0073	
Distribution	Normal	Normal
95% Con UTL	32	31.81

Summary and Recommendations

- Based upon the independent analyses (summarized in this letter report) for some of the inorganic compounds, it is noted that appropriate statistical methods have been used by the Navy to compare two or more populations (concentrations in geological zones and surface and subsurface soils).
- It is also noted that outlier analyses have been conducted for some of the analytes (e.g., arsenic and lead). Since outliers often distort the statistics of interest (background

statistics – UTLs here), it is suggested that outlier analyses be performed for all analytes. The project team and experts familiar with the site and background conditions may decide about the proper disposition of outliers.

- For analytes with all observations below the detection limit(s), an estimate of the background threshold value (BTV) should also be considered as a nondetect value. It is not advisable to use substitution methods (e.g., replacement by detection limits (DLs), or $\frac{1}{2}$ DLs) to compute summary statistics and background statistics such as UTLs.
- For analytes with both detected and nondetected observations (censored data sets), appropriate statistical methods should be used to compute summary and background statistics (e.g., see Singh, Maichle, and Lee, 2006).

Note: For data sets with nondetect observations, ProUCL 4.0 (an upgrade of ProUCL 3.0) software has several methods such as Kaplan-Meier method, ROS methods, and bootstrap methods that may be used to compute the various summary statistics and upper threshold values such as UPLs, UTLs, and also UCLs.

References

ProUCL 3.0. (2004). *A Statistical Software*. National Exposure Research Lab, EPA, Las Vegas Nevada, October 2004. The software ProUCL 3.0 can be freely downloaded from the EPA website: <http://www.epa.gov/nerlesd1/tsc/tsc.htm>

Singh, A., Maichle, R., and Lee, S. 2006. *On the Computation of a 95% Upper Confidence Limit of the Unknown Population Mean Based Upon Data Sets With Below Detection Limit Observations.* , EPA/600/R-06/022, March 2006.

APPENDIX A

Graphical Comparisons of Two or More Soil Groups Using ProUCL 4.0

Aluminum

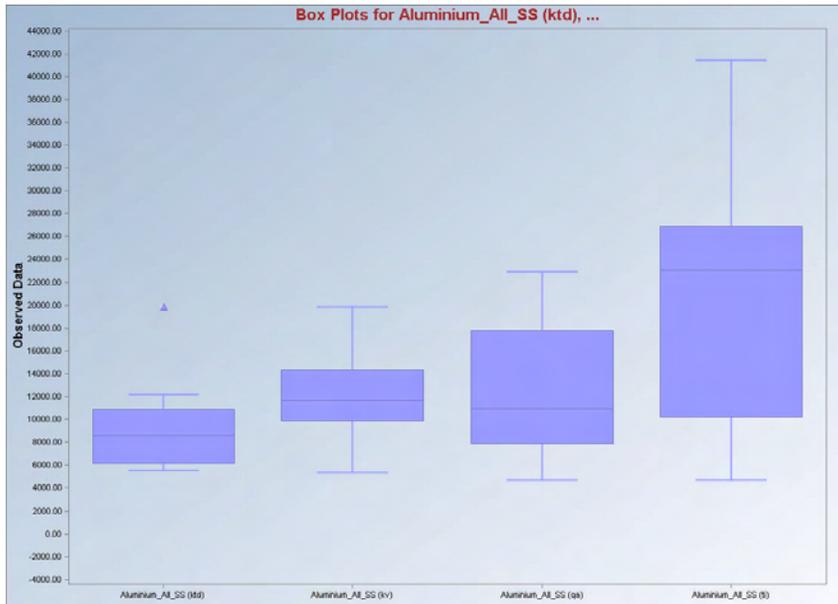


FIGURE 1: BOXPLOTS FOR AL FOR ALL 4 ZONES IN SS

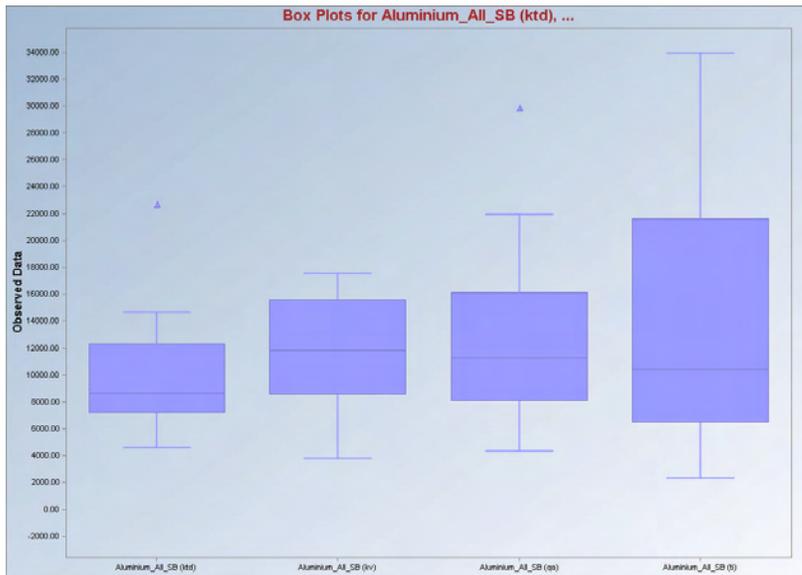


FIGURE 2: BOXPLOTS FOR AL FOR ALL 4 ZONES IN SB

Antimony



FIGURE 3: BOXPLOTS FOR ALL 4 ZONES IN SS

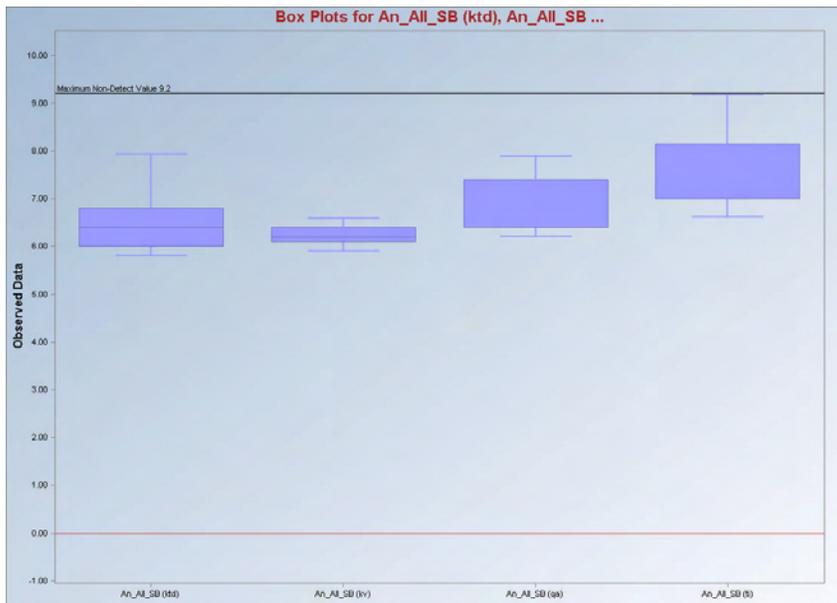


FIGURE 4: BOXPLOTS FOR ALL 4 ZONES IN SB

Arsenic

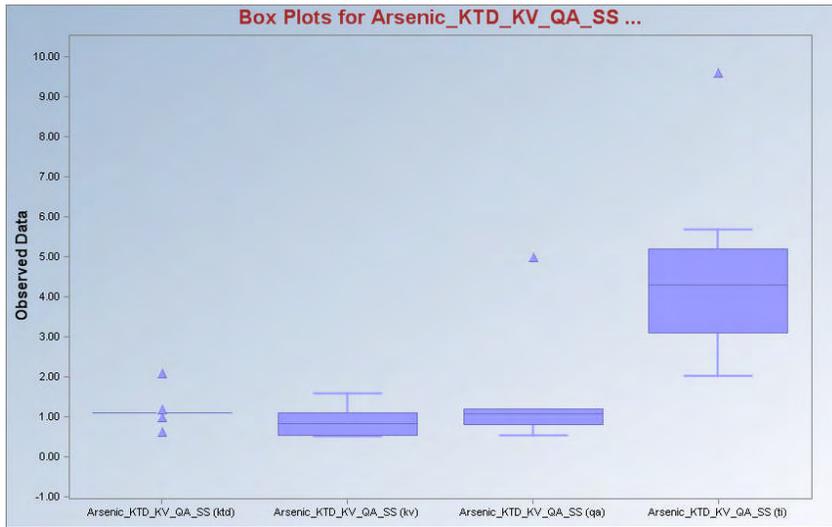


FIGURE 5: BOXPLOTS FOR ALL 4 ZONES IN SS

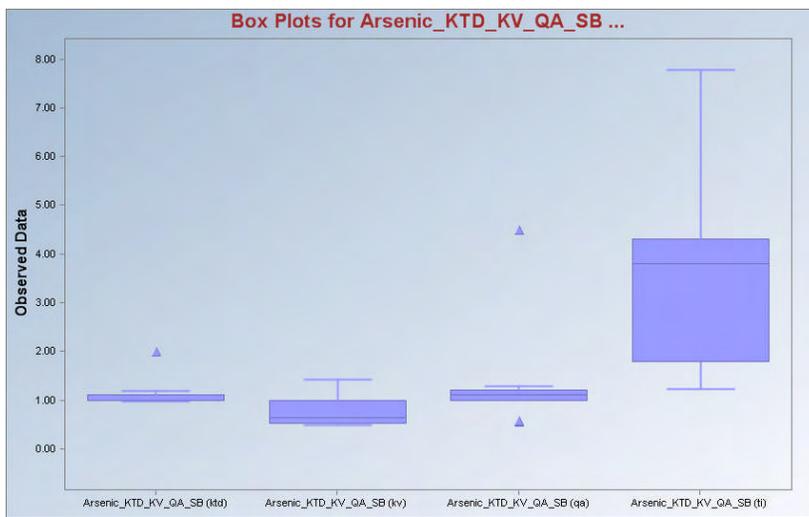


FIGURE 6: BOXPLOTS FOR ALL 4 ZONES IN SB

Arsenic

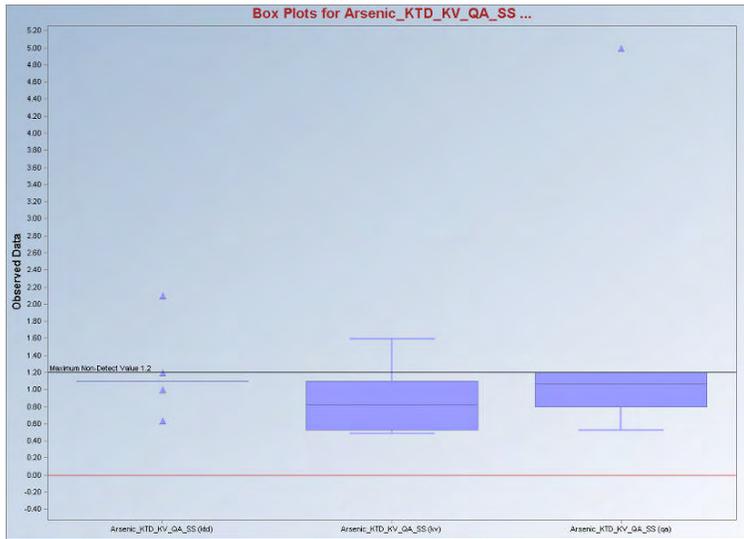


FIGURE 7: BOXPLOTS FOR AS FOR KTD, KV AND QA ZONES IN SS.

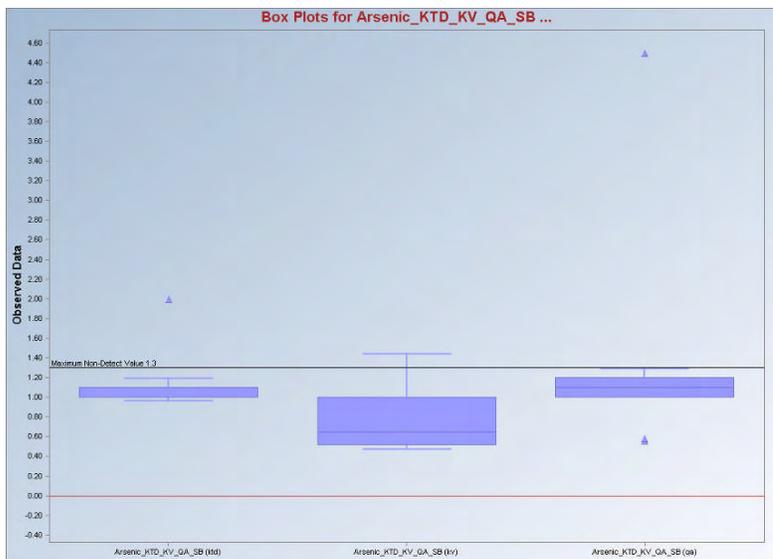


FIGURE 8: BOXPLOTS FOR AS FOR KTD, KV AND QA ZONES IN SB.

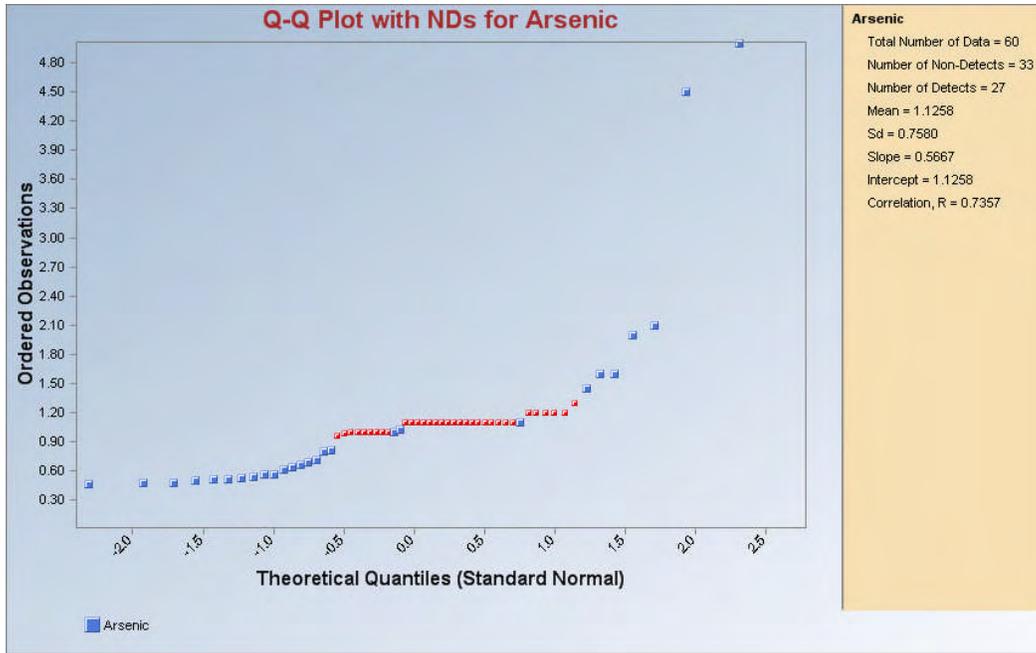


FIGURE8A. Q-Q PLOT FOR ARSENIC (KTD, KV, QA) WITH NONDETECTS IN RED

Arsenic

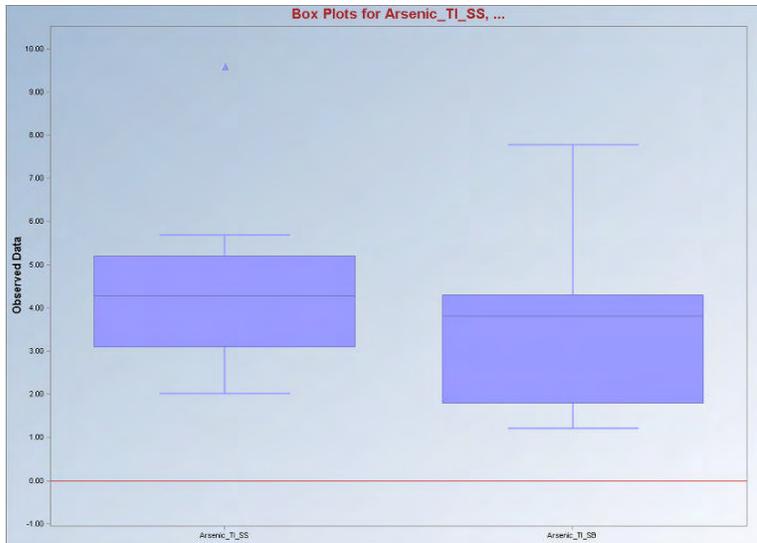


FIGURE 9: BOXPLOTS FOR AS FOR TI ZONE IN SS AND SB.

Cyanide

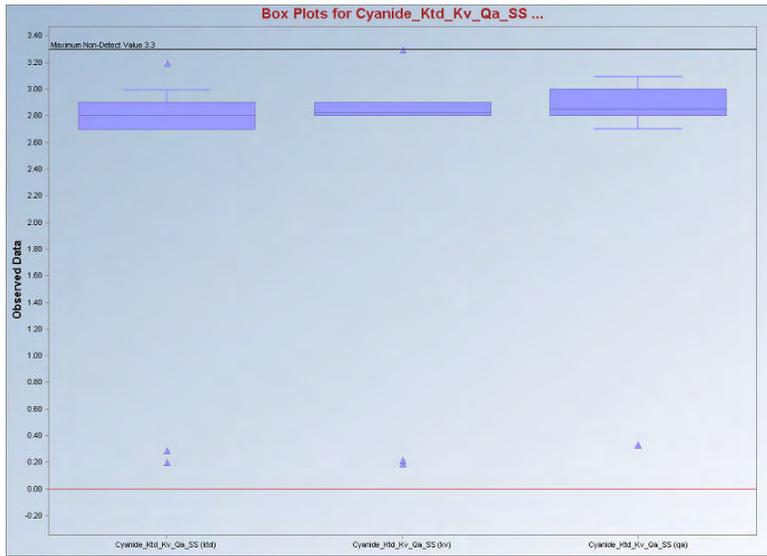


FIGURE 10: BOXPLOTS FOR CYANIDE FOR KTD KV AND QA ZONES IN SS.

Cyanide

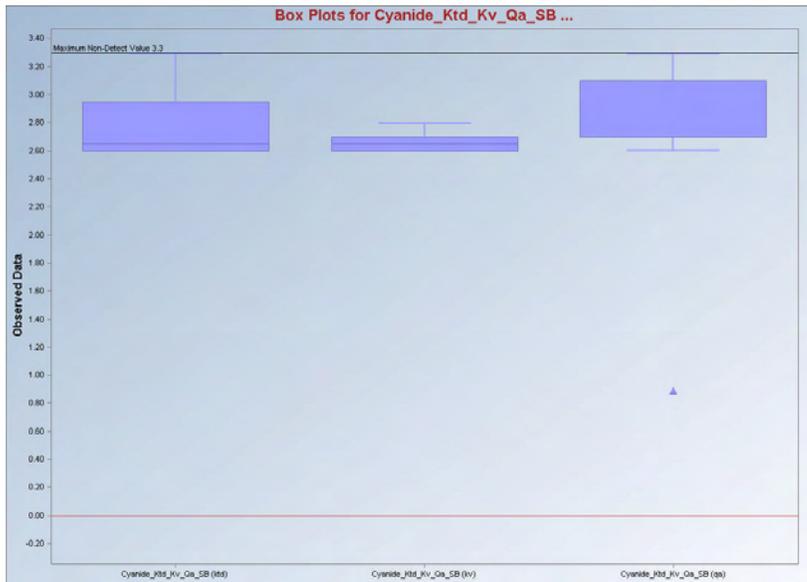


FIGURE 11: BOXPLOTS FOR CYANIDE FOR KTD KV AND QA ZONES IN SB.

Cyanide

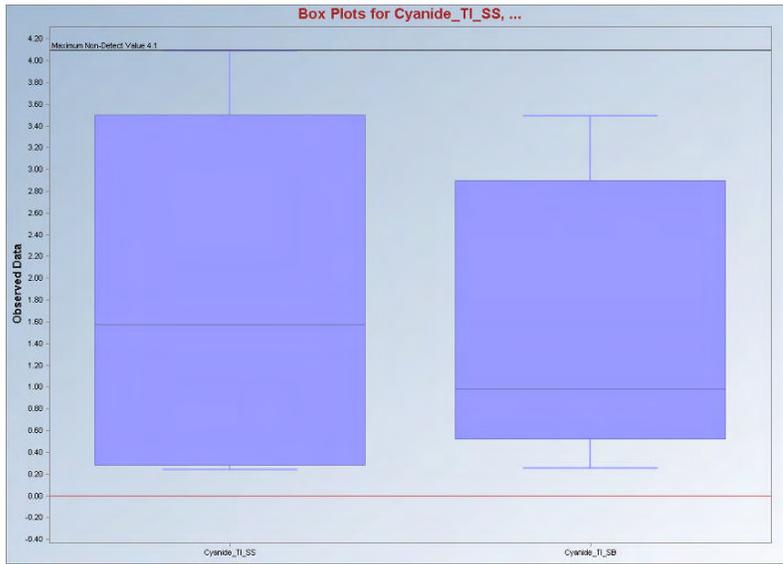


FIGURE 12: BOXPLOTS FOR CYANIDE FOR TI ZONE IN BOTH SS AND SB.

Silver

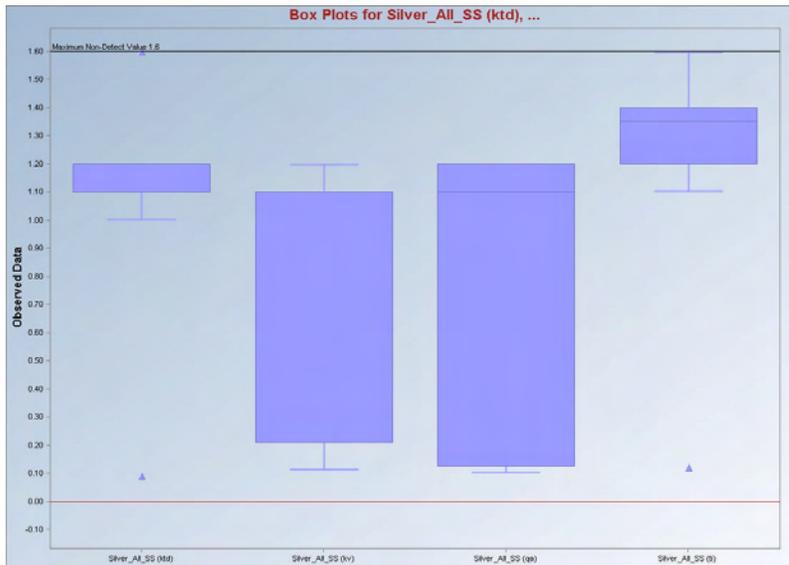


FIGURE 13: BOXPLOTS FOR SILVER FOR ALL 4 ZONES IN SS.

Silver

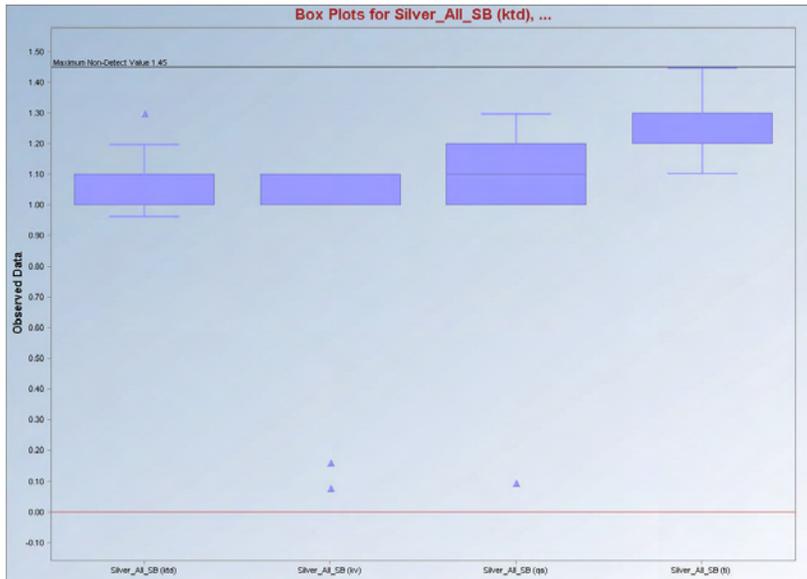


FIGURE 14: BOXPLOTS FOR SILVER FOR ALL 4 ZONES IN SB.

Lead

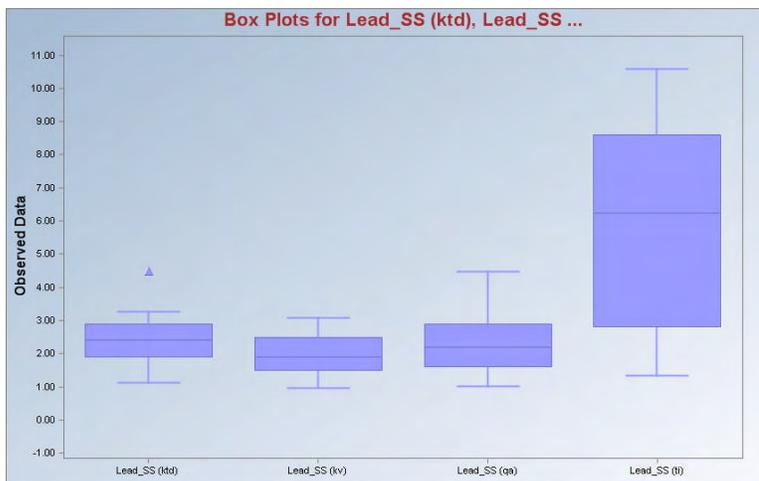


FIGURE 15. GRAPHICAL COMPARISON FOR LEAD IN SS FOR 4 SOIL ZONES

Lead

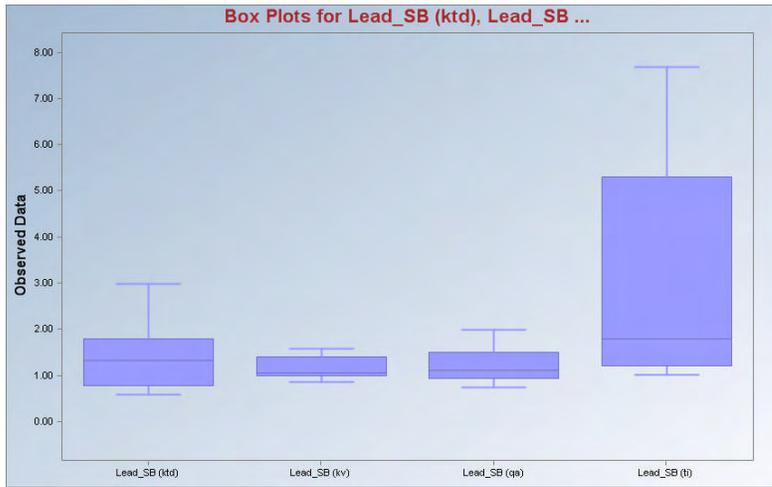


FIGURE16. GRAPHICAL COMPARISON FOR LEAD IN SB FOR 4 SOIL ZONES

Lead

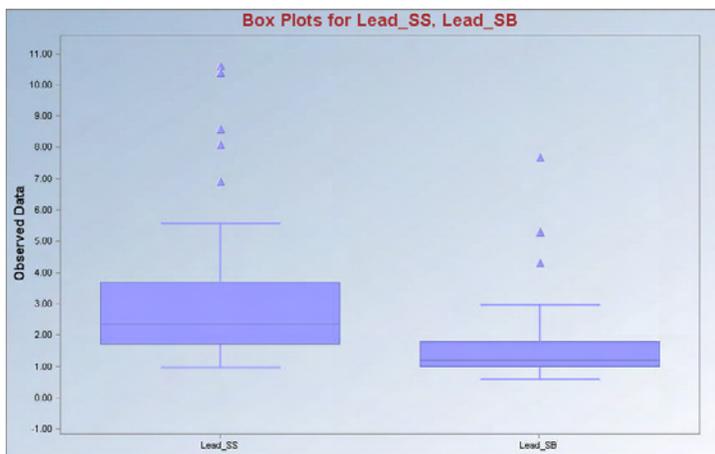


FIGURE17. GRAPHICAL COMPARISON FOR LEAD IN SS VERSUS SB

Zinc

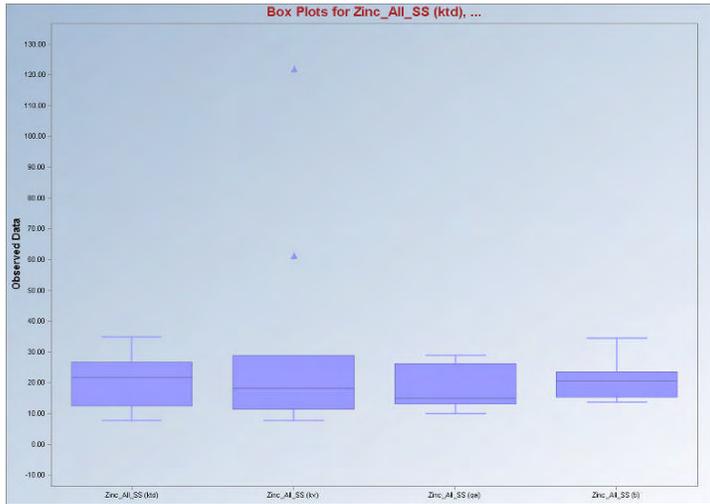


FIGURE 18: BOXPLOTS FOR ZINC FOR ALL ZONES IN SS.

Zinc

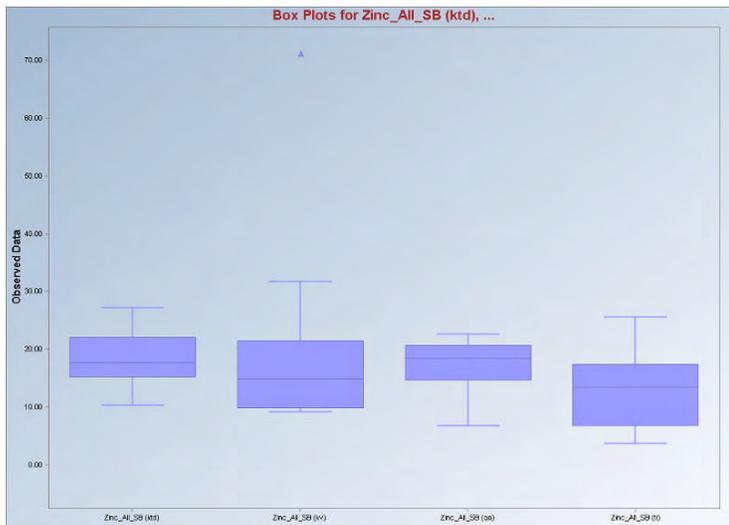


FIGURE 19: BOXPLOTS FOR ZINC FOR ALL ZONES IN SB.

Outlier Identification and GOF Test for Zn Using ProUCL 4.0

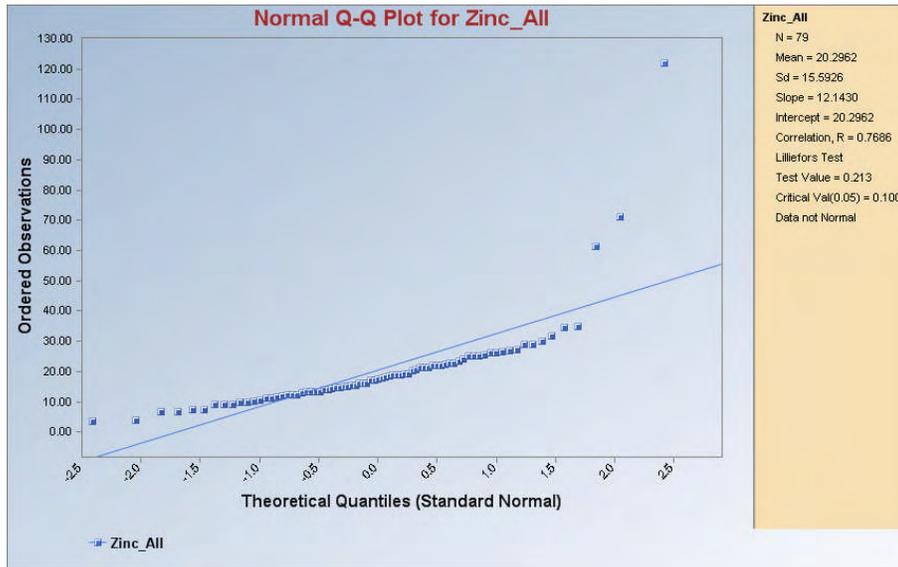


FIGURE 20: Q-Q PLOT FOR ZINC USING THE COMBINED DATA SET FROM 4 ZONES.

GOF Test for Zn without the Three Outliers

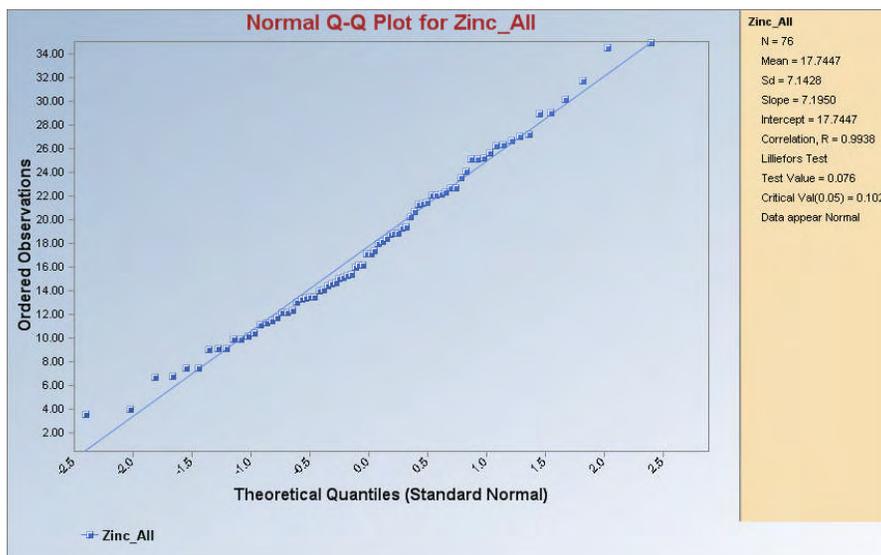


FIGURE 21: Q-Q PLOT FOR ZINC WITHOUT THREE OUTLIERS- SHOWN IN FIGURE 20

Appendix B

Background Statistics and t - Tests of Two or More Soil Groups Using ProUCL 4.0

Arsenic Results (t-Test) Using ProUCL 4.0

t-Test Site vs Background Comparison for Full Data Sets without NDs

User Selected Options

From File	G:\viques\Boxplot-Arsenic.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean Equal to Background Mean (Two Sided Alternative)
Alternative Hypothesis	Site or AOC Mean Not Equal to Background Mean

Area of Concern Data: Arsenic_KTD_KV_QA_SB

Background Data: Arsenic_KTD_KV_QA_SS

Raw Statistics

	Site	Background
Number of Valid Samples	40	41
Number of Distinct Samples	25	27
Minimum	0.47	0.48
Maximum	7.8	9.6
Mean	1.654	1.959
Median	1.1	1.1
SD	1.518	1.92
SE of Mean	0.24	0.3

Site vs Background Two-Sample t-Test

H0: Mu of Site = Mu of Background

Method	DF	t-Test Value	Critical - t (0.050)	P-Value
Pooled (Equal Variance)	79	-0.79	1.991	0.432
Satterthwaite (Unequal Variance)	75.8	-0.793	1.992	0.431

Pooled SD: 1.733

Conclusion with Alpha = 0.050

* Student t (Pooled): Do Not Reject H0, Conclude Site = Background

* Satterthwaite: Do Not Reject H0, Conclude Site = Background

Test of Equality of Variances

Numerator DF	Denominator DF	F-Test Value	P-Value

40

39

1.598

0.146

Conclusion with Alpha = 0.05

* Two variances appear to be equal

Arsenic Results (Background Statistics) Using ProUCL 4.0

General Background Statistics for Data Sets with Non-Detects

User Selected Options

From File	D:\Narain\WORKORDER37\WorkOrder37_Arsenic.wst
Full Precision	OFF
Confidence Coefficient	95%
Coverage	95%
Different or Future K Values	1
Number of Bootstrap Operations	2000

Arsenic

General Statistics

Number of Valid Samples	60	Number of Detected Data	27
Number of Unique Samples	24	Number of Non-Detect Data	33
		Percent Non-Detects	55.00%

Raw Statistics

Minimum Detected	0.47
Maximum Detected	5
Mean of Detected	1.166
SD of Detected	1.137
Minimum Non-Detect	0.96
Maximum Non-Detect	1.3

Log-transformed Statistics

Minimum Detected	-0.755
Maximum Detected	1.609
Mean of Detected	-0.115
SD of Detected	0.664
Minimum Non-Detect	-0.0408
Maximum Non-Detect	0.262

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended
 For all methods (except KM, DL/2, and ROS Methods),
 Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	53
Number treated as Detected with Single DL	7
Single DL Non-Detect Percentage	88.33%

Background Statistics

Normal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.622
5% Lilliefors Critical Value	0.923

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.838
5% Lilliefors Critical Value	0.923

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method	
Mean	0.825
SD	0.817
95% UTL 95% Coverage	2.473
95% UPL (t)	2.202
90% Percentile (z)	1.872
95% Percentile (z)	2.169
99% Percentile (z)	2.726

Maximum Likelihood Estimate(MLE) Method

Mean	-2.109
SD	2.84
95% UTL with 95% Coverage	3.619
95% UPL (t)	2.676
90% Percentile (z)	1.531
95% Percentile (z)	2.562
99% Percentile (z)	4.498

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	1.813
Theta Star	0.643
nu star	97.89

A-D Test Statistic	2.12
5% A-D Critical Value	0.757
K-S Test Statistic	0.22
5% K-S Critical Value	0.171

Data not Gamma Distributed at 5% Significance Level**Assuming Gamma Distribution**

Gamma ROS Statistics with extrapolated Data	
Mean	1.179
Median	1.014
SD	0.84
k star	2.567
Theta star	0.459
Nu star	308.1
95% Percentile of Chisquare (2k)	11.28

Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean (Log Scale)	-0.386
SD (Log Scale)	0.508
95% UTL 95% Coverage	1.895
95% UPL (t)	1.601
90% Percentile (z)	1.304
95% Percentile (z)	1.568
99% Percentile (z)	2.217

Log ROS Method

Mean in Original Scale	0.902
SD in Original Scale	0.812
95% UTL with 95% Coverage	2.23
95% BCA UTL with 95% Coverage	4.5
95% Bootstrap (%) UTL with 95% Coverage	4.5
95% UPL (t)	1.862
90% Percentile (z)	1.495
95% Percentile (z)	1.822
99% Percentile (z)	2.638

Data Distribution Test with Detected Values Only**Data do not follow a Discernable Distribution (0.05)****Nonparametric Statistics**

Kaplan-Meier (KM) Method	
Mean	0.865
SD	0.804
SE of Mean	0.108
95% KM UTL with 95% Coverage	2.486
95% KM Chebyshev UPL	4.397
95% KM UPL (t)	2.219
90% Percentile (z)	1.895
95% Percentile (z)	2.187
99% Percentile (z)	2.735

90% Percentile	2.164
95% Percentile	2.589
99% Percentile	3.517

Note: UPL (or upper percentile for gamma distributed data) represents a preferred estimate of BTV

For an Example: KM-UPL may be used when multiple detection limits are present

Note: DL/2 is not a recommended method.

Arsenic Results (Background Statistics) Using ProUCL 4.0 (Without outliers)

General Background Statistics for Data Sets with Non-Detects

User Selected Options

From File	D:\Narain\WORKORDER37\WorkOrder37_Arsenic.wst
Full Precision	OFF
Confidence Coefficient	95%
Coverage	95%
Different or Future K Values	1
Number of Bootstrap Operations	2000

Arsenic

General Statistics

Number of Valid Samples	53	Number of Detected Data	20
Number of Unique Samples	18	Number of Non-Detect Data	33
Number of Missing Values	7	Percent Non-Detects	62.26%

Raw Statistics

Minimum Detected	0.47
Maximum Detected	1.1
Mean of Detected	0.662
SD of Detected	0.193
Minimum Non-Detect	0.96
Maximum Non-Detect	1.3

Log-transformed Statistics

Minimum Detected	-0.755
Maximum Detected	0.0953
Mean of Detected	-0.448
SD of Detected	0.266
Minimum Non-Detect	-0.0408
Maximum Non-Detect	0.262

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	53
Number treated as Detected with Single DL	0
Single DL Non-Detect Percentage	100.00%

Background Statistics**Normal Distribution Test with Detected Values Only**

Lilliefors Test Statistic	0.849
5% Lilliefors Critical Value	0.905

Data not Normal at 5% Significance Level**Lognormal Distribution Test with Detected Values Only**

Lilliefors Test Statistic	0.898
5% Lilliefors Critical Value	0.905

Data not Lognormal at 5% Significance Level**Assuming Normal Distribution**

DL/2 Substitution Method	
Mean	0.59
SD	0.133
95% UTL 95% Coverage	0.862
95% UPL (t)	0.815
90% Percentile (z)	0.761
95% Percentile (z)	0.809
99% Percentile (z)	0.9

Maximum Likelihood Estimate(MLE) Method N/A

Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean (Log Scale)	-0.547
SD (Log Scale)	0.187
95% UTL 95% Coverage	0.848
95% UPL (t)	0.794
90% Percentile (z)	0.735
95% Percentile (z)	0.787
99% Percentile (z)	0.894

Log ROS Method

Mean in Original Scale	0.635
SD in Original Scale	0.15
Mean in Log Scale	-0.479
SD in Log Scale	0.22
95% UTL 95% Coverage	0.97
95% UPL (t)	0.898
90% Percentile (z)	0.821
95% Percentile (z)	0.889
99% Percentile (z)	1.032

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	12.07
Theta Star	0.0549
nu star	482.7

A-D Test Statistic	0.85
5% A-D Critical Value	0.741
K-S Test Statistic	0.178
5% K-S Critical Value	0.194

Data follow Appx. Gamma Distribution at 5% Significance Level**Assuming Gamma Distribution**

Gamma ROS Statistics with extrapolated Data	
Mean	0.668
Median	0.678

Data Distribution Test with Detected Values Only**Data follow Appr. Gamma Distribution at 5% Significance Level****Nonparametric Statistics**

Kaplan-Meier (KM) Method	
Mean	0.635
SD	0.163
SE of Mean	0.0333
95% KM UTL with 95% Coverage	0.967
95% KM Chebyshev UPL	1.35
95% KM UPL (t)	0.91
90% Percentile (z)	0.843
95% Percentile (z)	0.903

SD	0.124	99% Percentile (z)	1.013
k star	30.89		
Theta star	0.0216		
Nu star	3274		
95% Percentile of Chisquare (2k)	81.13		
90% Percentile	0.826		
95% Percentile	0.878		
99% Percentile	0.98		

Note: UPL (or upper percentile for gamma distributed data) represents a preferred estimate of BTV

For an Example: KM-UPL may be used when multiple detection limits are present

Note: DL/2 is not a recommended method.

Lead Results (t-Test) Using ProUCL 4.0

t-Test Site vs Background Comparison for Full Data Sets without NDs

User Selected Options

From File	G:\viques\Boxplot-Lead.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean Equal to Background Mean (Two Sided Alternative)
Alternative Hypothesis	Site or AOC Mean Not Equal to Background Mean

Area of Concern Data: Lead_SB

Background Data: Lead_SS

Raw Statistics

	Site	Background
Number of Valid Samples	39	40
Number of Distinct Samples	23	28
Minimum	0.57	0.94
Maximum	7.7	10.6
Mean	1.728	3.25
Median	1.2	2.35
SD	1.48	2.485
SE of Mean	0.237	0.393

Site vs Background Two-Sample t-Test

H0: Mu of Site = Mu of Background

Method	DF	t-Test Value	Critical - t (0.050)	P-Value
Pooled (Equal Variance)	77	-3.296	1.992	0.001
Satterthwaite (Unequal Variance)	63.9	-3.317	1.998	0.002

Pooled SD: 2.051

Conclusion with Alpha = 0.050

* Student t (Pooled): Reject H0, Conclude Site <> Background

* Satterthwaite: Reject H0, Conclude Site <> Background

Test of Equality of Variances

Numerator DF	Denominator DF	F-Test Value	P-Value
39	38	2.818	0.002

Conclusion with Alpha = 0.05

* Two variances are not equal

Lead Results (WMW Test) Using ProUCL 4.0

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Full Data Sets without NDs

User Selected Options

From File	G:\viques\Boxplot-Lead.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Less Than or Equal to Background Mean/Median (Form 1)
Alternative Hypothesis	Site or AOC Mean/Median Greater Than Background Mean/Median

Area of Concern Data: Lead_SB

Background Data: Lead_SS

Raw Statistics

	Site	Background
Number of Valid Samples	39	40
Number of Distinct Samples	23	28
Minimum	0.57	0.94
Maximum	7.7	10.6
Mean	1.728	3.25

Median	1.2	2.35
SD	1.48	2.485
SE of Mean	0.237	0.393

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC \leq Mean/Median of Background

Site Rank Sum W-Stat	1108
WMW Test U-Stat	-4.437
WMW Critical Value (0.050)	1.645
P-Value	1

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Site \leq Background

P-Value \geq alpha (0.05)

Zinc Results Using ProUCL 4.0

General Background Statistics for Full Data Sets

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Coverage	95%
Different or Future K Values	1
Number of Bootstrap Operations	2000

Zinc_All

General Statistics

Total Number of Samples	76	Number of Unique Samples	65
Number of Missing Values	3		

Raw Statistics

Minimum	3.6
Maximum	35
Second Largest	34.6
First Quartile	12.25
Median	17.2
Third Quartile	22.63
Mean	17.74
SD	7.143
Coefficient of Variation	0.403
Skewness	0.305

Log-Transformed Statistics

Minimum	1.281
Maximum	3.555
Second Largest	3.544
First Quartile	2.506
Median	2.845
Third Quartile	3.119
Mean	2.783
SD	0.462

Background Statistics

Normal Distribution Test

Lilliefors Test Statistic	0.076
Lilliefors Critical Value	0.102

Data appear Normal at 5% Significance Level

Lognormal Distribution Test

Lilliefors Test Statistic	0.0668
Lilliefors Critical Value	0.102

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% UTL with 95% Coverage	31.81
95% UPL (t)	29.72
90% Percentile (z)	26.9
95% Percentile (z)	29.49
99% Percentile (z)	34.36

Assuming Lognormal Distribution

95% UTL with 95% Coverage	40.16
95% UPL (t)	35.07
90% Percentile (z)	29.22
95% Percentile (z)	34.56
99% Percentile (z)	47.35

Gamma Distribution Test

k star	5.321
Theta Star	3.335
nu star	808.8

A-D Test Statistic	0.268
5% A-D Critical Value	0.754
K-S Test Statistic	0.0622
5% K-S Critical Value	0.103

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

90% Percentile	28.04
95% Percentile	31.99
99% Percentile	40.33

Data Distribution Test

Data appear Normal at 5% Significance Level

Nonparametric Statistics

90% Percentile	27.16
95% Percentile	30.44
99% Percentile	35

95% UTL with 95% Coverage	34.6
95% Percentile Bootstrap UTL with 95% Coverage	32.36
95% BCA Bootstrap UTL with 95% Coverage	34.6
95% UPL	30.44
95% Chebyshev UPL	49.08
Upper Threshold Limit Based upon IQR	38.19

Note: UPL (or upper percentile for gamma distributed data) represents a preferred estimate of BTV

**Puerto Rico Environmental Quality Board
Technical Evaluation**

***Draft East Vieques Background Soil Inorganics Investigation Report
Former Vieques Naval Training Range, Vieques Island, Puerto Rico
January 2007***

INTRODUCTION

The Draft East Vieques Background Soil Inorganics Investigation Report describes the soil inorganics background investigation at the former Vieques Naval Training Range (VNTR) in order to establish representative background concentrations of soil inorganics that can be compared to site-specific soil inorganic data to assess whether inorganic concentrations detected at a particular environmental site (solid waste management unit [SWMU], area of concern [AOC], potential area of concern [PAOC], or photo-identified [PI] site) are attributable to releases from these sites or consistent with background levels.

Page-Specific Comments

Page ES-II, Third bullet. This item states that samples were located at least 100 yards away from roads. However, Section 2.1 (second paragraph) indicates that samples were located at least 100 feet away from roads or mowed areas. Please correct the discrepancy between these two sections.

Navy Response: In accordance with the *Final Work Plan and Sampling and Analysis Plan, Soil Inorganics Background Investigation, Former Vieques Naval Training Range, Vieques, Puerto Rico* (CH2M HILL, May 2006), all samples were collected at least 100 feet from roads or mowed areas. The word “yards” in the third bullet on Page ES-II has been changed to “feet.”

Page ES-III, Paragraph 1. The second full sentence in this paragraph states that “...the average inorganic concentrations for this sample are lower...” Please clarify how average concentrations were calculated from one sample result.

Navy Response: The word “average” has been removed from the sentence.

Page 2-3, Section 2.1, Third Bullet. Please revise the text of the second sentence to the following: “These analyses were conducted to evaluate whether the background sample locations were impacted by bombing activities at the Live Impact Area.” This revision is requested as the analysis of these samples for explosives will not address the public concern that the entire east end of Vieques has been impacted by bombing activities. It will, however, address whether background sample locations have been impacted by the bombing activities.

Navy Response: Comment incorporated.

Page 2-4, Section 2.3, Paragraph 2. Please revise the last sentence of this paragraph to the following: “A total of six locations within the Qa soil type did not reach 6 feet bls: two locations encountered groundwater, two locations reached competent bedrock, and two locations encountered weathered bedrock.”

Navy Response: Comment incorporated.

Page 2-4, Section 2.3, Paragraph 4. Please revise the second sentence by replacing the word “have” with “consist of.”

Navy Response: Comment incorporated. Both occurrences of “have” have been changed to “consist of.”

Page 2-5, Section 2.5, Paragraph 2. Please include in the text how far from the original locations KTd-1 and KTd-10 were moved. Also, briefly describe the topography and terrain at the new locations and distance from the road for all relocated samples.

Navy Response: As discussed in the April 24, 2007 ERP Technical Subcommittee Meeting, the references to the distances moved have been removed from the text. The key points (i.e., that they were moved within the same geologic zone, that the new locations were approved by EPA and EQB, and that the new locations met the original objectives) are emphasized in the text.

The topography of each geologic zone (Qa, KTd, Kv, and TI) is described in Section 2.3, Paragraph 2, first sentence.

All samples were a minimum of 100 feet from roadways or mowed areas as stated in Section 2.1, Paragraph 2, second to last sentence. Also please refer to Section 2.5, second paragraph, last sentence which reads: “Although collected in a different location than originally planned, each of the relocated samples still meet the sample location selection criteria documented in the Final Work Plan (CH2M HILL, May 2006) and, therefore, appropriately represented background locations.”

Page 2-6, Section 2.5, Paragraph 4. Please add a discussion of the reporting limits reported for the EPA split samples. Please separate the last sentence into two or three sentences, and clarify why the EPA data “suggests” rather than “demonstrates” that explosives are not ubiquitous at the background locations. Please begin the third of these paragraphs with “Third” rather than “Further” to be consistent with the first two items in the list. Please combine this paragraph with the next two paragraphs since they are all part of a list and do not stand alone as separate paragraphs.

Navy Response: The last sentence in Section 2.5, paragraph 4 has been replaced with the following: “First, EPA collected split samples from all soil types during the background

investigation, and their explosives data demonstrate explosives are not ubiquitous at the background locations. Of the 16 split samples collected by EPA, only one explosive was reported (at an estimated concentration) in the validated data. The reporting limit for the EPA split samples was 100 µg/kg for some explosives and 200 µg/kg for others. Second, the potential presence of explosives at the one location does not correspond to increased inorganic concentrations (see Section 3.1.1 for a more detailed discussion).”

The next two paragraphs have been combined with the above.

Page 2-6, Section 2.5, Paragraph 5. The following issues must be corrected or clarified.

- a. **The reference to EPA Region IX PRGs should be corrected as it currently references Region II.**
- b. **There is a reference to a 1,2-trinitrobenzene. Based on an earlier statement, it appears this should be 1,3-dinitrobenzene.**
- c. **To clarify the reporting limits which were not achieved, please provide the MDLs for the 1,3-dinitrobenzene and 2-nitrotoluene, corrected for sample-specific issues (e.g., sample weight, moisture content, etc.). This will provide a clearer understanding of the disparity between the MDL and the Region IX PRG.**

Navy Response:

- a. The comment is correct, but to be consistent with EQB comment Page 2-6, Section 2.5, Paragraph 7 (see below) and what was concurred upon during the April 24, 2007 ERP Technical subcommittee meeting, the sentence containing this reference has been deleted.
- b. The comment is correct, but is actually referring to paragraph 7. To be consistent with the response to EQB comment Page 2-6, Section 2.5, Paragraph 7 (see below), the sentences containing these references have been deleted.
- c. The MDL for 1,3-dinitrobenzene was 377 µg/kg. The MDL for 2-nitrotoluene was 726 µg/kg. These MDLs are lower than the respective PRGs of 610 µg/kg and 880 µg/kg. Please note that MDLs are never corrected for sample weight, moisture content, etc. as the comment suggests. After considering these and other factors, the laboratory presents reporting limits that can be achieved.

Page 2-6 , Section 2.5, Paragraph 7. Please clarify why the laboratory did not reach the RLs specified in the work plan.

The purpose of analyzing background soil samples for explosives is to determine whether the samples are representative of areas that have not been impacted by bombing activities. Therefore, please clarify why the RLs were compared to risk-based screening criteria. This exercise is useful for determining whether the reported absence of an analyte may pose a risk due to the elevated RL; however, that is not the purpose of analyzing samples for explosives. The significance of the elevated explosives RLs should be discussed in the context of the purpose of the

background investigation (i.e., to determine the presence or absence of the target compounds).

Navy Response: The following text has replaced the first sentence of the fourth paragraph of Section 2.5: “The explosives reporting limit (RL) in the Work Plan, which referenced the 2003 Master QAPP (CH2M HILL, 2003a), is 250 µg/kg. However, the laboratory utilized achievable reporting limits provided in a more recent QAPP, following the process provided in the Draft Final Master Quality Assurance Project Plan, Environmental Restoration Program, Vieques, Puerto Rico (CH2M HILL, February 2007), which superseded the 2003 Master QAPP.”

In addition, the last paragraph of Section 2.5 has been revised to eliminate the discussion of reporting limits versus PRGs and now reads: “It should also be noted that laboratory method detection limits (MDLs) are the limits to which the laboratory instruments can generally detect constituents, and are below the RLs. Therefore, if explosives were present above the MDLs in the soil samples, they likely would have been detected and qualified as estimated.”

Page 3-2, Section 3.1.1, Paragraph 1. Based on the information provided, it appears that the detected result reported for 2,6-dinitrotoluene in sample TI-6B by the split laboratory should have been rejected. This is based on the following observations.

- d. The laboratory calculated the percent difference (%D) between the dual column results as 84%. However, the calculation used for the %D was not consistent with calculations in the CLP method. When calculating %D as per CLP methods, the true value is assumed to be the lower of the two values. If the %D was calculated as required in the CLP methods, the %D would be 532% and therefore the result would be rejected.**
- e. The laboratory used SW-846 method 8330 for the analysis of explosives. As per SW-846, %Ds between dual column results are not calculated. Instead, the method requires that a relative percent difference be calculated since neither result can really be considered the true value. The RPD of the dual column results is 145 which would also result in rejection of data.**
- f. The elimination of the positive result for 2,6-dinitrotoluene in the split sample would require modifications to the following pages (Page ES-III, Paragraph 1; Page 3-2, Paragraphs 1 and 2, Table 3-3, page 4 of 4).**

Navy Response:

- d. Because this is not a CLP method, the lab was not required to report the lower of the two values as the “true” value. In this instance, the lab reported the result from the primary column (as opposed to the secondary, confirmation column) on Form 1 as the “true” value. If the explosives analytical method (8330) was a CLP method and validated accordingly, the 84 %D would have resulted in the 2,6-dinitrotoluene detection being rejected upon validation. This information has been added to Section 3.1.1, fourth paragraph.**

- e. The data validation guidance (Explosive Residues Standard Operating Procedure U.S. EPA Region II Revision 1.3) indicates that percent difference (%D) is to be used to apply the J or R qualifiers, not the relative percent difference (RPD). The %D was calculated to be 84% and the result was therefore J-qualified.
- f. Please see responses to “d” and “e” above.

Page 3-2, Section 3.1.1, Paragraph 4. Section 2.5, paragraph 7 presents the concept that if an organic chemical was present in a sample below the RL but above the MDL, it would have been reported and J-qualified. However, this section attempts to limit the validity of the explosive detected below the RL but above the MDL. Please clarify this apparent discrepancy between these two sections.

Navy Response: There is no discrepancy. Section 3.1.1, paragraph 4 discusses the limitation of the reported estimated concentration of the explosive because of the large percent difference, not because it was detected below the RL.

Page 3-2, Section 3.1.1, Paragraph 5. Please delete the parenthetical statement in the second sentence. The purpose of this investigation is to establish a dataset of inorganics concentrations, not to compare the data to risk-based screening criteria or consider whether chemicals are appropriate for risk assessment purposes. Note also that the parenthetical statement does not add anything to the fact that calcium and magnesium were detected at higher concentrations in subsurface soil than in surface soil. Also, please clarify in the text why it is noteworthy that most inorganics detected in TI-06 were detected at lower concentrations in subsurface soil than in the surface soil. In the third sentence, please replace the word “was” with the word “were” in the following phrase “...none of the inorganic concentrations in the subsurface soil sample... were identified...”

Navy Response: The parenthetical statement has been deleted, and the following sentence has been added at the end of that sentence: “Calcium and magnesium are associated with marine sedimentary carbonates (e.g., limestone) and shales that make up the rocks beneath the soil. The lower concentrations in surface soil likely represent natural weathering of the calcite and dolomite minerals that formed the soil profile and preferential removal (leaching) of magnesium and calcium from the soil by this natural process.”

The following sentence has been added after the newly inserted sentence above: “Therefore, even if there is an explosive constituent in the subsurface soil at this location, its presence does not correspond to elevated inorganic concentrations.”

The verb must agree with the subject, not the object of the preposition as suggested by the comment. The subject is “none,” which is singular. Therefore, use of the singular verb “was” in the third sentence is grammatically correct.

Page 3-2, Section 3.1.2, Paragraph 2. Please clarify what is meant by “similar” in the first sentence. This is a significant word, as the second paragraph states that the fact

that concentrations of inorganics for two soil types are similar helps support the finding that the dataset is representative of broad background conditions.

Navy Response: The first two sentences have been combined as follows: “A comparison of data collected from both the Qa and KTd soil types shows that the concentrations are very similar (i.e., within an order of magnitude) and that the only significant difference (i.e., greater than an order of magnitude) in concentrations is for thallium.”

Page 3-3, Section 3.2. Please correct the phrase “95 percent confidence upper limit” to “95 percent upper confidence limit.”

Navy Response: Comment incorporated.

Section 3.2.1.

- a) **There is no mention in this section of how samples below detection limit are treated in the non-parametric ANOVA. It is suggested in the final sentence of Section 3.2.2.1 that 1/2 RL value is used as a proxy. Is this so? Please add this information to Section 3.2.1.**
- b) **There is no listing for the reference in section 4 for the Mason, Gunst, and Hess citation in paragraph 9 of this section.**

Navy Response:

- a. The first sentence of Section 3.2 has been replaced with the following: “Statistical analysis was conducted on the validated analytical data, where one-half the RL was used as a proxy concentration for inorganic results reported as not detected. The statistical process was used to develop a statistically sound dataset representative of background inorganic concentrations.”
- b. The following reference has been added to the References section: “Mason, Robert L., Richard F. Gunst, and James L. Hess. *Statistical Design and Analysis of Experiments: With Applications to Engineering and Science*. John Wiley & Sons, New York. 1993.”

Page 3-5, Section 3.2.1, Paragraph 11. Please clarify what is meant by “significantly lower” and “significantly higher” in the context of a statistical evaluation. Note that other phrases used within the same paragraph are “statistically similar” and “statistically indistinguishable.” Please use the same terminology to explain the same statistical observation.

Navy Response: To clarify what is meant by “significantly higher” and “significantly lower,” the following sentence has been added as the last sentence in Section 3.2.1, paragraph 8: “Tukey’s Test was applied with a significance level of 0.05. A calculated probability lower than the significance level of 0.05 is defined as ‘statistically different.’ Conversely, a calculated probability higher than or equal to the significance level of 0.05 is defined as ‘statistically similar.’” The occurrences of “statistically indistinguishable”

have been replaced with “statistically similar.” The occurrences of “significantly higher” and “significantly lower” used when referring to the Tukey’s test results have been changed to “statistically higher” and “statistically lower.”

Section 3.2.2. Please list/tabulate the transformations applied to soil/depth groups for outlier analysis when data were not normal.

Navy Response: Comment Incorporated. The following sentence has been inserted after the second sentence of the third paragraph of Section 3.2.2: “The transformations used for each outlier analysis are included in Table 3-9.”

Page 3- 7, Section 3.2.2.1. The first mention that one-half the RL was used as a proxy concentration for non-detects is at the end of this section. Please add a discussion of the data used in the statistical analyses in Section 3.2, where it states that statistical analysis was conducted on validated data. Statistical analysis was conducted on validated data, where one-half the RL was used as a proxy concentration for inorganics reported as not detected.

Navy Response: The first sentence of Section 3.2 has been replaced with the following: “Statistical analysis was conducted on the validated analytical data, where one-half the RL was used as a proxy concentration for inorganic results reported as not detected. The statistical process was used to develop a statistically sound dataset representative of background inorganic concentrations.”

Section 3.3. Please include basis for tolerance factor (K) in UTL formulas. Also include in table 3-10.

Navy Response: The K factor was computed using a statistical function known as a non-central t statistic, available in the statistical software used to calculate the statistics herein. These K factors have been added to Table 3-10.

Table 3-3. Please format the table borders to visually group a sample with its corresponding split sample. Although they are placed together, it would be helpful to have a heavy line bordering the two columns so that the viewer can easily determine which samples are the pair being compared.

Navy Response: Comment incorporated. Double lines have been placed between each set of sample/split sample.

Table 3-7. Please define A and B on the table.

Navy Response: The following has been added to the Notes section of the table: “See Section 3.2.1 for detailed explanation of the A, B, and C designations.

A = Highest concentration

B = Statistically lower concentration than A

AB = Statistically similar concentration to A and B

C = Statistically lower concentration than B
BC = Statistically similar concentration to B and C”

Figure 3-1. Please define the ratios (presented as fractions) at the top of each scatter plot in the text.

Navy Response: The following sentence has been added as the last sentence in Section 3.2.1, paragraph 3: “The ratios shown in Figure 3-1 represent the number of detects divided by the total number of samples for each constituent.”

Figure 3-1. Please explain the meanings of fractions at the top of scatterplots (i.e., number of detects over total samples?).

Navy Response: The following has been added as a legend in Figure 3-1: “The ratios shown represent the number of detects divided by the total number of samples for each constituent.”

Figure 3-2. Explain horizontal lines in text in section 3.2.2 and/or 3.3.

Navy Response: The following sentence has been added as the last sentence of Section 3.3: “The UTLs were included in the probability plots presented in Figure 3-2 as horizontal lines, enabling the reader to visually note the position of these background threshold values relative to the available data.” This information has also been added as a legend in Figure 3-2.

Appendix D, Surface Soil and Subsurface Soil Data Quality Evaluations, Section D.1.3.1.1. The text should provide discussion on why results were U-qualified. The second bullet states that 39.6% (subsurface) and 42.4% (surface) of explosive results were U-qualified as not detected. However, this qualification is not further discussed below as was done for the other bullets in this section.

Navy Response: This qualification was not further discussed because it was not indicative of a QA/QC problem. In other words, the results were U-qualified only because those constituents were not detected. Thus, it isn’t necessary to mention these U qualifiers in the bullets and, to help avoid confusion, the U-qualified bullet associated with non-detected results in both the explosives (D.1.3.1.1) and metals (D.1.3.1.2) subsections have been deleted from both the surface soil and subsurface soil DQEs.

Appendix D, Surface Soil and Subsurface Soil Data Quality Evaluations, Section D.2, Paragraph 3. The text states that blank contamination was associated only with the metals fraction. However, as discussed in comment #3 above, the explosives results were noted as being U-qualified. Please explain.

Navy Response: Blank contamination was associated only with the metals fraction. The U qualifiers in the explosives fraction are simply because those compounds were not detected. As stated above, to eliminate any confusion and because no explanation is

necessary for the explosives fraction, the U qualifier bullets associated with non-detected results in both the explosives and metals subsections have been removed from the bulleted lists. The U-qualifier bullet associated with blank contamination in the metals subsection will remain.