N00174.AR.000512
NSWC INDIAN HEAD
5090.3a

Final

Lab Area Baseline Ecological Risk Assessment Report

Naval Support Facility, Indian Head
Indian Head, Maryland

Contract Task Order 43

May 2006

Prepared for
Department of the Navy
Naval Facilities Engineering Command, Washington

Under the
LANTDIV CLEAN III Program
Contract N62470-02-D-3052

Prepared by

CH2MHILL

Herndon, Virginia

Executive Summary

This report presents the results of a Baseline Ecological Risk Assessment (BERA) for the Lab Area (Sites 14, 15, 16, 49, 50, 53, 54, and 55) at the Naval Support Facility, Indian Head (NSF-IH) in Indian Head, Maryland. This BERA report was prepared by CH2M HILL under the United States Department of the Navy (Navy), Naval Facilities Engineering Command, Atlantic Division (LANTDIV), Comprehensive Long-Term Environmental Action Navy (CLEAN) III Contract N62470-02-D-3052, Contract Task Order (CTO) 43. This BERA has been submitted to the Naval Facilities Engineering Command (NAVFAC) Washington, NSF-IH, the United States Environmental Protection Agency (EPA), and the Maryland Department of the Environment (MDE). The activities described herein are part of the overall Installation Restoration Program (IRP) being implemented at NSF-IH.

A screening ecological risk assessment (SERA) was completed for the Lab Area as part of the remedial investigation for the site (CH2M HILL, 2004). The results of the SERA suggested the potential for unacceptable ecological risk at the site. The results of the SERA revealed that several metals, polycyclic aromatic hydrocarbons (PAHs), and semivolatile organic compounds (SVOCs) posed potential risks to various biota, and that further investigation was warranted. The assessment and measurement endpoints selected for the BERA are described in Table ES-1.

TABLE ES-1
MEASUREMENT ENDPOINTS AT THE LAB AREA

Assessment Endpoints	Measurement Endpoints
Survival and growth of soil invertebrate communities.	Comparison of results of 28-day soil toxicity tests (survival and growth) with the earthworm (*E. foetida*) using site and reference soils.
Survival, growth, and reproduction of birds and mammals that feed on soil invertebrates at the site.	Comparison of estimated exposure dose to toxicity reference value using site-specific bioaccumulation data obtained from lead, mercury, and zinc concentrations in earthworm tissue (from soil bioassays) to a reference LOAEL-based HQ of 1.0. As stated in the Data Quality Objectives of the BERA Work Plan (CH2M HILL, 2005), the American robin (avian insectivore) and white-footed mouse (mammalian omnivore) are considered the surrogates for birds and mammals, respectively.

In support of the BERA, surface soil samples were collected from ten locations at the Lab Area and from one reference location, on May 23 and 24, 2005. The soil samples were analyzed for TAL metals, methylmercury, PAHs (SIM method), SVOCs, pH, total organic carbon (TOC), and grain size (by sieve analysis). To evaluate direct toxicity to soil invertebrates, laboratory toxicity tests with the earthworm *E. foetida* were conducted on split samples from the soil sampling locations.

To more accurately characterize the potential risk to birds and mammals that might consume soil invertebrates from the Lab Area, the test earthworms were analyzed for EPA Target Analyte List (TAL) metals and methylmercury at the conclusion of the soil toxicity

tests. The concentrations of metal COPCs (lead, mercury, and zinc) in the tissue samples were used to estimate exposure to insectivorous birds and omnivorous mammals.

The results of the soil invertebrate toxicity tests indicate that soil invertebrate survival is not affected at the Lab Area. Significantly reduced growth was observed in nine samples (eight sample locations plus one duplicate). Methylmercury was identified as possibly contributing to reduced growth in soil invertebrates at the Lab Area. However, the level of effect is unlikely to impair the soil invertebrate community. The observed decrease in growth was less than 20 percent at all locations, except one in comparison to the reference sample. In general, a less than 20 percent reduction in the measurement endpoint is considered protective of the assessment endpoint (Suter *et al.,* 1995).

The results of the earthworm tissue analyses and exposure calculations for insectivorous terrestrial birds and omnivorous terrestrial mammals indicate that the risks to these receptors from COPCs in surface soils at the site are within ranges presumed to be acceptable. HQs based on the LOAEL were less than 1, indicating that population-level impacts are likely not occurring and no further investigation is required. The results of the BERA indicate that the COPCs identified in the RI Report for the Lab Area do not pose unacceptable risks; thus, further investigation is not required.

Contents

Executive Summary ..... **iii**

Acronyms and Abbreviations ..... **vii**

1 **Introduction** **1-1**
- 1.1 Site Background 1-1
- 1.2 Results of Steps 1-3A of the Ecological Risk Assessment 1-2
- 1.3 Chemicals, Media, and Areas of Focus for the BERA 1-2

2 **Problem Formulation** **2-1**
- 2.1 Ecotoxicity Review 2-1
- 2.2 Conceptual Model 2-6

3 **Investigation Activities** **3-1**
- 3.1 Soil Invertebrate Community 3-1
- 3.2 Upper-Trophic-Level Receptors 3-1
- 3.3 Reference Sample 3-2

4 **Investigation Results** **4-1**
- 4.1 Soil Chemistry and Physical Characteristics 4-1
- 4.2 Soil Toxicity 4-2
- 4.3 Earthworm Tissue 4-2

5 **Risk Characterization** **5-1**
- 5.1 Assessment Endpoints 5-1
- 5.2 Uncertainties 5-2
- 5.3 Conclusion 5-5

6 **References** **6-1**

Appendices

A Grain Size Data

B Lab Area Chemistry Results: Soil and Tissue

C Soil Toxicity Testing Report

D Food Web Exposure Model and Ingestion Screening Values

Tables (Tables are located at the end of each section)

ES-1 Measurement Endpoints at the Lab Area

1-1 Summary of Affected Biota and COPCs after Step 3A

2-1 Measurement Endpoints at the Lab Area

4-1 Grain Size and TOC data for Surface Soil Samples

4-2 Summary Statistics - Surface Soil

4-3 Surface Soil Toxicity Test Results for Earthworm Survival and Growth

4-4 Summary Statistics - Earthworm Tissue

4-5 Results of Exposure Calculations for Upper Trophic Level Receptors

Figures (Figures are located at the end of each section)

1-1 Site Location Map
1-2 Previous Sample Locations

2-1 Conceptual Site Model

3-1 Soil Toxicity Test Locations
3-2 Reference Toxicity Test Locations

5-1 Scatter Plot of Average Earthworm Growth versus Total Mercury in Soil
5-2 Scatter Plot of Average Earthworm Growth versus Methylmercury in Soil

Acronyms and Abbreviations

BCF	Bioconcentration Factor
BERA	Baseline Ecological Risk Assessment
CLEAN	Comprehensive Long-Term Environmental Action Navy
CNO	Chief of Naval Operations
COPC	Chemical of Potential Concern
CTO	Contract Task Order
EC_{10}	Effects Concentration 10 Percent
EC_{50}	Effects Concentration 50 Percent
EPA	United States Environmental Protection Agency
GPS	Global Positioning System
HQ	Hazard Quotient
IHIRT	Indian Head Installation Restoration Team
IRP	Installation Restoration Program
LANTDIV	Naval Facilities Engineering Command, Atlantic Division
LC50	Lethal Concentration 50 Percent
LOAEL	Lowest Observed Adverse Effect Level
MDE	Maryland Department of the Environment
µg	micrograms
mg/kg	milligrams per kilogram
mg/kg/d	milligrams per kilogram per day
MHSPE	Ministry of Housing, Spatial Planning and Environment
NAVFAC-Washington	Naval Facilities Engineering Command-Washington, DC
NOAEL	No Observed Adverse Effect Level
NOEC	No Observed Effect Concentration
NSF-IH	Naval Support Facility, Indian Head
PAH	Polycyclic Aromatic Hydrocarbons
ppm	parts per million
RI	Remedial Investigation
SERA	Screening Ecological Risk Assessment
SVOC	Semi-Volatile Organic Compound
TAL	Target Analyte List
TOC	Total Organic Carbon

SECTION 1

Introduction

This report presents the results of a Baseline Ecological Risk Assessment (BERA) for the Lab Area (Sites 14, 15, 16, 49, 50, 53, 54, and 55) at the Naval Support Facility, Indian Head (NSF-IH) in Indian Head, Maryland. This BERA report was prepared by CH2M HILL under the United States Department of the Navy (Navy), Naval Facilities Engineering Command, Atlantic Division (LANTDIV), Comprehensive Long-Term Environmental Action Navy (CLEAN) III Contract N62470-02-D-3052, Contract Task Order (CTO) 43. This BERA has been submitted to the Naval Facilities Engineering Command (NAVFAC) Washington, NSF-IH, the United States Environmental Protection Agency (EPA), and the Maryland Department of the Environment (MDE). The activities described herein are part of the overall Installation Restoration Program (IRP) being implemented at NSF-IH.

This report was prepared in accordance with EPA guidance (EPA, 1997 and 1998) and Chief of Naval Operations (CNO) policy (CNO, 1999).

The report is organized as follows:

- Section 1: Introduction
- Section 2: BERA Problem Formulation
- Section 3: BERA Investigation Activities
- Section 4: BERA Results
- Section 5: Risk Characterization
- Section 7: References

1.1 Site Background

NSF-IH is a Navy facility in northwestern Charles County, Maryland. The facility provides services, research, development, testing, and evaluation in energetics (TTNUS, 2004). The facility consists of the Main Area, located on Cornwallis Neck Peninsula, and the Stump Neck Annex, located across Mattawoman Creek from the main facility area. The Main Area is bounded by the Potomac River to the northwest, west, and south; Mattawoman Creek to the south and east; and the town of Indian Head to the northeast.

The Lab Area consists of IRP Sites 14, 15, 16, 49, 50, 53, 54, and 55. As a result of similar historic usage, proximity, the sharing of sewer utilities, and overlapping field investigations, it was decided by the Indian Head Installation Restoration Team (IHIRT) in May 2000 to refer to the area encompassing these sites as the Lab Area. Figure 1-1 shows the location of the Lab Area within the facility. The Lab Area contains various office buildings, current and former laboratories, storage magazines, and other buildings and structures. Most of the structures in the Lab Area were used as laboratories or for chemical storage at one time in their history [refer to Section 1.4 of the *Final Remedial Investigation Report, Lab Area* (herein referred to as RI Report) (CH2M HILL, 2004) for more information].

The Lab Area covers approximately 14 acres. Figure 1-2 shows the layout and associated features of the Lab Area. The majority of the area contains maintained grass and trees (oaks are common). A small emergent wetland (less than 0.5 acre) with cattails, rushes, and several trees receives runoff from the Lab Area, blow-off water from the steam system, and recharge from periodically broken water lines that run beneath the northern edge of the wetland. The emergent wetland changes in shape throughout the seasons and is particularly affected by ruptured (or repaired) water lines that run beneath it. Groundwater is more than 40 feet below ground surface throughout the site (Ensafe/Allen & Hoshall, 1994) and, therefore, does not discharge to the wetland. Overflow from the wetland area drains into the storm drain system, which discharges to Mattawoman Creek near IRP Site 41. As recommended in Section 7.2 of the RI Report, a soil and sediment removal action and restoration is planned for the wetland area after the BERA is completed for the upland portion of the Lab Area. The wetland restoration will be completed after the BERA to ensure that potential sources upgradient of the wetland are contained before restoration to minimize the potential for recontaminating the restored wetland. A preliminary remedial goal for the wetland sediments will be developed using literature-based information. Nature and extent and fate and transport information developed during the RI will be used in conjunction with the results of the BERA to select an appropriate remedy for the upland soils that will minimize the potential for recontaminating the wetland.

1.2 Results of Steps 1-3A of the Ecological Risk Assessment

A screening ecological risk assessment (SERA) was completed for the Lab Area as part of the remedial investigation for the site (CH2M HILL, 2004). The results of the SERA suggested the potential for unacceptable ecological risk at the site. For most endpoints, multiple chemicals were associated with hazard quotients (HQs) in excess of 1 (Section 6.4 in the RI).

The results of the Step 3A evaluation in the SERA revealed that several metals, polycyclic aromatic hydrocarbons (PAHs), and semivolatile organic compounds (SVOCs) posed potential risks to soil invertebrates. Table 1-1 shows the list of these chemicals of potential concern (COPCs) for various biota.

Based on data collected for the RI, inorganic contamination, while generally higher near facility buildings upgradient of the wetland, is distributed throughout much of the Lab Area. Although the distribution of organic COPCs is not clearly defined, based on data collected for the RI, their occurrence may be a result of small, isolated releases. Maximum concentrations of copper (4,000 mg/kg), lead (31,200 mg/kg), mercury (962 mg/kg), and zinc (6,000 mg/kg) were found in site surface soils at concentrations higher than background levels (6.5 mg/kg, 17.9 mg/kg, 0.05 mg/kg, and 20.2 mg/kg for copper, lead, mercury, and zinc, respectively).

1.3 Chemicals, Media, and Areas of Focus for the BERA

Based on visual inspection by a CH2M HILL ecologist (September 2002), terrestrial vegetation in the Lab Area is growing and shows no obvious signs of stress. Although the absence of chemically induced adverse effects on the gross physical structure does not

preclude the potential for other, less-apparent effects, it demonstrates that the soil substrate will support a vegetative community. Therefore, plants were excluded from further analysis in the BERA. The COPCs on which the BERA focused, organized by receptor, are shown in Table 1-1.

TABLE 1-1
COPCS AND ECOLOGICAL RECEPTORS IDENTIFIED FOR THE BERA

Soil Invertebrates	Insectivorous Birds	Insectivorous Mammals
Copper	Lead	Mercury
Lead	Mercury	
Mercury	Zinc	
Zinc		
Total PAHs		
Acetophenone		
Carbazole		
Dibenzofuran		

File Path: v:\18gis\indianhead\figures\site_47_BERA.apr

N

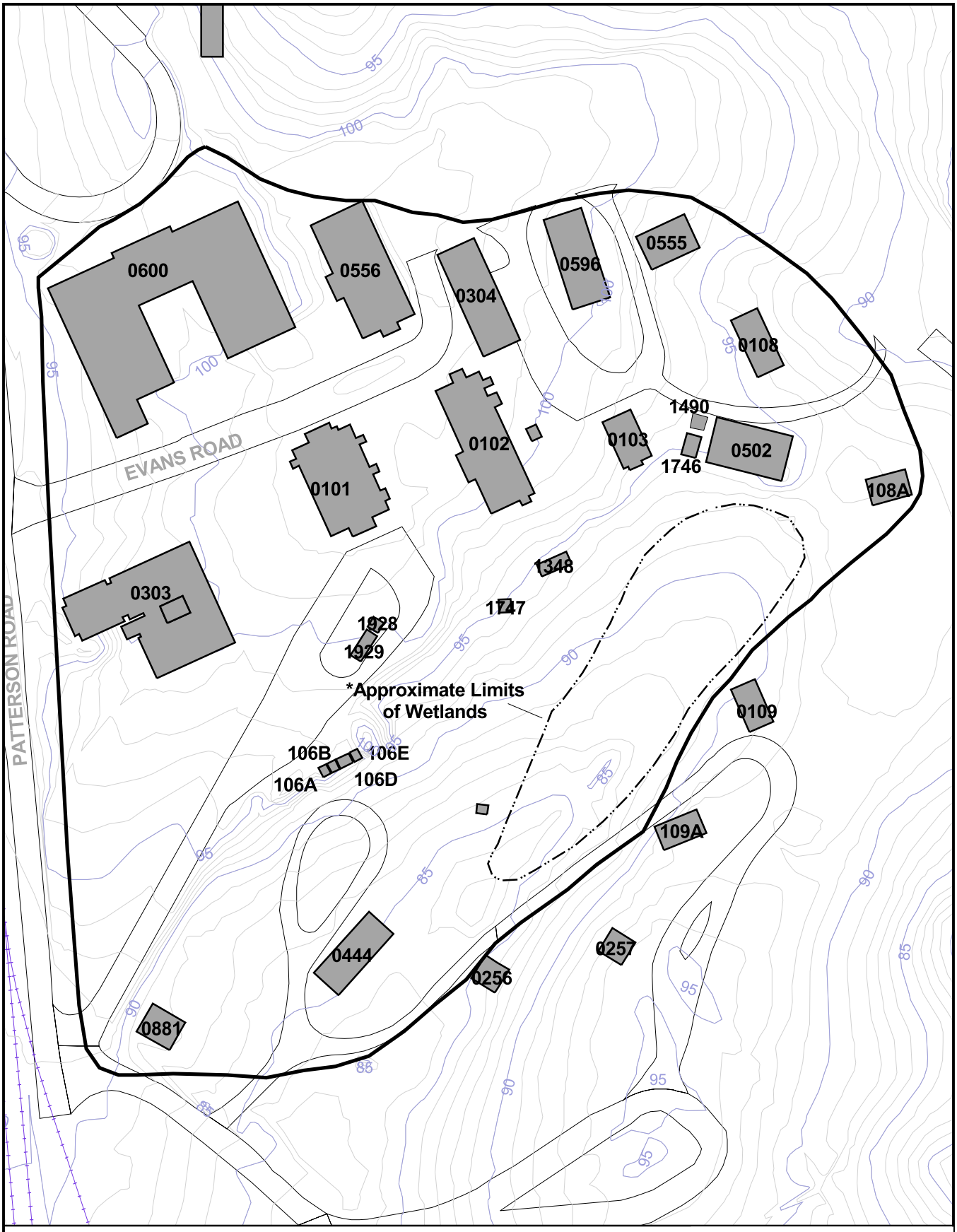
0 1100 2200 Feet

1" = 2200 ft

Figure 1-1
Location of Lab Area
BERA Report
NSF-IH, Indian Head, Maryland

CH2MHILL

File Path: V:\18gis\IndianHead\figures\lab_area.apr



LEGEND

Lab Area Boundary

Approximate Limits of Emergent Wetland

*Estimated location of emergent wetland in March 2001. Wetland area changes depending on precipitation and saturation, as well as the presence of underground leaking freshwater pipes (refer to section 1.3.3 of Final RI Report, CH2M Hill, January 2004).

N

0 50 100 Feet

Figure 1-2
Limits of Lab Area
BERA Report
NSF-IH, Indian Head, Maryland

CH2MHILL

SECTION 2

Problem Formulation

The BERA problem formulation is a revision of the SERA problem formulation and focuses the BERA on the key chemicals, exposure pathways, and receptors that were identified from the results of Step 3A. This revised problem formulation consists of an evaluation of the toxicity of the COPCs and a refined conceptual model. The conceptual model includes a discussion of exposure pathways, assessment endpoints, and risk hypotheses.

2.1 Ecotoxicity Review

The classes of compounds from which COPCs were selected include inorganics, SVOCs, and PAHs. Based on the Step 3A results, copper, lead, mercury, zinc, acetophenone, carbazole, dibenzofuran, and PAHs may pose a risk to the soil invertebrate community in the Lab Area. In addition, lead, mercury, and zinc in the surface soil may pose a risk to upper–trophic-level receptors (insectivorous birds and insectivorous mammals).

2.1.1 Inorganics

2.1.1.1 Copper

The bioavailability and toxicity of copper in soil is largely determined by the content of organic carbon (Streit and Jaggy, 1983). Acidic soil conditions also increase the availability of copper. Copper may bioaccumulate in earthworms (Czarnowska and Jopkiewicz, 1978; Ireland, 1979). A study by Van Rhee (1977) suggests that the population density of earthworms is not related to the concentration of copper in soil; however, the concentration of copper in worm tissue was found to be highly correlated to copper concentration in soil. Other studies, including Ma (1987), Carter (1983), Beyer and Cromartie (1987), and Beyer *et al.* (1987) suggest poor correlation between the concentration of copper in soil and in worm tissue.

High concentrations of copper in soil can adversely affect growth, reproduction, and survivorship rates in earthworms. Earthworm rates of reproduction are generally more sensitive to the metal than mortality rates, and there is no evidence that any one genus of earthworms is less tolerant to copper, given the same set of conditions. After 6 weeks, a study reported that 2,000 milligrams per kilogram (mg/kg) of copper decreased growth of *E. foetida* by 75 percent and cocoon production by 85 percent; however, no adverse affects were observed at a concentration of 1,000 mg/kg (Neuhauser *et al.*, 1984). Spurgeon *et al.* (1994) kept adult *E. foetida* in soil contaminated with cupric nitrate [$Cu(NO_3)_2$] at a pH of 6.3 for 8 weeks to test the survival and growth rates. Lethal Concentration 50 percent (LC_{50}) was 555 mg/kg and Effects Concentration 50 percent (EC_{50}) for cocoon production was 53.3 mg/kg. In experiments by Ma (1987), soil with 1,000 mg/kg of cupric chloride [$CuCl_2$] caused an 82 percent decrease in survival on *Lumbricus rubellus*. Streit and Jaggy (1983) studied the effect of soil organic carbon on toxicity of cupric sulfate ($CuSO_4$) to the earthworm *Octolasium cyaneum*. The 14-day LC_{50} for soil with 3.2 percent organic carbon was

180 mg/kg, 850 mg/kg for soil with 14 percent organic carbon, and 2,500 mg/kg for soil with 43 percent organic carbon.

2.1.1.2 Lead

Due to the strong absorption of lead to soil organic matter, the bioavailability of lead is commonly limited. Organic compounds of lead are more bioavailable than inorganic lead. Compared to lead carbonate, lead sulfate is relatively soluble and likely to be more bioavailable. Lead can be bioaccumulated by plants and animals. The primary route of lead exposure to plants is through root uptake, though translocation to shoots is limited (Wallace *et al.*, 1977). Biomagnification of lead has not been reported. Earthworms may bioaccumulate lead (Roberts and Dorough, 1984; Beyer, 1990).

Earthworm (*E. foetida*) growth and survival have been shown to be reduced following exposure to soil-associated lead [as lead nitrate, $Pb(NO_3)_2$] for 8 weeks (Spurgeon *et al.*, 1994). In this study, the LC_{50} and EC_{50} (cocoon production) values for *E. foetida* were 3,760 mg/kg and 1,940 mg/kg, respectively. The 14-day LC_{50} value for adult *E. foetida* exposed to lead [as $Pb(NO_3)_2$] in artificial soil was 5,941 mg/kg (Neuhauser *et al.*, 1985). A 4-month study was carried out to discover the effects of lead to the earthworm (*Dendrobaena rubida*) at varying soil pH (Bengtsson *et al.*, 1986). Following exposure to 500 mg/kg lead in soil with a pH of 4.5, the number of cocoons produced per worm, hatchlings per cocoon, and percent of cocoons hatched were reduced by 75, 100, and 100 percent, respectively. No adverse effects were noted with exposure to 100 mg/kg lead at the same pH. At pH 5.5 and 6.5, no adverse effects to the earthworms were observed.

Lead poisoning in birds is particularly well documented, but most lead poisoning in wild birds results from ingestion of lead pellets. In contrast, lead poisoning of birds, such as raptors, from biologically incorporated lead is considered unlikely. A 7-month study on the toxicological effects of lead ingestion in American kestrels found that an oral dose of 3.85 milligrams per kilogram per day (mg/kg/d) did not cause any adverse reproductive effects (Sample *et al.*, 1996); this dose was considered a chronic No Observed Adverse Effect Level (NOAEL). A chronic Lowest Observed Adverse Effect Level (LOAEL) of 38.5 mg/kg/d was estimated by multiplying the chronic NOAEL by an uncertainty factor of 10. A 12-week study with Japanese quail found that oral exposures to lead acetate in the diet did not have any adverse reproductive effects at doses of 1.13 mg/kg/d (chronic NOAEL), although adverse effects were observed at a dose of 11.3 mg/kg/d (chronic LOAEL) (Sample *et al.*, 1996).

2.1.1.3 Mercury

Most mercury in soil is bound in the organic soil horizon (Steinnes, 1990; Lindquist *et al.*, 1991). Ionic forms of mercury are bound tightly to soil by forming complexes with organic matter in the upper soil horizon (Lindquist *et al.*, 1991). Schuster (1991) found that mercury absorption decreases with increasing pH. Lodenius *et al.* (1990) found that solid organic matter in acidified soil decreases leaching of mercury by 300 percent. The dominant mercury species in soil are gaseous elemental mercury (Hg^o), the mercuric ion (Hg^{2+}), and small amounts of monomethyl (CH_3Hg^+) and dimethylmercury [$(CH_3)_2Hg$] (Revis *et al.*, 1989; Steinnes, 1990; Schuster, 1991). The mercuric ion rarely occurs in the free ionic form under natural conditions due to its strong complexing with organic matter (Steinnes, 1990).

Mercury is persistent in the environment and may cause significant effects on ecological receptors. The form of mercury most readily assimilated by biota is methylmercury. Once incorporated in tissues, methylmercury is very slow to depurate. The rate of bioaccumulation of methylmercury is species- and site-specific.

Survival and cocoon production in the earthworm *Octochaetus pattoni* were reduced by 65 and 40 percent, respectively, following exposure to 0.5 mg/kg mercury (Abbasi and Soni, 1983); however, exposure did not affect the number of juveniles produced. Studies have shown the effect of methylmercury to survivorship and segment regeneration in the earthworm (*E. foetida*) (Beyer *et al.*, 1985). A concentration of 12.5 mg/kg mercury reduced survival by 21 percent, and the ability to regenerate excised segments was reduced by 69 percent. Furthermore, exposure to 2.5 mg/kg methylmercury had no effect [No Observed Effect Concentration (NOEC)]. A slug species (*Arion ater*) was used to determine the effect of mercury (as $HgCl_2$) on terrestrial mollusks (Marigomez *et al.*, 1986). After 27 days of dietary exposure, *A. ater* displayed a 26 percent decrease in growth at 1,000 mg/kg mercury, while 300 mg/kg had no effect.

A three-generation study on the effects of mercury (administered orally as methylmercury chloride) on the reproduction of rats indicated an LOAEL of 0.16 mg/kg/d because reduced pup viability was observed (Verschuuren *et al.*, 1976). A chronic NOAEL of 0.032 mg/kg/d was established because no adverse reproductive effects were observed at this level.

A 93-day study conducted on mink indicated that a dose of 1.8 ppm (administered orally as methylmercury chloride) caused mortality, weight loss, and behavioral abnormalities (Wobeser *et al.*, 1976). No adverse effects were observed at 1.1 ppm, so this dose was considered a chronic NOAEL. These values were converted to a daily dose of 0.25 mg/kg/d (chronic LOAEL) and 0.15 mg/kg/d (chronic NOAEL).

A literature search was conducted on the toxicological effects of mercury ingestion to birds. A 1-year study conducted on Japanese quail indicated that an oral dose of 0.9 mg/kg/d (as mercuric chloride) caused reduced fertility and egg hatchability (Sample *et al.*, 1996). This dose was considered a chronic LOAEL. No adverse reproductive effects were observed at a dose of 0.45 mg/kg/day. This dose was considered a chronic NOAEL.

Mallards fed methylmercury during a three-generation study showed significant reproductive effects (reduced egg and duckling production) at a daily dose 0.064 mg/kg/d (Sample *et al.*, 1996). This dose was considered a chronic LOAEL. A chronic NOAEL of 0.0064 mg/kg/d was estimated by multiplying the chronic LOAEL by an uncertainty factor of 0.1.

2.1.1.4 Zinc

In the environment, the most common form of zinc is in the +2 oxidation state. Zinc is highly reactive in soils and can be adsorbed to clay minerals or metallic oxides (Sachdev *et al.*, 1992). The active zinc species in the adsorbed state is the singly charged zinc hydroxide species [i.e., $Zn(OH)^+$] (Sanders and El Kherbawy, 1987). This metal forms stable complexes with organic substances such as humic and fulvic acids. Metallic zinc is insoluble, but the solubilities of zinc compounds range from insoluble (oxides, carbonates, phosphates, silicates) to extremely soluble (sulfates and chlorides) (Environment Canada, 1996).

Zinc solubility and mobility increases with decreasing soil pH. In soils with pH above 7.7, zinc hydroxide [$Zn(OH)_2$] becomes the dominant form and solubility is very low. Zinc in a soluble form, such as zinc sulfate, is fairly mobile in most soils; however, relatively little zinc in most soils is in soluble form, and mobility is, therefore, limited by a slow rate of dissolution. Low pH (less than 7) and high ionic strength of the leaching solution favor desorption (Saeed and Fox, 1977; EPA, 1987).

E. foetida exposed to zinc [as zinc nitrate, $Zn(NO_3)$] exhibited lethal and sublethal effects (e.g., growth effects) (Spurgeon and Hopkin, 1995). Zinc exposure resulted in estimated LC_{50} and EC_{50} (growth) values of 216 mg/kg and 400 mg/kg, respectively. Further studies evaluating the effects of zinc (as zinc acetate) in horse manure to *E. foetida* showed reduced cocoon production (Malecki *et al.*, 1982). Following an 8-week exposure, 2,000 mg/kg resulted in a 36 percent decrease in cocoon production, while 1,000 mg/kg had no effects. Following a 20-week exposure, 5,000 mg/kg resulted in a 53 percent reduction in cocoon production, while 2,500 mg/kg had no effect. Following zinc exposure in soil, the terrestrial isopod, *Porcellio scaber,* exhibited prolonged molting (Drobne and Strus, 1996). The NOEL for *P. scaber* molting was 250 mg/kg.

Zinc toxicity to earthworms (*E. foetida*) was evaluated through studies with a range of artificial soils having varying organic content and pH (Spurgeon and Hopkin, 1996). In general, mortality increased as zinc concentrations increased, and a decrease in pH and organic matter (i.e., within the range tested) tended to decrease zinc toxicity. Depending on soil chemistry, the estimated EC_{50} values (cocoon production) for this study ranged from 136 mg/kg to 592 mg/kg. Studies in which adult earthworms were exposed to $Zn(NO_3)$ in artificial soil (pH 6) were used to estimate LC_{50} values (Neuhauser *et al.*, 1985). Following 14 days of exposure, an LC_{50} value of 662 mg/kg was calculated.

Reproduction in chickens exposed to zinc in the diet for 44 weeks was not adversely affected at a daily dose of 14.5 mg/kg/d, but was adversely affected at 131 mg/kg/d. These doses are considered chronic NOAEL and LOAEL values, respectively (Sample *et al.*, 1996).

2.1.2 Semivolatile Organics

Acetophenone

Information about the toxicity of acetophenone to soil invertebrates was not located in the literature.

Carbazole

Sverdrup *et al.* (2002) reported an NOEC, a growth Effects Concentration 10 percent (EC_{10}), a growth EC_{50}, and an LC_{50} of 31 mg/kg, 35 mg/kg, 54 mg/kg, and 106 mg/kg, respectively, for the earthworm, *E. veneta.* An NOEC, a growth EC_{10}, a growth EC_{50}, and an LC_{50} of 17 mg/kg, 10 mg/kg, 35 mg/kg, and 2,500 mg/kg, respectively, were calculated for the collembolan, *F. fimetaria* (Sverdrup *et al.*, 2001). No other information about the toxicity of carbazole to soil invertebrates was located in the literature.

Dibenzofuran

Dibenzofuran is a polynuclear aromatic compound that may be found in coke dust, grate ash, fly ash, and flame soot. It has been listed as a pollutant of concern to EPA's Great

Waters Program because of its persistence in the environment, potential to bioaccumulate, and toxicity to the environment. Sverdrup *et al.* (2002) reported an NOEC, a growth EC_{10}, a growth EC_{50}, and an LC_{50} of 30 mg/kg, 36 mg/kg, 61 mg/kg, and 78 mg/kg, respectively, for the earthworm (*E. veneta*). An NOEC, a growth EC_{10}, a growth EC_{50}, and an LC_{50} of 14 mg/kg, 19 mg/kg, 23 mg/kg, and 50 mg/kg, respectively, were calculated for the collembolan, *F. fimetaria* (Sverdrup *et al.*, 2001). No other information about the toxicity of dibenzofuran to soil invertebrates was located in the literature.

2.1.3 Polynuclear Aromatic Hydrocarbons (PAHs)

PAHs are virtually ubiquitous in nature, primarily as a result of natural processes such as forest fires, microbial synthesis, and volcanic activity. Anthropogenic sources of PAHs in the environment include the high-temperature combustion of organic materials typical of processes used in the steel industry, heating and power generation, and petroleum refining. They have been detected in animal and plant tissues, sediments, soils, air, surface water, drinking water, and groundwater.

In most multicellular organisms, however, PAHs show little tendency for long-term bioaccumulation despite their high lipid solubility, probably because most PAHs are rapidly metabolized (Eisler, 1987).

Information on PAH-toxicity to soil invertebrates as a group is largely inferred from information on benzo(a)pyrene [B(a)P]. Salt-marsh caterpillars *(Estigmene aerea)* were observed to excrete most ingested B(a)P as fecal products. Approximately 50 percent of the 50 micrograms (µg) of B(a)P fed to two caterpillars was excreted intact, while most of the remainder was degraded by hydroxylation and conjugation to highly polar derivatives (Lu *et al.*, 1977). Isopods *(Porcellio saber)* fed leaf litter contaminated with 0 to 125 mg B(a)P per kg leaf showed minimal mortality unrelated to B(a)P exposure. These results supported previous aquatic toxicity data that suggested a low acute toxicity for B(a)P (Neff, 1979; van Straalen and Verweij, 1991). Exposure to the highest level of B(a)P resulted in a significant increase in the rate of food assimilation and a significant decrease in the growth efficiency of male animals only, but the reasons for these changes were unclear. No other effects related to B(a)P ingestion were observed (van Straalen and Verweij 1991). Earthworms *(E. foetida)* exposed to deposits of B(a)P on filter paper for 48 hours showed an LC_{50} greater than 1,000 µg per square centimeter (Roberts and Dorough, 1984). Repeated dermal applications of a 0.5 percent solution of B(a)P to the earthworm (*L. terrestris)* resulted in hyperplasia and incipient tumors both at the application site and at other parts of the body after 8 to 10 weeks of exposure (Montizaan *et al.*, 1989).

NOEC, growth EC_{10}, growth EC_{50}, and LC_{50} values for fluoranthene, fluorene, phenanthrene, and pyrene have been established for the earthworm (*E. veneta*) (Sverdrup *et al.*, 2002) and the collembolan (*F. fimetaria*) (Sverdrup *et al.*, 2001). *F. fimetaria* was more sensitive than *E. veneta,* with NOECs ranging from 13 mg/kg (pyrene) to 47 mg/kg (fluoranthene), as compared to 28 mg/kg (fluorene) to 98 mg/kg (fluoranthene) for *F. fimetaria*. LC_{50} values were also lower for the *F. fimetaria,* ranging from 41 mg/kg (phenanthrene) to 81 mg/kg (fluoranthene), as compared to 69 mg/kg (fluorene) to 416 mg/kg (fluoranthene) for *F. fimetaria*.

Toxicity information for total PAHs was not located in the literature. A Dutch soil quality standard screening value for total PAHs is available, and, using the site-specific total organic carbon (TOC) adjustment, was calculated at 12,915 µg/kg (MHSPE, 1994).

2.2 Conceptual Model

Figure 2-1 presents the conceptual site model for ecological receptors at the Lab Area. The model integrates information regarding the physical characteristics of the site, potentially exposed receptors, sources of contamination, and contaminant mobility (fate and transport) to identify exposure routes, receptors, and endpoints. A well-defined conceptual site model allows for a better understanding of the risks at a site and aids in the identification of the potential need for remediation. Figure 2-1 has been revised to reflect the results of the SERA and Step 3A from the remedial investigation.

2.2.1 Exposure Pathways

Copper, lead, mercury, zinc, acetophenone, carbazole, dibenzofuran, and PAHs are present in Lab Area surface soil, possibly owing to past disposal activities. Mercury is known to be present from past disposal activities as described in the RI Report. The source of contamination is historic disposal of laboratory waste near the laboratory buildings. The ecological receptors are terrestrial species that have contact with the soil (e.g., soil invertebrates, American robin, and white-footed mouse) or consume organisms that have direct contact with the soil (e.g., American robin and white-footed mouse).

2.2.2 Assessment Endpoints

Refined assessment endpoints for the BERA are as follows:

Survival and growth of soil invertebrates— Soil invertebrates serve as a forage base for many terrestrial species. The soils at the site will support fewer birds and mammals if chemical concentrations are limiting the survival, growth, and reproduction of soil invertebrates.

Survival, growth, and reproduction of insectivorous birds— These receptors are third-order consumers and, thus, are more susceptible to bioaccumulative chemicals, especially those that have the potential to biomagnify. The American robin (*Turdus migratorius*) was chosen to represent this endpoint. Robins live in a variety of habitats, including woodlands, swamps, suburbs, and parks. They forage on the ground in open areas, along edge habitats, or along the edges of streams. Robins forage for ground-dwelling invertebrates and search for fruit and foliage-dwelling insects in low tree branches (Malmborg and Willson, 1988). As robins forage for soil invertebrates, their exposure to soil contamination would likely be significant.

Survival, growth, and reproduction of omnivorous terrestrial mammals— These receptors are second-order consumers and, thus, are more susceptible to bioaccumulative chemicals, especially those that have the potential to biomagnify. The white-footed mouse (*Peromyscus leucopus*) was chosen to represent this endpoint. The white-footed mouse inhabits nearly all types of dry-land habitats within its range (Burt and Grossenheider, 1980). They are opportunistic feeders, and eat seeds, arthropods, some green vegetation, roots, and fruit.

2.2.3 Risk Hypotheses

Risk hypotheses are questions about how assessment endpoints could be affected. Risk hypotheses clarify and articulate relationships that are possible through consideration of available data, information from the scientific literature, and the best professional judgment of risk assessors. The risk hypotheses/questions associated with the assessment endpoints include the following:

1. Are the concentrations of copper, lead, mercury, zinc, acetophenone, carbazole, dibenzofuran, and PAHs in surface soil at the Lab Area impairing the survival and growth of soil invertebrate communities to the extent that the prey base to support terrestrial insectivores has been adversely affected?
2. Is lead, mercury, or zinc in the surface soil at the Lab Area bioaccumulating in soil invertebrates to the extent that the growth, survival, or reproduction of omnivorous terrestrial mammals and insectivorous birds that forage at the site may be impaired?

2.2.4 Measurement Endpoints

Measurement endpoints are measures of biological effects (e.g., laboratory toxicity test results) that are related to each respective assessment endpoint (EPA, 1997). Table 2-1 shows the measurement endpoints associated with each assessment endpoint for the Lab Area.

TABLE 2-1
MEASUREMENT ENDPOINTS AT THE LAB AREA

Assessment Endpoints	Measurement Endpoints
Survival and growth of soil invertebrate communities.	Comparison of results of 28-day soil toxicity tests (survival and growth) with the earthworm (*E. foetida*) using site and reference soils.
Survival, growth, and reproduction of birds and mammals that feed on soil invertebrates at the site.	Comparison of estimated exposure dose to toxicity reference value using site-specific bioaccumulation data obtained from lead, mercury, and zinc concentrations in earthworm tissue (from soil bioassays) to a reference LOAEL-based HQ of 1.0. As stated in the Data Quality Objectives of the BERA Work Plan (CH2M HILL, 2005), the American robin (avian insectivore) and white-footed mouse (mammalian omnivore) are considered the surrogates for birds and mammals, respectively.

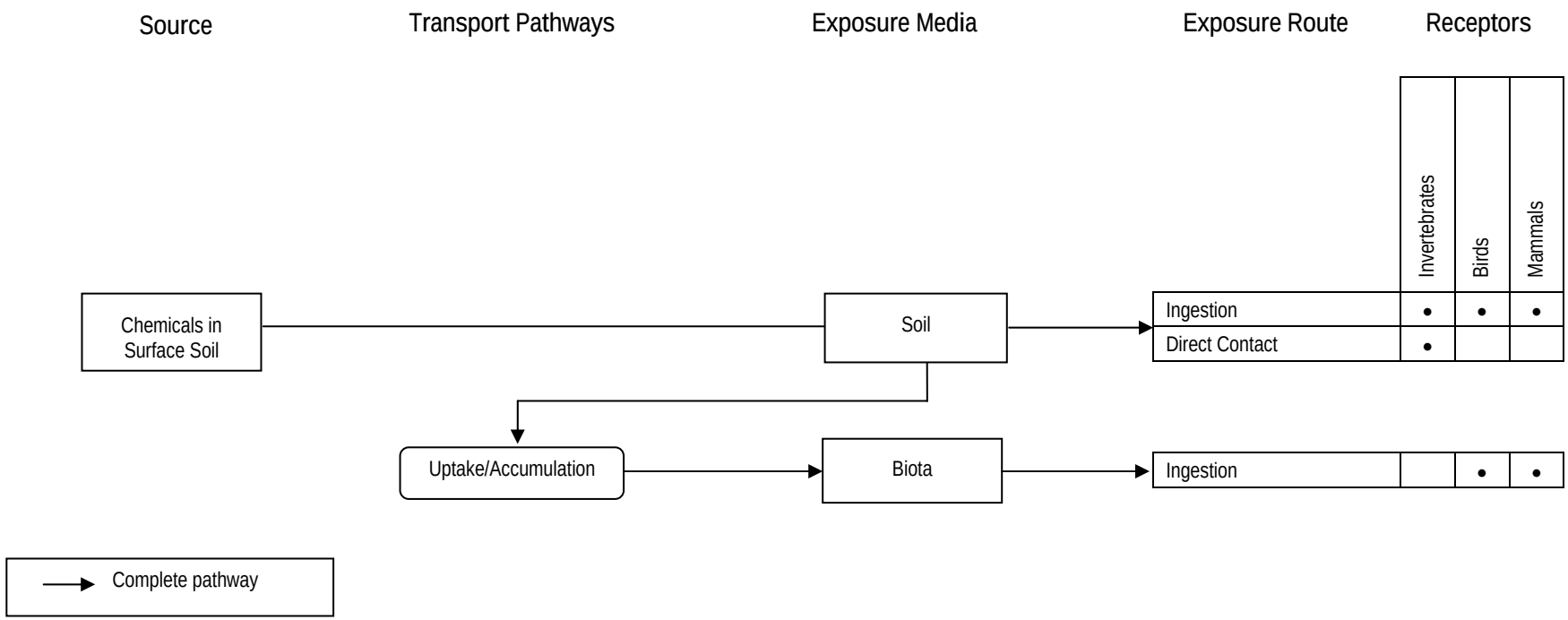


Figure 2-1
Ecological Conceptual Model
BERA Report
NSF-IH, Indian Head, Maryland

CH2MHILL

SECTION 3

Investigation Activities

Investigation activities for the BERA were conducted at the Lab Area in May 2005 in accordance with the approved *Final Work Plan for Baseline Ecological Risk Assessment, Lab Area* (herein referred to as BERA Work Plan) (CH2M HILL, 2005). The following sections discuss sampling procedures and laboratory analyses for the soil invertebrate community, upper-trophic-level receptors, and reference sample.

3.1 Soil Invertebrate Community

Surface soil samples were collected from ten locations (TX01 through TX10) at the Lab Area on May 23 and 24, 2005. Figure 3-1 shows the sample locations, which were surveyed with a Global Positioning System (GPS). The BERA Work Plan outlines the rationale for the selection of the sample locations.

Soil samples were collected from a depth of 0 to 6 inches below ground surface to capture the bulk of the biologically active zone, because the O- and A-soil-horizons (the upper soil horizons that contain decaying organic matter) at the site are thin and not well developed. All soil samples were analyzed for TAL metals, methylmercury, PAHs (SIM method), SVOCs, pH, total organic carbon (TOC), and grain size (by sieve analysis). To evaluate direct toxicity to soil invertebrates, laboratory toxicity tests were conducted on split samples from the soil sampling locations. At each location, sufficient sample volume to conduct the tests was collected and mixed to a consistent color and texture in the field before filling bottles for chemical and toxicological analyses.

E. foetida was used as the test organism for the toxicity testing. The toxicity tests were conducted for 28 days, with growth and survival as test endpoints. The growth and survival of test organisms in the site soil were statistically compared with the results of these parameters in the reference and control soils. An alpha level of 0.05 was used in the statistical comparisons, which corresponds to a 5 percent chance of incorrectly concluding that the response of the site samples is statistically equivalent to the reference or control samples, when in fact they are statistically different.

3.2 Upper-Trophic-Level Receptors

To more accurately characterize the potential risk to birds and mammals that might consume soil invertebrates from the Lab Area, the test earthworms were analyzed for Target Analyte List (TAL) metals and methylmercury at the conclusion of the soil toxicity tests. The earthworms were not depurated prior to analysis to account for soil exposure to metals COPCs in the gut content of the earthworms. The concentrations of metal COPCs (lead, mercury, and zinc) in the tissue samples were used to estimate exposure to insectivorous birds and omnivorous mammals. Only the COPCs were considered in the evaluation (the remaining TAL metals were not evaluated).

The ingestion-based exposure model presented in the SERA and Step 3A in the RI Report was used to estimate exposure, but modified by replacing the literature-derived factors used in the SERA and Step 3A with actual site-specific bioaccumulation data from the earthworm bioassays. Unacceptable risk constituted of exceedance of LOAEL-based reference toxicity values for these receptors.

3.3 Reference Sample

A surface soil reference sample, ISLBSSREF1, was collected from a location known to be free of contamination (Figure 3-2). The soil reference site was one of the sampling locations (BGDSS03) used in the *Background Soil Investigation Report for Indian Head and Stump Neck Annex* (TTNUS, 2002). This location is in an undeveloped, wooded area. The location was selected to ensure that the reference soil closely resembled the physical characteristics of the site soil (i.e., similar grain size and amount of organic material). The reference soil was analyzed for the same parameters as the site samples: TAL metals, methylmercury, PAHs (SIM method), SVOCs, pH, total organic carbon (TOC), and grain size (by sieve analysis)

The survival and growth of the organisms exposed to the reference soil was statistically compared to the response of organisms exposed to the site soil to ensure that only risk from site-related chemicals (at levels above basewide background) was evaluated. The responses of organisms to the control soil were also compared to the responses to site and reference soils to evaluate the results of the toxicity tests.

SECTION 4

Investigation Results

Potential risk to the soil invertebrate community was evaluated using soil toxicity tests. Risk estimates for birds and mammals that might forage at the Lab Area were refined by estimating exposure, using the concentrations of COPCs in earthworm tissue obtained at the conclusion of the soil toxicity tests. Grain size data are presented in Appendix A. Analytical data are presented in Appendix B. Toxicity test data are presented in Appendix C. Food web exposure model is presented in Appendix D.

4.1 Soil Chemistry and Physical Characteristics

All soil samples (site and reference) were analyzed for copper, lead, mercury, zinc, methylmercury, SVOCs, pH, TOC, and grain size. Physical properties of soil, such as grain size distribution and TOC content, can directly affect the environmental fate and bioavailability of contaminants. For example, soils with more silt and clay and high TOC will generally retain contaminants adsorbed to the particles more so than soils with a more sand and gravel content and less TOC. Furthermore, some contaminants are less bioavailable in soils with a high TOC content because the contaminants are bound to the organic matter in the soil and, thus, are not readily available for uptake by organisms.

Grain size distribution curves for the soil samples are included in Appendix A. The TOC data are presented in Table B-1 in Appendix B. The grain size distribution curves reflect variability between the reference sample and site samples and within the site samples. Table 4-1 provides a summary of the grain size distribution and TOC for all samples. Except for samples ISLBSS02, ISLBSS04, ISLBSS06, and ISLBSS07, which show the percent of fines (silt and clay) to be less than 50 percent, all other site samples and the reference sample have percent fines greater than about 60 percent. With respect to the fractions coarser than the fines, the percentages vary as shown on the table. The grain size distribution varies among the site samples with ranges for each size fraction as follows: 27.4 to 75.5 percent silt and clay, 16.1 to 28.4 percent fine sand, 5 to 21.9 percent medium sand, 0.9 to 6.5 percent coarse sand, and 0 to 34 percent gravel. The TOC content of the reference sample (28,200 mg/kg, or 2.82 percent) was within the range measured in the site samples (4,700 to 34,300 mg/kg or 0.47 to 3.43 percent, respectively).

Analytical results of the surface soil samples collected from the ten locations at the Lab Area and one reference location are presented in Table B-1 in Appendix B. Table 4-2 presents the summary statistics for the COPCs and methylmercury. COPC metals were detected in all samples. Acetophenone was detected in two samples, whereas carbazole and dibenzofuran were not detected. One or more individual PAH was detected in all samples and were used to calculate the total PAHs (i.e., the sum of the 10 individual PAHs was used to derive the total PAHs soil invertebrate screening value).

4.2 Soil Toxicity

The soil toxicity testing report, including raw data, summary tables, and statistical analyses, is provided in Appendix C. Toxicity tests were conducted with earthworms (*E. foetida*), exposed to soil collected from the ten locations at the Lab Area, one reference location, and laboratory control. The toxicity tests were conducted for 28 days with survival and growth as test endpoints. Earthworm reproduction results are included in the soil toxicity testing report, but are not considered in the evaluation of risk to soil invertebrates. Laboratory measurements of earthworm reproduction can be unreliable due to the life cycle *E. foetida*, which is 6 to 9 months (ASTM, 2004). Therefore, the worms that are used in the tests are assumed to be sexually mature, but in fact may or may not be in reproductive mode at the time of the test. In addition, reproductive output can be directly affected by non-chemical confounding factors such as the variability of TOC content in the samples. For these reasons, earthworm reproduction was not included as a measurement endpoint for the BERA.

The mean survival of earthworms in the laboratory control sample and reference samples was 100 percent and 97.5 percent, respectively (Table 4-3). The mean survival in the Lab Area samples was 100 percent in all samples, except the duplicate for ISLBSS080505, which was 97.5 percent. Statistical analysis of the site data to the reference and to the control showed that there was no statistically significant reduction in survival in the site samples.

Earthworm growth was 0.485 mg (average weight per earthworm) in the reference sample, 0.415 mg in the control sample, and ranged from 0.373 mg to 0.438 mg in the site samples (Table 4-3). Comparison of growth in the site samples to growth in the control sample indicates that only soil sample from location ISLBTX08 exhibited a statistically significant reduction in growth. Comparison of growth in the site samples to growth in the reference sample indicates that all site samples except soil samples from locations ISLBTX01 and ISLBTX11 exhibited a statistically significant reduction in growth.

4.3 Earthworm Tissue

Earthworm tissue data for earthworms exposed to soil collected from the ten locations at the Lab Area and the reference location are presented in Table B-2 in Appendix B. The COPC concentrations in the earthworm tissue samples were used to refine the risk estimate for birds and mammals that might forage at the Lab Area. Table 4-4 presents the summary statistics of the COPC concentrations in earthworm tissue samples.

The American robin and white-footed mouse were chosen as the surrogate species to represent the bird and mammal receptor groups that might forage on earthworms at the Lab Area. The ingestion-based exposure model used in the SERA and Step 3A was modified to refine the risk estimate for these receptors by including site-specific earthworm tissue data. The food web model, modifications to the food web model, and the ingestion screening values to which the exposure doses were compared are described in Appendix D. Calculated NOAEL-based and LOAEL-based HQs for the American robin and white-footed mouse are presented in Table 4-5. All LOAEL-based HQs were less than 1.0 for both receptors.

All NOAEL HQs were less than 1.0 except for mercury (HQ= 3.5) in the white-footed mouse. The NOAEL HQ for lead exposure to American robin was 1.0. Although the NOAEL HQ for mercury in the white-footed mouse exceeded 1.0, the LOAEL HQ was below 1.0 and the Maximum Acceptable Threshold Concentration (MATC) [(average of the NOEAL and LOAEL] HQ is 1.6. In addition, the risk to the white-footed mouse is considered to be overestimated because of the following: (1) The total exposure for the white-footed mouse was based almost entirely on estimated mercury in plant tissue; and (2) Literature-derived bioconcentration factors (BCFs) for mercury were found to overestimate mercury uptake at the site, as indicated in earthworm tissue concentrations. Typically, soil-to-earthworm BCFs for mercury are higher than soil-to-plant BCFs. Considering the marginal exceedence of the MATC value and the likely overestimation of risk to the white-footed mouse, the potential risk to omnivorous mammals is considered acceptable.

TABLE 4-1

SUMMARY OF GRAIN SIZE DISTRIBUTION AND TOC FOR SURFACE SOIL SAMPLES

Sample ID	% Silt and Clay	% Fine Sand	% Medium Sand	% Coarse Sand	% Gravel	% TOC
Reference (ISLBSSREF1)	62.2	26.9	10.2	0.7	0	2.82
ISLBSS010505 (TX01)	68.2	24.6	5.6	1.5	0	1.10
ISLBSS020505 (TX02)	32.3	25.7	15.7	6.5	19.9	3.43
ISLBSS030505 (TX03)	59.6	25.6	8.5	1.4	5	1.04
ISLBSS040505 (TX04)	35.7	22.8	21.9	4.2	15.5	2.65
ISLBSS050505 (TX05)	63.4	16.1	5	1.6	13.9	1.22
ISLBSS060505 (TX06)	47.5	28.4	16.5	1.1	6.4	1.88
ISLBSS070505 (TX07)	27.4	18.6	14.8	5.2	34	2.69
ISLBSS080505 (TX08)	73.1	18.3	6.2	1.9	0.6	1.93
ISLBSS080505 – Duplicate (TX11)	65.7	20.7	9.8	1.5	2.4	2.67
ISLBSS090505 (TX09)	64.7	25.6	7.1	1.8	0.7	0.47
ISLBSS100505 (TX10)	75.5	16.1	7.2	0.9	0.3	2.50

TABLE 4-2

SUMMARY STATISTICS FOR COPCS IN SURFACE SOIL SAMPLES

COPC	Reference Sample	Range of Non-Detected Values	Frequency of Detection	Range of Detected Values	Sample ID of Maximum Concentration	Arithmetic Mean [1]	Standard Deviation of Mean
Metals (mg/kg)							
Copper	10.1	-- - --	10 / 10	7.6 - 127	ISLBSS070505	32.0	37.9
Lead	26.5	-- - --	10 / 10	32.1 - 850	ISLBSS100505	236	296
Total Mercury	0.19	-- - --	10 / 10	0.75 - 127	ISLBSS070505	26.7	40.1
Methylmercury	0.000048	-- - --	10 / 10	0.000307 - 0.00249	ISLBSS020505	0.0012	0.0006
Zinc	19.3	-- - --	10 / 10	40 - 576	ISLBSS070505	166.2	183.7
SVOCs (µg/kg)							
Acetophenone	460 (ND)	380 - 430	2 / 10	410 - 530	ISLBSS070505	259	123
Carbazole	460 (ND)	380 - 430	0 / 10	-- - --	NA	203	8.23
Dibenzofuran	460 (ND)	380 - 430	0 / 10	-- - --	NA	203	8.23
Total PAHs [2]	4600 (ND)	-- - --	10 / 10	93.4 - 5801	ISLBSS050505	1631	1625

[1] Arithmetic mean calculated using one-half of reporting limit for non-detects

[2] Total PAHs is the sum of 10 individual PAHs: anthracene, benzo(a)anthracene, benzo(a)pyrene, benoz(k)fluoranthene, benzo(g,h,i)perylene, chrysene, fluoranthene, indeno(1,2,3-c,d)pyrene, naphthalene, and phenanthrene. Individual PAHs that were not detected were included at their reporting limit in the calculation of the total PAHs.

"—" Not applicable because it was detected or not detected in all samples

NA – Not Applicable because it was not detected.

ND – Not Detected

TABLE 4-3
SURFACE SOIL TOXICITY TEST RESULTS FOR EARTHWORM SURVIVAL AND GROWTH

Sample	Survival (%)	Significant Difference?	Growth (mg)	Significant Difference?
Control	100	--	0.415	--
Reference (ISLBSSREF1)	97.5	--	0.482	--
ISLBSS010505 (TX01)	100	No	0.455	No
ISLBSS020505 (TX02)	100	No	0.400	Yes (Reference)
ISLBSS030505 (TX03)	100	No	0.435	Yes (Reference)
ISLBSS040505 (TX04)	100	No	0.410	Yes (Reference)
ISLBSS050505 (TX05)	100	No	0.428	Yes (Reference)
ISLBSS060505 (TX06)	100	No	0.435	Yes (Reference)
ISLBSS070505 (TX07)	100	No	0.410	Yes (Reference)
ISLBSS080505 (TX08)	100	No	0.373	Yes (Control and Reference)
ISLBSS080505 – Duplicate (TX11)	97.5	No	0.453	No
ISLBSS090505 (TX09)	100	No	0.438	Yes (Reference)
ISLBSS100505 (TX10)	100	No	0.413	Yes (Reference)

TABLE 4-4
SUMMARY STATISTICS OF COPCS IN EARTHWORM TISSUE SAMPLES

COPC	Reference Sample	Range of Non-Detected Values	Frequency of Detection	Range of Detected Values	Sample ID of Maximum Concentration	Arithmetic Mean [1]	Standard Deviation of Mean
Metals (mg/kg)*							
Lead	9.2	-- - --	10 / 10	3.6 - 133	ISLBTX10	29	41
Total Mercury	0.037 (ND)	-- - --	10 / 10	0.11 - 130	ISLBTX07	15.5	40.4
Methylmercury	0.0012 (ND)	-- - --	10 / 10	0.0018 - 0.09	ISLBTX02	0.022	0.026
Zinc	18.1	-- - --	10 / 10	18.5 - 68.6	ISLBTX10	34.1	17.3

[1] Arithmetic mean calculated using 1/2 reporting limit for non-detects
ND – Not Detected
"—" Not applicable because it was detected in all samples
*Concentrations are reported in wet weight.

TABLE 4-5
RESULTS OF EXPOSURE CALCULATIONS FOR UPPER TROPHIC LEVEL RECEPTORS

COPC	NOAEL-based Hazard Quotient		LOAEL-based Hazard Quotient	
	American Robin	White-footed Mouse	American Robin	White-footed Mouse
Lead	1.0	0.1	0.2	<0.1
Mercury	<0.1	3.5	<0.1	0.7
Zinc	0.3	<0.1	<0.1	<0.1

SECTION 5

Risk Characterization

5.1 Assessment Endpoints

Risk to each of the assessment endpoints described in Section 2.2.2 are characterized below.

Survival and growth of soil invertebrates – The results of the soil invertebrate toxicity tests indicate that soil invertebrate survival is not affected at the Lab Area. Significantly reduced growth was observed in nine earthworm ?? samples (eight sample locations plus one duplicate) and was further evaluated with a comparison to COPC concentrations. Carbazole and dibenzofuran were not detected in any surface soil samples and were eliminated as COPCs. Acetophenone was detected in soil or earthworm ?? samples from ISLBSS07 and ISLBSS08. Because significantly reduced growth was observed in nine samples, the contribution of acetophenone to observed effects, if any, is limited to these two sample locations. Concentrations of copper, lead, and zinc also exceeded screening values at only two sample locations (ISLBSS07 and ISLBSS10). PAHs were detected in all samples, with the maximum concentration at ISLBSS07 (5,801 µg/kg); however, in comparison to the total organic carbon adjusted screening value for PAHs (MHSPE, 1994), only the concentration at ISLBSS05 exceeded the screening level. In contrast, mercury was detected above screening levels in all surface soil samples. Therefore, the contribution of all COPCs, except mercury, to the observed decrease in growth (if any) is occurring in only a limited area that is unlikely to affect the soil invertebrate community at the Lab Area.

Mercury (total and methylmercury) was further evaluated as a COPC for growth using correlation analyses. Scatter plots of earthworm growth versus total mercury and methylmercury are shown in Figures 5-1 and 5-2, respectively. Total mercury was weakly correlated with earthworm growth ($r^2 = 0.29$). A strong negative correlation ($r^2 = 0.60$) was observed with increasing methylmercury concentrations and decreasing growth, which suggests that methylmercury in Lab Area surface soil may reduce soil invertebrate growth.

Although methylmercury may contribute to reduced growth in soil invertebrates at the Lab Area, the level of effect is unlikely to impair the soil invertebrate community. Nine of eleven samples had significantly reduced growth, compared to the reference sample, and sample ISLBSS080505 had significantly reduced growth compared to the control. In contrast, soil invertebrate growth in the duplicate sample to ISLBSS080505 was not significantly reduced when compared to both the control and reference (uncertainties associated with this duplicate sample are discussed in Section 5.2).

Although reproductive data are reported in Appendix C, apparent effects to earthworm reproduction should not be considered when evaluating the overall effect in this bioassay. Laboratory measurements of earthworm reproduction can be unreliable due to the life cycle *E. foetida*, which is 6 months to 9 months (ASTM, 2004). Therefore, the worms that are used in the tests are assumed to be sexually mature, but in fact may or may not be in reproductive

mode at the time of the test. In addition, reproductive output can be directly affected by non-chemical confounding factors [e.g., the variability of TOC content in the samples]. For these reasons, earthworm reproduction was not included as a measurement endpoint for the BERA.

The problems associated with using the reproduction endpoint are evident in the results for this study; the lowest reproduction was observed in sample ISLBSS0010505 (TX01), which demonstrated the highest earthworm survival and growth (i.e., less energy expended on reproduction would leave more energy to support growth); while the highest reproduction was observed in sample ISLBSS0080505 (TX08), which demonstrated the lowest earthworm growth (i.e., more energy was likely expended for reproduction, leaving less available to support growth).

Although significant differences from a reference population should also be considered when evaluating the level of effect (Suter *et al.,* 1995), this comparison may not be suitable in this case because the reference sample outperformed the control sample. Because the level of effects in site samples were equivalent to those in the control sample and, thus, are unlikely to affect the soil invertebrate community, risks to the soil invertebrate community are not presumed to pose unacceptable levels of risk, and no further investigation is required.

Survival, growth, and reproduction of insectivorous birds – The results of the earthworm tissue analyses and exposure calculations for insectivorous terrestrial birds indicate that the risks to these receptors from COPCs in surface soils at the site are within ranges presumed to be acceptable. HQs based on the LOAEL were less than 1, indicating that population-level impacts are likely not occurring and no further investigation is required.

Survival, growth, and reproduction of omnivorous terrestrial mammals – The results of the earthworm tissue analyses and exposure calculations for omnivorous terrestrial mammals indicate that the risks to these receptors from COPCs in surface soils at the site are within ranges presumed to be acceptable. HQs based on the LOAEL were less than 1, indicating that population-level impacts are likely not occurring and no further investigation is required.

5.2 Uncertainties

Uncertainties are present in all risk assessments because of the limitations of the available data and the need to make certain assumptions and extrapolations based on incomplete information. The uncertainties in this BERA are principally attributable to the following factors:

- Selection of COPCs – Acetophenone, carbazole, and dibenzofuran were retained as COPCs from the SERA and Step 3A, but had no screening values. During the BERA these chemicals were either not detected or infrequently detected. Because available data suggest that organic contaminants are not the primary ecological concern at the Lab Area, the undetected organics, if present, are expected to pose acceptable levels of risk.
- Ingestion Screening Values - Data on the toxicity of lead, mercury, and zinc to the American robin and white-footed mouse were lacking, requiring the extrapolation of data from other wildlife species or from laboratory studies with non-wildlife species. This is a typical limitation and typical extrapolation for ERAs because so few wildlife

species have been tested directly for most chemicals. The uncertainties associated with toxicity extrapolation were minimized by selecting the most appropriate test species for which suitable toxicity data were available. The factors considered in selecting a test species to represent a receptor species included taxonomic relatedness, trophic level, foraging method, and similarity of diet.

A second uncertainty related to the derivation of ingestion screening values for lead and zinc relates to the toxicological studies, which used forms of the metals (e.g., salts) that had high water solubility and high bioavailability to receptors. For lead and zinc, the analytical samples on which site-specific exposure estimates were based involved total metal. Since these highly bioavailable forms are expected to compose only a fraction of the total metal concentration, overestimation of potential risks for these chemicals likely results.

- Chemical Mixtures - Information on the ecotoxicological effects of chemical interactions among copper, lead, mercury, zinc, and PAHs is generally lacking, which required (as is standard for ERAs) that the chemicals be evaluated on a compound-by-compound basis during the comparison to screening value (PAHs were evaluated as a total). This could result in an underestimation (if there are additive or synergistic effects among chemicals) or an overestimation of risks (if there are antagonistic effects among chemicals).

- Food Web Exposure Modeling - Chemical concentrations in plants were modeled from soil concentrations and were not directly measured. The use of generic, literature-derived exposure models and bioaccumulation factors introduces some uncertainty into the resulting estimates. The values and methodology selected and employed were intended to provide a reasonable estimate of potential food web exposure concentrations.

  Area use factors were assumed to equal one. This is a conservative assumption because a percentage of the robin's time could be spent foraging offsite in areas where chemical concentrations are expected to be significantly lower.

- Reference Area Suitability - The growth of earthworms in the reference area samples exceeded growth in the control sample. Statistical comparisons were conducted between Lab Area samples and reference samples as well as between Lab Area samples, reference samples, and laboratory controls. The test results indicated that growth in Lab Area soils was significantly reduced compared to the reference sample, but not to the control sample. Failure to choose appropriate reference sites could result in inaccurate conclusions concerning bioassay results that will introduce uncertainty into the overall risk conclusions (EPA, 1994).

- Duplicate Sample Usability – Significant differences in earthworm growth between the reference and control samples were observed in sample ISLBSS080505, but not the duplicate sample. The differences may be due to several reasons, including inadequate homogenization of the collected sample, which limits its usability. Because both samples were used in the correlation analyses, the resulting coefficients may be over- or underestimated (i.e., a weaker or stronger negative correlation may be present). This uncertainty has a negligible impact on the risk conclusions, however, because low-

magnitude effects on growth (less than 20 percent) were observed in all of the remaining sample locations.

- Level of Statistical Significance Used to Interpret Bioassay Results - It is desirable for both alpha and beta to be as small as possible to minimize the chance of making a Type I (rejecting the tested hypothesis when it is true) or Type II error (accepting the tested hypothesis when it is false), respectively, when evaluating bioassay results; however, to reduce beta for a fixed alpha level, the number of replicates used for each sample would need to be increased. The number of replicates is specified in the protocol for this bioassay and one would assume that the design has been optimized to balance the chance of making a Type II error versus increasing analysis costs unnecessarily. It is likely that the beta value is higher than the alpha value in this analysis; however, this ensures if an error is made in evaluating the tested hypothesis, it is more likely that the error will be more protective of the environment, rather than less protective (i.e., a conclusion of a significant difference will be found, when in fact there is no statistical difference). This adds some uncertainty to the conclusions regarding the bioassay results, but ultimately the uncertainty should minimize the chance of incorrectly concluding that the response of organisms in the site samples are equivalent to those of the reference or control samples (i.e., making a Type I error).

- Toxicity Test Results - There is uncertainty associated with the growth endpoint results for the toxicity test. Multiple factors can affect the growth of earthworms independent of chemical concentrations in the soil. For example, the amount of total organic matter (typically indicated by TOC) in the soil samples can have a direct effect on growth because the earthworms feed directly on the organic matter. Therefore, it would be expected that earthworms placed in soil with less TOC might display less growth that those placed in soil with higher levels of TOC. The results of this study, however, do not necessarily support this point: sample ISLB010505 (TX01) had the highest growth rate in soil with 1.10 percent TOC, while several other samples with lower earthworm growth rates contained at least twice as much TOC (2 percent to 3 percent). It should be noted that 6 of the 10 samples contained approximately 1 percent or less TOC and the reference sample contained 2.82 percent TOC. This might explain why earthworms in many of the site samples displayed less growth than the earthworms in the reference sample.

  In addition, reproductive output can directly affect earthworm growth by shifting energy use to reproduction, reducing the energy stores available for growth. This effect may be more pronounced in soils with limited TOC content, such as those found at the Lab Area. For this reason, earthworm reproduction was not included as a measurement endpoint for the BERA. The problems associated with using the reproduction endpoint are evident in the results for this study, in which the lowest reproduction was observed in sample ISLBSS010505 (TX01), which demonstrated the highest earthworm survival and growth (i.e., less energy expended on reproduction would leave more energy to support growth); while the highest reproduction was observed in sample ISLBSS080505 (TX08), which demonstrated the lowest earthworm growth (i.e., more energy was likely expended for reproduction, leaving less available to support growth). Therefore, there is additional uncertainty surrounding the finding of significantly less growth in several of

the site samples relative to the growth of earthworms in the reference sample. This uncertainty should be considered when weighing the growth endpoint results.

5.3 Conclusion

The results of the BERA indicate that the COPCs identified in the RI Report for the Lab Area do not pose unacceptable risks; thus, further investigation is not required. Significant effects on soil invertebrate survivorship were not observed. Although significant decreases in growth were observed in soil invertebrates, that phenomenon may have been related to methylmercury concentrations in Lab Area surface soils and the level of effect (less than 20 percent) is unlikely to adversely affect the soil invertebrate community. The results of the earthworm tissue analyses and exposure calculations for insectivorous terrestrial birds and omnivorous terrestrial mammals indicate that the risks to these receptors from COPCs in surface soils at the site are within ranges presumed to be acceptable.

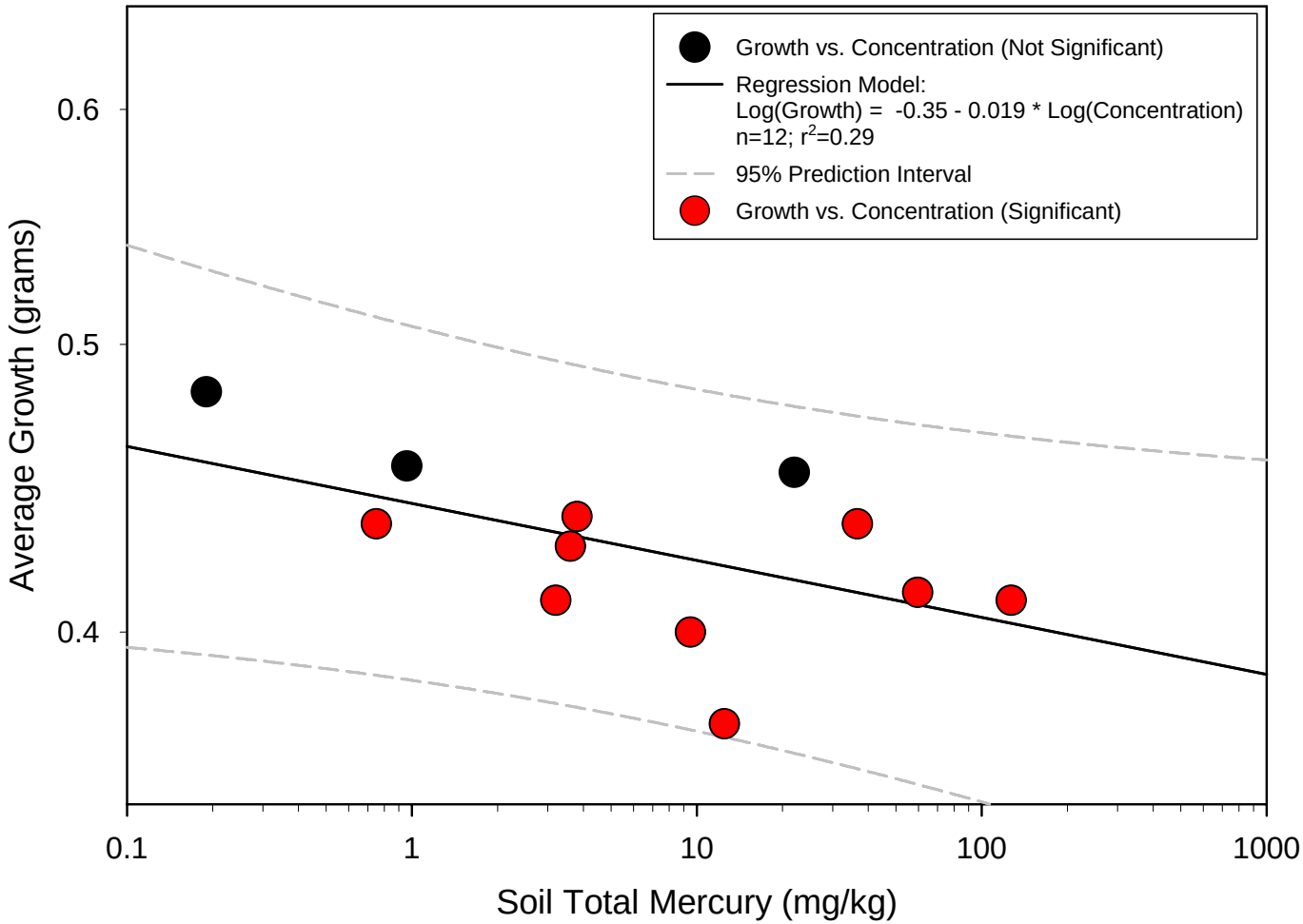


Figure 5-1
Scatter Plot of Average Earthworm Growth versus Soil Total Mercury
BERA Report
NSF-IH, Indian Head, Maryland

CH2MHILL

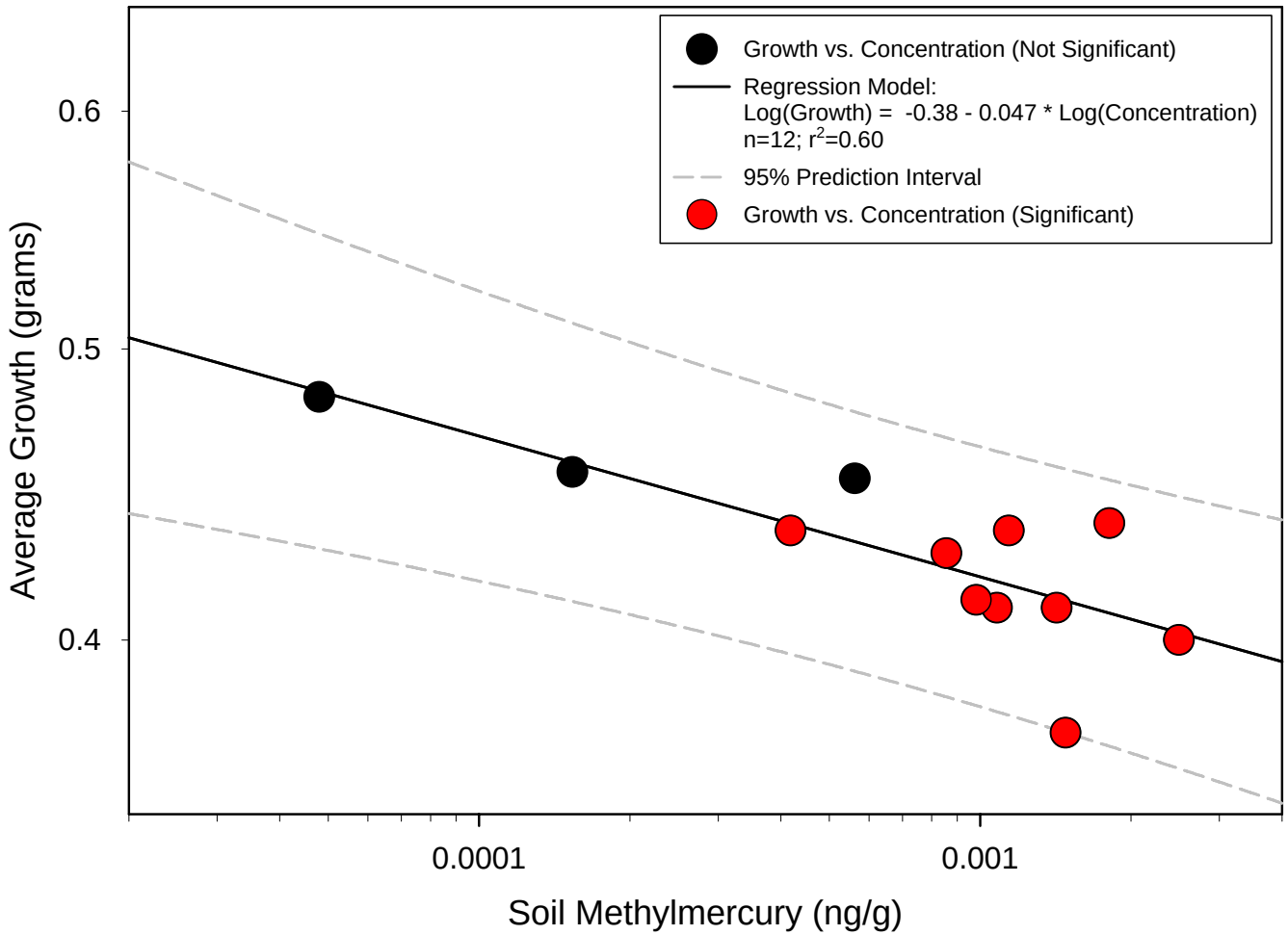


Figure 5-2
Scatter Plot of Average Earthworm Growth versus Soil Methylmercury
BERA Report
NSF-IH, Indian Head, Maryland

CH2MHILL

SECTION 6

References

Abbasi, S.A., and R. Soni. 1983. Stress-induced enhancement of reproduction in earthworm *Octochaetus pattoni* exposed to chromium (VI) and mercury (II) - Implications in environmental management. *Intern. J. Environ. Stud*. 22:43-47.

ASTM. 2004. Volume 11.05. *Standard Guide for Conducting Laboratory Soil Toxicity or Bioaccumulation Tests with the Lumbricid Earthworm Eisenia Fetida*. E1676-97.

Bechtel Jacobs. 1998. *Empirical models for the uptake of inorganic chemicals from soil by plants.* Prepared for U.S. Department of Energy. BJC/OR 133. September 1998.

Bengtsson, G. T. Gunnarsson and S. Rundgren. 1986. Effects of metal pollution on the earthworm Dendrobaena rubida (Sav.) in acidified soils. *Water Soil Air Pollut.* 28:361-383.

Beyer, W.N. 1990. *Evaluating soil contamination*. *U.S. Fish and Wildlife Service Biological Report* 90:25.

Beyer, W. N., and E. J. Cromartie. 1987. A survey of Pb, Cu, Zn, Cd, Cr, As, and Se in earthworms and soil from diverse sites. *Environ. Monit. Assess*. 8: 27-36.

Beyer, W.N., E. Cromartie, and G.B. Moment. 1985. Accumulation of methylmercury in the earthworm *Eisenia foetida,* and its effect on regeneration. *Bull. Environ. Contam. Toxicol.* 35:157-162.

Beyer, W.N., G. Hensler, and J. Moore. 1987. Relation of pH and other soil variables to concentrations of Pb, Cu, Zn, Cd, and Se in earthworms. Pedobiologia 30:167–172.

Burt, W.H. and R.P. Grossenheider. 1980. A field guide to the mammals of North America north of Mexico. Boston, MA: Houghton Mifflin Co.

Carter, A. 1983. Cadmium, copper, and zinc in soil animals and their food in a red clover system. *Can. J. Zool.* 61: 2751-2757.

CH2MHILL. 2004. *Final Remedial Investigation Report, Lab Area, Naval District Washington, Indian Head*, Indian Head, Maryland. CH2M HILL, Inc., January 2004.

CH2MHILL. 2005. *Final Work Plan for the Baseline Ecological Risk Assessment, Lab Area, Naval District Washington, Indian Head*, Indian Head, Maryland. CH2M HILL, Inc., March 2005.

Chief of Naval Operations (CNO). 1999. *Navy policy for conducting ecological risk assessments.* Memorandum from Chief of Naval Operations to Commander, Naval Facilities Engineering Command. Ser N453E/9U595355. April 5, 1999.

Czarnowska, K., and K. Jopkiewicz. 1978. Heavy metals in earthworms as an index of soil contamination. *Polish J. Soil Sci.* 11: 57-62.

Drobne, D., J. Strus. 1996. Moult frequency of the isopod Procellio scaber, as a measure of azinc-contaminated food. *Environ. Toxicol. Chem.*15(2): 126–130.

Ensafe/Allen & Hoshall, 1994. *Final Site Inspection Report, Phase II Indian Head Division, Naval Surface Warfare Center*. March 4, 1994.

Environment Canada. 1996. *Canadian Soil Quality Guidelines for Zinc: Environmental Health.* Guidelines Division, Evaluation and Interpretation branch, Environmental Conservation Service, Environment Canada, Ottawa. Draft document.

Ireland, M. P. 1979. Metal accumulation by the earthworms *Lumbricus rubellus, Dendrobaena venata,* and *Eiseniella tetraedra* living in heavy metal polluted sites. *Environ. Poll.* 19: 201-206.

Levey, D.J. and W.H. Karasov. 1989. Digestive responses of temperate birds switched to fruit or insect diets. Auk. 106:673-686.

Lindquist, O., Johansson, K., Aastrup, M., Andersson, A., Bringmark, L., Hovsenius, G., Hakanson, L., Iverfeldt, A., Meile, M. and Timm, B. 1991. Mercury in the Swedish Environment. *Water, Air and Soil Pollut.* 55, 1.

Lodenius, M. 1990. *Sorption of Mercury in Soils*. Control Technology, Gulf Pub. Co., Houston.

Lu, P.-Y., R.L. Metcalf, N. Plummer, and D. Mandel. 1977. The environmental fate of three carcinogens: Benzo*(a)*pyrene, benzidine, and vinyl chloride evaluated in laboratory model ecosystems. *Arch. Environ. Contam. Toxicol*. 6:129–142.

Ma, W.C. 1987. Heavy metal accumulation in the mole, *Talpa euorpa*, and earthworms as an indicator of metal bioavailability in terrestrial environments. *Bull. Environ. Contam. Toxicol.* 39: 933-938.

Malecki, M.R., E.F. Neuhauser and R.C. Loehr. 1982. The effect of metals on the growth and reproduction of Eisenia foetida (Oligochaeta, Lumbricidae). *Pedobiologia.* 24: 129-137.

Malmborg, P.K., and M.F. Willson. 1988. Foraging ecology of avian frugivores and some consequences for seed dispersal in an Illinois woodlot. *Condor* 90: 173-186.

Marigomez, J.A., E. Angulo, and V. Saez. 1986. Feeding and growth responses to copper, zinc, mercury, and lead in the terrestrial gastropod *Arion ater* (Linne). *J. Moll. Stud*. 52:68-78.

Martin, A.C., H.S. Zim, and A.L. Nelson. 1951. *American wildlife and plants: a guide to wildlife food habits.* Dover Publications, Inc. New York, NY. 500 pp.

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

Montizaan, G.K., P.G.N. Kramers, J.A. Janus, and R. Posthumus. 1989. Integrated criteria document—Polynuclear aromatic hydrocarbons (PAH): Effects of 10 selected compounds. Appendix to Report No. 758474007. National Institute of Public Health and Environmental Protection, Bilthoven, Netherlands.

Neff, J.M. 1979. *Polycyclic Aromatic Hydrocarbons in the Aquatic Environment: Sources, Fates, and Biological Effects*. Applied Science Publishers Ltd., London.

Neuhauser, E.F., M.R. Malecki, and R.C. Loehr. 1984. Growth and reproduction of the earthworm *Eisenia fetida* after exposure to sublethal concentrations of metals. *Pedobiologia.* 27:89-97.

Neuhauser, E.F., R.C. Loehr, D.L. Milligan, and M.R. Malecki. 1985. Toxicity of metals to the earthworm *Eisenia fetid*a. *Biol. Fertil. Soils* 1:149-152.

Revis, N.W., Osborne, T.R., Holdsworth, G. and Hadden, C. 1989. *Water, Air and Soil Pollut*. 45: 105.

Roberts, B.L. and H.W. Dorough. 1984. Relative Toxicities of Chemicals to the Earthworm *Eisenia foetida*. *Environ. Toxicol. Chem.* 3: 67-78.

Sachdev, P., W.L. Lindsay, and D.L. Deb. 1992. Activity measurements of zinc in soils of different pH using EDTA. *Geoderma*. 55:247-257.

Saeed, M and R.L. Fox. 1977. Relations between suspension pH and zinc solubility in acid and calcareous soils. *Soil Sci.* 124:199-204.

Sample, B.E., and G. W. Suter II. 1994. *Estimating exposure of terrestrial wildlife to contaminants*. Environmental Restoration Division, ORNL Environmental Restoration Program. ES/ER/TM 125.

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. *Toxicological benchmarks for wildlife: 1996 revision.* Environmental Restoration Division, ORNL Environmental Restoration Program. ES/ER/TM-86/R3.

Sanders, J.R. and M.I. El Kherbawy. 1987. The effect of pH on zinc adsorption equilibria and exchangeable zinc pools in soils. *Environ. Pollut.* 44:165-176.

Schuster, E. 1991. The Behavior of Mercury in the Soil with Special Emphases on Complexation and Adsorption Processes-A Review of the Literature. *Water, Air and Soil Pollut*. 56, 667.

Silva, M. and J.A. Downing. 1995. CRC handbook of mammalian body masses. CRC Press, Boca Raton, FL. 359 pp.

Spurgeon, D.J. and S.P. Hopkin. 1995. Extrapolation of the laboratory-based OECD earthworm toxicity test to metal-contaminated field sites. *Ecotoxicology*. 4:190-205.

Spurgeon, D. J. and S. P. Hopkin. 1996. Effects of variations in organic matter content and pH of soils on the availability and toxicity of zinc to the earthworm *Eisenia fetid*a. *Pedobiologia.* 40:80-96.

Spurgeon, D.J., S.P. Hopkin and D.T. Jones. 1994. Effects of cadmium, copper, lead and zinc on growth, reproduction and survival of the earthworm *Eisenia fetida* (Sav.): Assessing the environmental impact of point-source metal contamination in terrestrial ecosystems. *Environ. Pollut*. 84:123-130.

Steinnes, E. 1990, *Mercury*, in B.J. Alloway (ed.), Heavy Metals in Soils, Blackie and Son, LTD, London.

Streit, B. and A. Jaggy. 1983. Effect of soil type on copper toxicity and copper uptake in *Octolasium cyaneum* (Lumbricidae). In *New Trends in Soil Biology*. Ph. Lebrun *et al.*, (eds). pp. 569-575. Ottignies-Louvain-la-Neuve.

Suter, G.W., II, B.E. Sample, D.S. Jones, T.L. Ashwood, and J.M. Loar. 1995. *Approach and strategy for performing ecological risk assessments for the U.S. Department of Energy's Oak Ridge Reservation: 1995 revision.* Oak Ridge National Laboratory, Oak Ridge TN. ES/ER.TM-33/R2

Sverdrup, L.E., A.E. Kelley, P.H. Krogh, T. Nielsen, J. Jensen, J.J. Scott-Fordsmand, and J. Stenersen. 2001. Effects of eight polycyclic aromatic compounds on the survival and reproduction of the springtail *Folsomia fimetaria* L. (Collembola, Isotomidae). *Environ. Toxicol. Chem.* 20:1332-1338.

Sverdrup, L.E., P.K. Henning, T. Nielsen, and J. Stenersen. 2002. Relative sensitivity of three terrestrial invertebrate tests to polycyclic aromatic compounds. *Environ. Toxicol. Chem*. 21: 1927–1933.

TTNUS. 2002. *Background Soil Investigation Report for Indian Head and Stump Neck Annex, Naval Surface Warfare Center, Indian Head, Indian Head, Maryland*. Tetra Tech NUS, February 2002.

TTNUS. 2004. *Master Plans for Installation Restoration Program Environmental Investigations, Naval District Washington, Indian Head, Indian Head, Maryland*. Tetra Tech NUS, June 2004.

United States Environmental Protection Agency (EPA). 1987. Ambient water quality criteria for zinc–1987. Washington, DC: US Environmental Protection Agency, Office of Water Regulations and Standards. EPA 440-5-87-003. PB87-153581.

United States Environmental Protection Agency (EPA). 1993. Wildlife exposure factors handbook. Volume I of II. EPA/600/R-93/187a.

United States Environmental Protection Agency (EPA). 1994. *Field studies for ecological risk assessment*. ECO Update 2*(3)*. EPA/540/F-94/014.

United States Environmental Protection Agency (EPA). 1995. *Great Lakes Water Quality Initiative criteria documents for the protection of wildlife: DDT, mercury, 2,3,7,8 TCDD, PCBs.* EPA/820/B-95/008.

United States Environmental Protection Agency (EPA). 1997. *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments*. Interim Final. EPA/540/R-97/006.

United States Environmental Protection Agency (EPA). 1998. *Guidelines for ecological risk assessment*. EPA/630/R-95/002F.

van Rhee, J. A. 1977. Effects of soil pollution on earthworms. *Pedobiologia.* 17: 201-208.

van Straalen, N.M., and R.A. [1]Verweij. 1991. Effects of benzo*(a)*pyrene on food assimilation and growth efficiency in *Porcellio scaber* (Isopoda). *Bull. Environ. Contam. Toxicol*. 46:134–140.

1

Verschuuren, R.G., R. Kroes, E.M. Den Tonkelaar, J.M. Berkvens, P.W. Helleman, A.G. Rauws, P.L. Schuller, and G.J. Van Esch. 1976. Toxicity of methylmercury chloride in rats. II. Reproduction study. *Toxicol.* 6:97-106.

Wallace, A., E.M. Romney, G.V. Alexander, R.T. Mueller, S.M. Soufi, and P.M. Patel. 1977. Some interactions in plants among cadmium, other heavy metals, and chelating agents. *Agronomy J.* 69:18-20.

Wobeser, G., N.O. Nielson, and B. Schiefer. 1976. Mercury and mink. II. Experimental methylmercury intoxication. *Can. J. Comp. Med.* 34-45.

Appendix A
Grain Size Data

3342 International Park Drive Atlanta, GA 30316 Phone: (404) 241-8722; Fax: (404) 241-4577

ACCURA AAR AASHTO R18

Geotechnical Laboratory

June 20, 2005

CompuChem.
501 Madison Avenue
Cary, NC 27513

Attention: Ms. Diane Byrd

Subject: CompuChem Project: CTO-0043 Indian Head
Geotechnical Testing
ACCURA Geotechnical Laboratory
Project Number G05-0033-00

Dear Ms. Byrd:

ACCURA is pleased to provide you with this final report for Geotechnical Testing. The testing consisted of 12 Grain Size Analyses without Hydrometer (ASTM D422).

Please find enclosed for your convenience, the individual test results, Summary of Testing and invoice.

We appreciate this opportunity to work with you. If you have any questions or require additional information, please call (404) 241-8722.

Sincerely,
ACCURA Engineering & Consulting Services, Inc.

Lev Buchko, P.E.
Geotechnical Laboratory Director

Enclosures: as noted

AASHTO & U.S. Army Corps of Engineers Accredited Testing:
ASTM: C40; C117; C127; C128; C136; C566; C702; D546; D421; D422; D558; D559; D560; D698; D854; D1140; D1557; D1883; D2166; D2216; D2217; D2434; D2435; D2487; D2488; D2850; D3080; D3740; D4318; D4767; D5084; E329
AASHTO: T11; T21; T27, T37; T84; T85; T87; T88; T89; T90; T99; T100; T134; T135; T136; T146; T180; T193; T208; T215; T216; T236; T248; T255; T265; T296; T297

ACCURA Engineering & Consulting Services, Inc.

ACCURA Geotechnical Laboratory

AASHTO R18

3342 International Park Drive
Atlanta, GA 30316

Phone: (404) 241-8722
Fax: (404) 241-4577

Summary of Soil Testing

Project Number: G05-0033-00

Project Name: CTO-0043 Indian Head

Sample Number	Client Sample Number	Sample Depth	USCS	Moisture Content (%)	Grain Size Distribution			Atterberg Limits			Proctor		Hydraulic Conductivity		
					%Finer #4 Sieve	% Finer #200 Sieve	% Finer 0.005mm	L.L. %	P.L. %	P.I. %	Opt. M.C. %	Max.Dry. Density pcf	Initial M.C. %	Init.Dry Density pcf	Hydraulic Conduct. cm/sec
G11987	ISLBSS010505	-	-	-	100.0	68.2	-	-	-	-	-	-	-	-	-
G11988	ISLBSS030505	-	-	-	95.0	59.6	-	-	-	-	-	-	-	-	-
G11989	ISLBSS040505	-	-	-	84.5	35.7	-	-	-	-	-	-	-	-	-
G11990	ISLBSS070505	-	-	-	66.0	27.4	-	-	-	-	-	-	-	-	-
G11991	ISLBSS100505	-	-	-	99.7	75.5	-	-	-	-	-	-	-	-	-
G11992	ISLBSS050505	-	-	-	86.1	63.4	-	-	-	-	-	-	-	-	-
G11993	ISLBSS080505	-	-	-	99.4	73.1	-	-	-	-	-	-	-	-	-
G11994	ISLBSS060505	-	-	-	93.6	47.5	-	-	-	-	-	-	-	-	-
G11995	ISLBSS020505	-	-	-	80.1	32.3	-	-	-	-	-	-	-	-	-
G11996	ISLBSS110505	-	-	-	97.6	65.7	-	-	-	-	-	-	-	-	-
G11997	ISLBSS090505	-	-	-	99.3	64.7	-	-	-	-	-	-	-	-	-
G11998	ISLBSSREF1	-	-	-	100.0	62.2	-	-	-	-	-	-	-	-	-

3342 International Park Drive Atlanta, GA 30316 Phone: (404) 241-8722 Fax: (404) 241-4577

ACCURA Engineering & Consulting Services, Inc.

ACCURA Geotechnical Laboratory

AASHTO R18

ASTM D422, D1140, C136, C117 / AASHTO T88, T27, T 11, T311
Standard Test Method for Particle-Size Analysis of Soils and Aggregates

PROJECT NUMBER	G05-0033-00	SAMPLE ID	G11987/ISLBSS010505	TECH	AV/VG
PROJECT NAME	CTO-0043 Indian Head	SAMPLE TYPE	Jar	DATE	06/02/05
SAMPLE LOCATION	-	SAMPLE DEPTH	-	CHECK	LB

AS-RECEIVED MOISTURE CONTENT

Mass of Wet Sample & Tare, g	620.52
Mass of Dry Sample & Tare, g	576.67
Mass of Tare, g	372.79
Moisture Content, %	21.5

HYGROSCOPIC MOISTURE CONTENT

Mass of Wet Sample & Tare, g	
Mass of Dry Sample & Tare, g	
Mass of Tare, g	
Moisture Content, %	NA

Mass of Wet Sample & Tare, g	620.52
Mass of Tare, g	372.79
Mass of Dry Sample, g	203.88

REMARKS

SIEVE ANALYSIS*

PORTION OF SAMPLE RETAINED ON # 4 SIEVE

Mass of Tare, g: 0.00

Sieve Size		Sample & Tare, g	% RETAINED	% PASSING
12"	COBBLES		0.0	100.0
3"	COARSE GRAVEL		0.0	100.0
2.5"			0.0	100.0
2"			0.0	100.0
1.5"			0.0	100.0
1"			0.0	100.0
.75"	FINE GRAVEL		0.0	100.0
.5"			0.0	100.0
.375"			0.0	100.0
#4	COARSE SAND	0.00	0.0	100.0

PORTION OF SAMPLE PASSING # 4 SIEVE

Sieve Size		Cumulative Mass retained, g	% PASSING
#10	MEDIUM SAND	3.15	98.5
#20		7.04	96.5
#40	FINE SAND	14.62	92.8
#60		25.15	87.7
#100		41.76	79.5
#200	FINES	64.81	68.2

* - ASTM Definitions of Classification
** - AASHTO Definitions of Classification

Oven ID #	109/399
Balance ID#	105/398/297
Sieve Shaker ID #	119/1529

PARTICLE-SIZE ANALYSIS*

% COBBLES	0.0	% MEDIUM Sand	5.6
% COARSE Gravel	0.0	% FINE Sand	24.6
% FINE Gravel	0.0	% FINES	68.2
% COARSE Sand	1.5	% TOTAL SAMPLE	100.0

PARTICLE-SIZE ANALYSIS**

% COBBLES	0.0	% COARSE Sand	5.6
% COARSE Gravel (Stone)	0.0	% FINE Sand	24.6
% MEDIUM Gravel (Stone)	0.0	% FINES (Silt-Clay)	68.2
% FINE Gravel (Stone)	1.5	% TOTAL SAMPLE	100.0

DESCRIPTION: NA

USCS (ASTM D2487; D2488): NA AASHTO (M 145): NA

3342 International Park Drive Atlanta, GA 30316 Phone: (404) 241-8722 Fax: (404) 241-4577

ACCURA Engineering & Consulting Services, Inc.

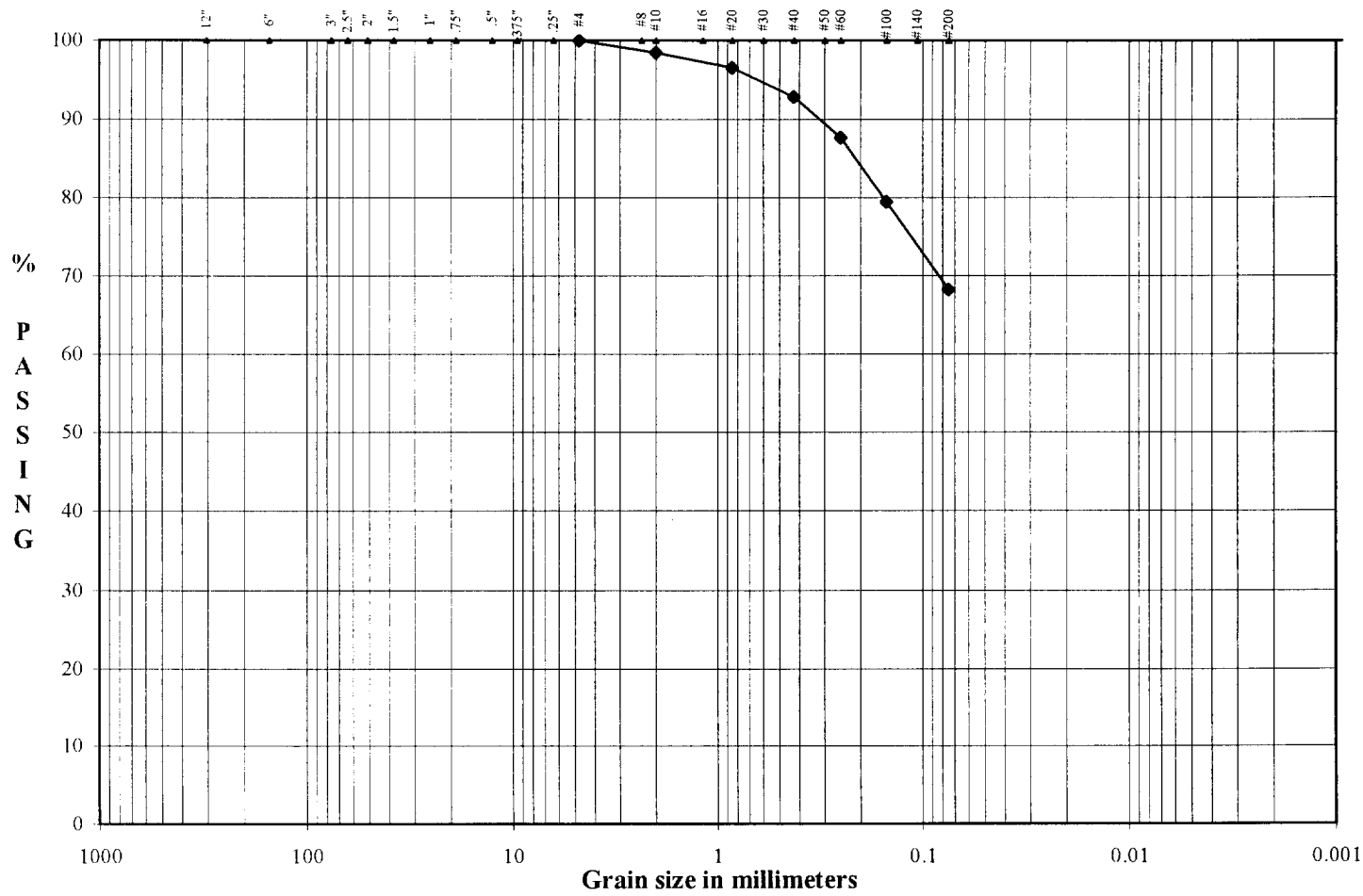
ACCURA Geotechnical Laboratory

AASHTO R18

ASTM D422, D1140, C136, C117 / AASHTO T88, T27, T 11, T311
Standard Test Method for Particle-Size Analysis of Soils and Aggregates

PROJECT #	G05-0033-00	SAMPLE ID	G11987/ISLBSS010505	TECH	AV/VG
PR. NAME	CTO-0043 Indian Head	SAMPLE TYPE	Jar	DATE	06/02/05
LOCATION	-	SAMPLE DEPTH	-	CHECK	LB

Particle-Size Analysis



Boulders	Cobbles	Coarse	Fine	Coarse	Medium	Fine	Silt-Clay
		Gravel		Sand			Fines

D_{10}	NA	mm
D_{30}	NA	mm
D_{60}	NA	mm
Cu	NA	
Cc	NA	

SOIL 3.xls [Particle-Size Graph], REV. 2; 07/21/04

3342 International Park Drive Atlanta, GA 30316 Phone: (404) 241-8722 Fax: (404) 241-4577

ACCURA Engineering & Consulting Services, Inc.

ACCURA Geotechnical Laboratory

AASHTO R18

ASTM D422, D1140, C136, C117 / AASHTO T88, T27, T 11, T311
Standard Test Method for Particle-Size Analysis of Soils and Aggregates

PROJECT NUMBER	G05-0033-00	SAMPLE ID	G11988/ISLBSS030505	TECH	AV/VG
PROJECT NAME	CTO-0043 Indian Head	SAMPLE TYPE	Jar	DATE	06/02/05
SAMPLE LOCATION	-	SAMPLE DEPTH	-	CHECK	KB

AS-RECEIVED MOISTURE CONTENT

Mass of Wet Sample & Tare, g	625.51
Mass of Dry Sample & Tare, g	588.33
Mass of Tare, g	367.75
Moisture Content, %	16.9

HYGROSCOPIC MOISTURE CONTENT

Mass of Wet Sample & Tare, g	
Mass of Dry Sample & Tare, g	
Mass of Tare, g	
Moisture Content, %	NA

Mass of Wet Sample & Tare, g	625.51
Mass of Tare, g	367.75
Mass of Dry Sample, g	220.58

REMARKS

SIEVE ANALYSIS*

PORTION OF SAMPLE RETAINED ON # 4 SIEVE

Mass of Tare, g: 0.00

Sieve Size		Sample & Tare, g	% RETAINED	% PASSING
12"	COBBLES		0.0	100.0
3"	COARSE GRAVEL		0.0	100.0
2.5"			0.0	100.0
2"			0.0	100.0
1.5"			0.0	100.0
1"			0.0	100.0
.75"	FINE GRAVEL		0.0	100.0
.5"		0.00	0.0	100.0
.375"		7.79	3.5	96.5
#4	COARSE SAND	10.94	5.0	95.0

PORTION OF SAMPLE PASSING # 4 SIEVE

Sieve Size		Cumulative Mass retained, g	% PASSING
#10	MEDIUM SAND	14.08	93.6
#20		19.99	90.9
#40	FINE SAND	32.72	85.2
#60		48.58	78.0
#100		67.21	69.5
#200	FINES	89.19	59.6

* - ASTM Definitions of Classification
** - AASHTO Definitions of Classification

Oven ID #	109/399
Balance ID#	105/398/297
Sieve Shaker ID #	119/1529

PARTICLE-SIZE ANALYSIS*

% COBBLES	0.0	% MEDIUM Sand	8.5
% COARSE Gravel	0.0	% FINE Sand	25.6
% FINE Gravel	5.0	% FINES	59.6
% COARSE Sand	1.4	% TOTAL SAMPLE	100.0

PARTICLE-SIZE ANALYSIS**

% COBBLES	0.0	% COARSE Sand	8.5
% COARSE Gravel (Stone)	0.0	% FINE Sand	25.6
% MEDIUM Gravel (Stone)	3.5	% FINES (Silt-Clay)	59.6
% FINE Gravel (Stone)	2.9	% TOTAL SAMPLE	100.0

DESCRIPTION: NA

USCS (ASTM D2487; D2488): NA AASHTO (M 145): NA

3342 International Park Drive Atlanta, GA 30316 Phone: (404) 241-8722 Fax: (404) 241-4577

ACCURA Engineering & Consulting Services, Inc.

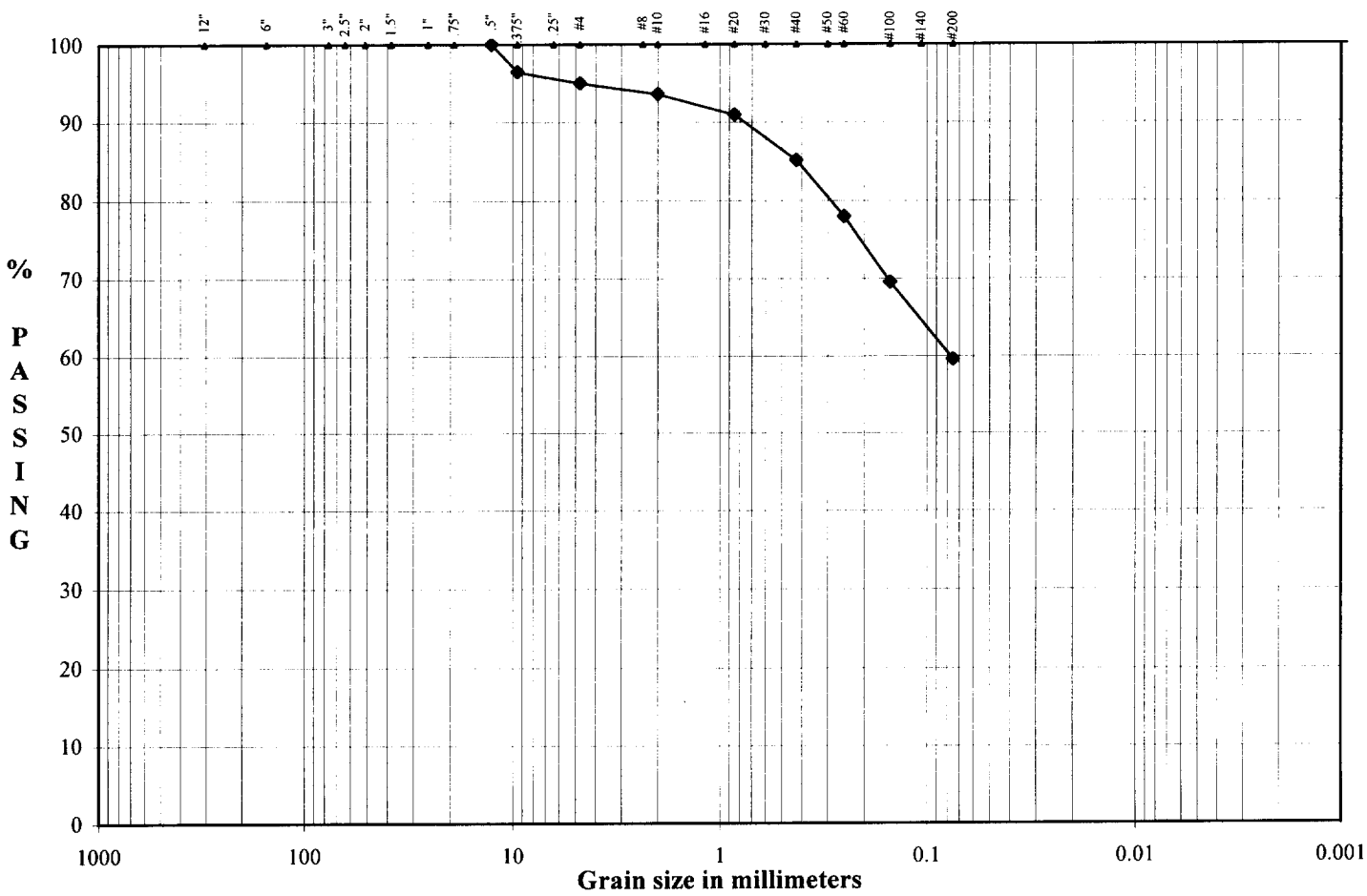
ACCURA Geotechnical Laboratory

AASHTO R18

ASTM D422, D1140, C136, C117 / AASHTO T88, T27, T 11, T311
Standard Test Method for Particle-Size Analysis of Soils and Aggregates

PROJECT #	G05-0033-00	SAMPLE ID	G11988/ISLBSS030505	TECH	AV/VG
PR. NAME	CTO-0043 Indian Head	SAMPLE TYPE	Jar	DATE	06/02/05
LOCATION	-	SAMPLE DEPTH	-	CHECK	

Particle-Size Analysis



Boulders	Cobbles	Coarse	Fine	Coarse	Medium	Fine	Silt-Clay
		Gravel		Sand			Fines

D_{10}	NA	mm
D_{30}	NA	mm
D_{60}	NA	mm
Cu	NA	
Cc	NA	

SOIL 3.xls [Particle-Size Graph], REV. 2; 07/21/04

3342 International Park Drive Atlanta, GA 30316 Phone: (404) 241-8722 Fax: (404) 241-4577

ACCURA Engineering & Consulting Services, Inc.

ACCURA Geotechnical Laboratory

AASHTO R18

ASTM D422, D1140, C136, C117 / AASHTO T88, T27, T 11, T311
Standard Test Method for Particle-Size Analysis of Soils and Aggregates

PROJECT NUMBER	G05-0033-00	SAMPLE ID	G11989/ISLBSS040505	TECH	AV/VG
PROJECT NAME	CTO-0043 Indian Head	SAMPLE TYPE	Jar	DATE	06/02/05
SAMPLE LOCATION	-	SAMPLE DEPTH	-	CHECK	LO

AS-RECEIVED MOISTURE CONTENT

Mass of Wet Sample & Tare, g	532.36
Mass of Dry Sample & Tare, g	496.41
Mass of Tare, g	306.23
Moisture Content, %	18.9

HYGROSCOPIC MOISTURE CONTENT

Mass of Wet Sample & Tare, g	
Mass of Dry Sample & Tare, g	
Mass of Tare, g	
Moisture Content, %	NA

Mass of Wet Sample & Tare, g	532.36
Mass of Tare, g	306.23
Mass of Dry Sample, g	190.18

REMARKS

SIEVE ANALYSIS*

PORTION OF SAMPLE RETAINED ON # 4 SIEVE

Mass of Tare, g: 0.00

Sieve Size		Sample & Tare, g	% RETAINED	% PASSING
12"	COBBLES		0.0	100.0
3"			0.0	100.0
2.5"	COARSE		0.0	100.0
2"	GRAVEL		0.0	100.0
1.5"			0.0	100.0
1"			0.0	100.0
.75"		0.00	0.0	100.0
.5"	FINE GRAVEL	11.59	6.1	93.9
.375"		18.52	9.7	90.3
#4	COARSE SAND	29.39	15.5	84.5

PORTION OF SAMPLE PASSING # 4 SIEVE

Sieve Size		Cumulative Mass retained, g	% PASSING
#10	MEDIUM	37.37	80.4
#20	SAND	54.92	71.1
#40		79.01	58.5
#60	FINE SAND	97.38	48.8
#100		109.65	42.3
#200	FINES	122.34	35.7

* - ASTM Definitions of Classification
** - AASHTO Definitions of Classification

Oven ID #	109/399
Balance ID#	105/398/297
Sieve Shaker ID #	119/1529

PARTICLE-SIZE ANALYSIS*

% COBBLES	0.0	% MEDIUM Sand	21.9
% COARSE Gravel	0.0	% FINE Sand	22.8
% FINE Gravel	15.5	% FINES	35.7
% COARSE Sand	4.2	% TOTAL SAMPLE	100.0

PARTICLE-SIZE ANALYSIS**

% COBBLES	0.0	% COARSE Sand	21.9
% COARSE Gravel (Stone)	0.0	% FINE Sand	22.8
% MEDIUM Gravel (Stone)	9.7	% FINES (Silt-Clay)	35.7
% FINE Gravel (Stone)	9.9	% TOTAL SAMPLE	100.0

DESCRIPTION: NA

USCS (ASTM D2487; D2488): NA AASHTO (M 145): NA

3342 International Park Drive Atlanta, GA 30316 Phone: (404) 241-8722 Fax: (404) 241-4577

ACCURA Engineering & Consulting Services, Inc.

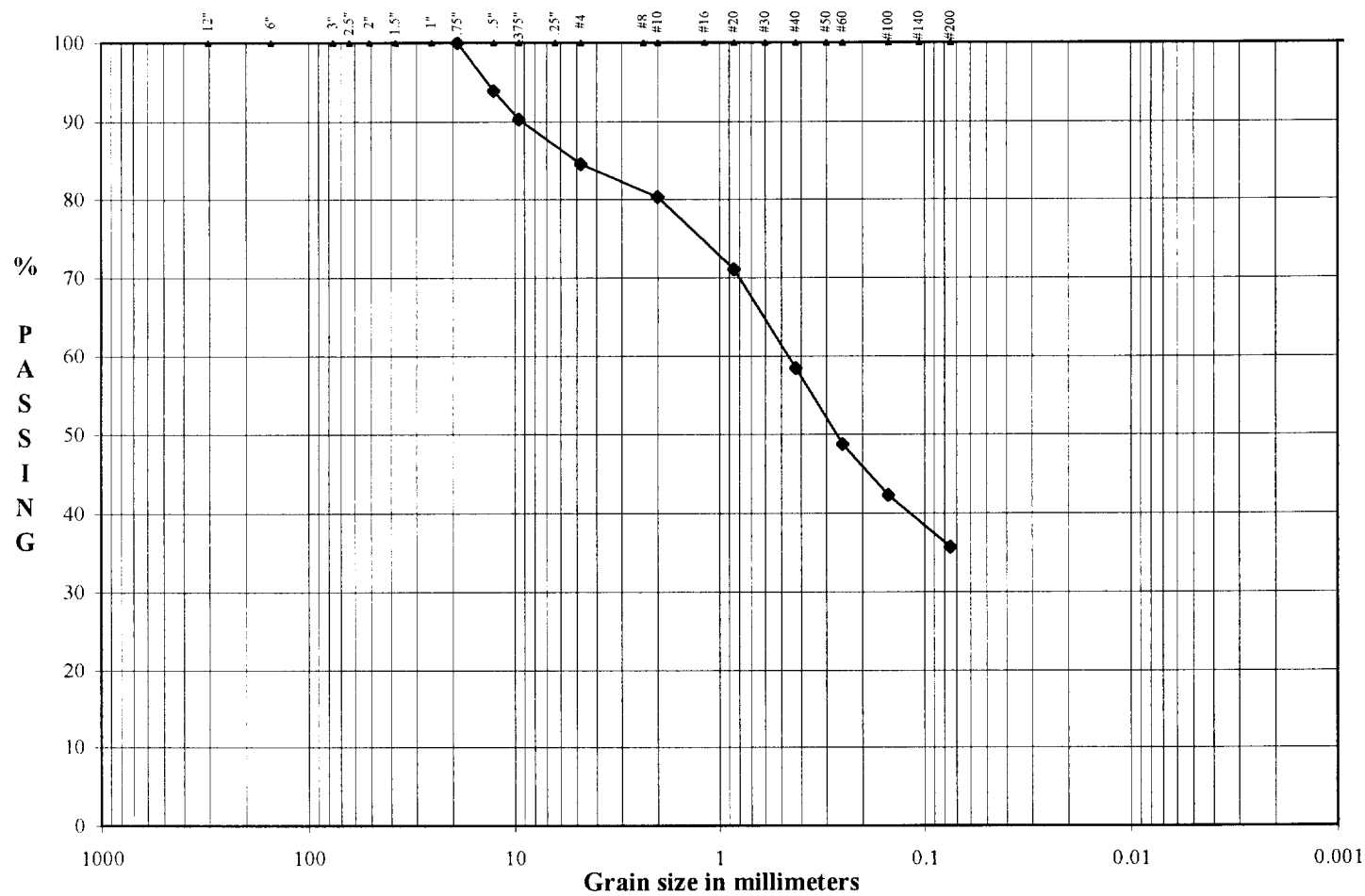
ACCURA Geotechnical Laboratory

AASHTO R18

ASTM D422, D1140, C136, C117 / AASHTO T88, T27, T 11, T311
Standard Test Method for Particle-Size Analysis of Soils and Aggregates

PROJECT #	G05-0033-00	SAMPLE ID	G11989/ISLBSS040505	TECH	AV/VG
PR. NAME	CTO-0043 Indian Head	SAMPLE TYPE	Jar	DATE	06/02/05
LOCATION	-	SAMPLE DEPTH	-	CHECK	LG

Particle-Size Analysis



Boulders	Cobbles	Coarse	Fine	Coarse	Medium	Fine	Silt-Clay
		Gravel		Sand			Fines

D_{10}	NA	mm
D_{30}	NA	mm
D_{60}	NA	mm
Cu	NA	
Cc	NA	

SOIL 3.xls [Particle-Size Graph], REV. 2; 07/21/04

3342 International Park Drive Atlanta, GA 30316 Phone: (404) 241-8722 Fax: (404) 241-4577

ACCURA Engineering & Consulting Services, Inc.

ACCURA Geotechnical Laboratory

AASHTO R18

ASTM D422, D1140, C136, C117 / AASHTO T88, T27, T 11, T311
Standard Test Method for Particle-Size Analysis of Soils and Aggregates

PROJECT NUMBER	G05-0033-00	SAMPLE ID	G11990/ISLBSS070505	TECH	AV/VG
PROJECT NAME	CTO-0043 Indian Head	SAMPLE TYPE	Jar	DATE	06/02/05
SAMPLE LOCATION	-	SAMPLE DEPTH	-	CHECK	LB

AS-RECEIVED MOISTURE CONTENT

Mass of Wet Sample & Tare, g	534.36
Mass of Dry Sample & Tare, g	499.20
Mass of Tare, g	321.43
Moisture Content, %	19.8

HYGROSCOPIC MOISTURE CONTENT

Mass of Wet Sample & Tare, g	
Mass of Dry Sample & Tare, g	
Mass of Tare, g	
Moisture Content, %	NA

Mass of Wet Sample & Tare, g	534.36
Mass of Tare, g	321.43
Mass of Dry Sample, g	177.77

REMARKS

SIEVE ANALYSIS*

PORTION OF SAMPLE RETAINED ON # 4 SIEVE

Mass of Tare, g: 0.00

Sieve Size		Sample & Tare, g	% RETAINED	% PASSING
12"	COBBLES		0.0	100.0
3"	COARSE GRAVEL		0.0	100.0
2.5"			0.0	100.0
2"			0.0	100.0
1.5"			0.0	100.0
1"		0.00	0.0	100.0
.75"	FINE GRAVEL	33.03	18.6	81.4
.5"		41.15	23.1	76.9
.375"		51.20	28.8	71.2
#4	COARSE SAND	60.43	34.0	66.0

PORTION OF SAMPLE PASSING # 4 SIEVE

Sieve Size		Cumulative Mass retained, g	% PASSING
#10	MEDIUM SAND	69.71	60.8
#20		79.28	55.4
#40	FINE SAND	96.04	46.0
#60		110.01	38.1
#100		119.62	32.7
#200	FINES	129.05	27.4

* - ASTM Definitions of Classification
** - AASHTO Definitions of Classification

Oven ID #	109/399
Balance ID#	105/398/297
Sieve Shaker ID #	119/1529

PARTICLE-SIZE ANALYSIS*

% COBBLES	0.0	% MEDIUM Sand	14.8
% COARSE Gravel	18.6	% FINE Sand	18.6
% FINE Gravel	15.4	% FINES	27.4
% COARSE Sand	5.2	% TOTAL SAMPLE	100.0

PARTICLE-SIZE ANALYSIS**

% COBBLES	0.0	% COARSE Sand	14.8
% COARSE Gravel (Stone)	0.0	% FINE Sand	18.6
% MEDIUM Gravel (Stone)	28.8	% FINES (Silt-Clay)	27.4
% FINE Gravel (Stone)	10.4	% TOTAL SAMPLE	100.0

DESCRIPTION: NA

USCS (ASTM D2487; D2488): NA AASHTO (M 145): NA

3342 International Park Drive Atlanta, GA 30316 Phone: (404) 241-8722 Fax: (404) 241-4577

ACCURA Engineering & Consulting Services, Inc.

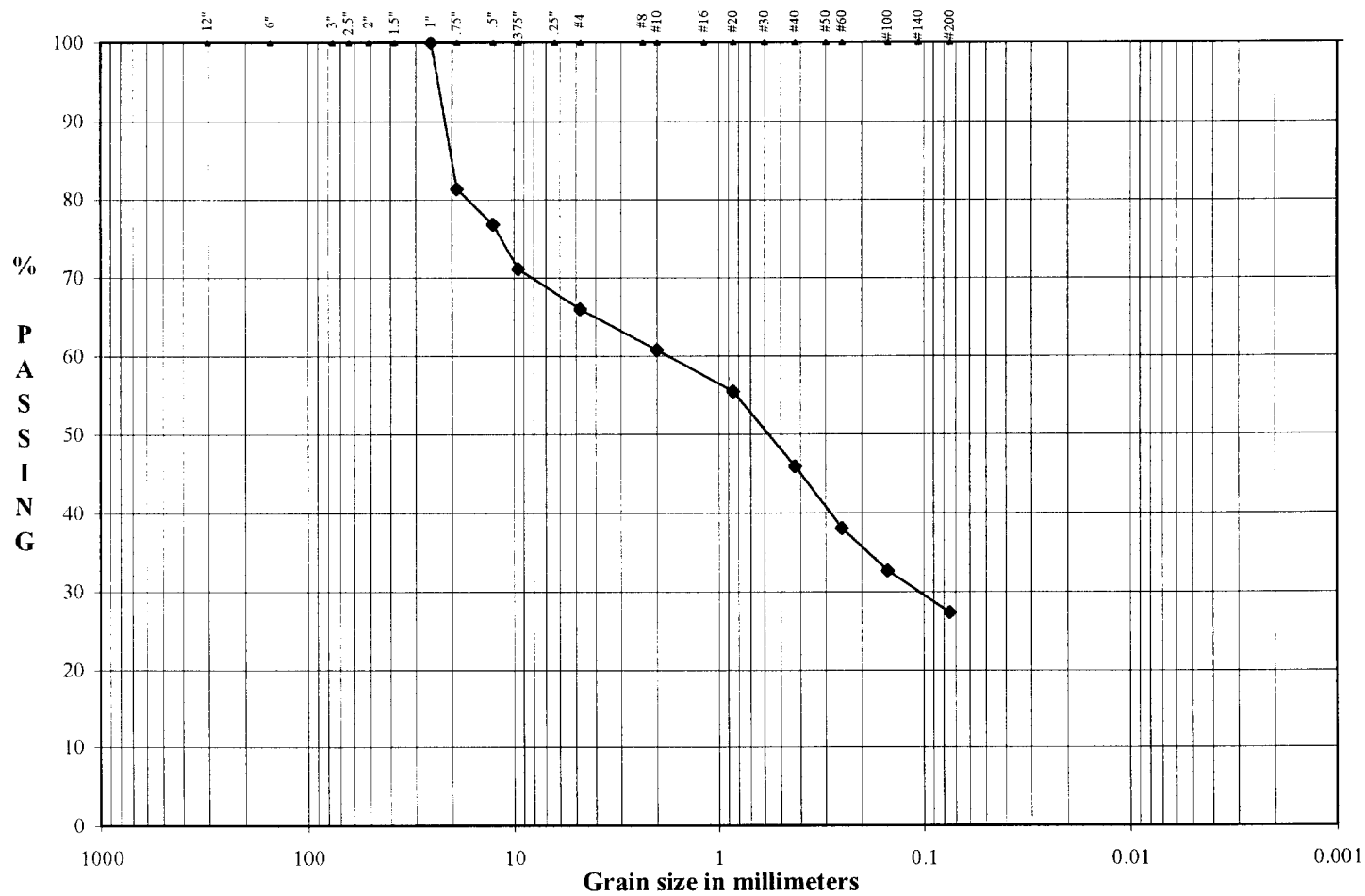
ACCURA Geotechnical Laboratory

AASHTO R18

ASTM D422, D1140, C136, C117 / AASHTO T88, T27, T 11, T311
Standard Test Method for Particle-Size Analysis of Soils and Aggregates

PROJECT #	G05-0033-00	SAMPLE ID	G11990/ISLBSS070505	TECH	AV/VG
PR. NAME	CTO-0043 Indian Head	SAMPLE TYPE	Jar	DATE	06/02/05
LOCATION	-	SAMPLE DEPTH	-	CHECK	LB

Particle-Size Analysis



Boulders	Cobbles	Gravel		Sand			Fines
		Coarse	Fine	Coarse	Medium	Fine	Silt-Clay

D_{10}	NA	mm
D_{30}	NA	mm
D_{60}	NA	mm
Cu	NA	
Cc	NA	

3342 International Park Drive Atlanta, GA 30316 Phone: (404) 241-8722 Fax: (404) 241-4577

ACCURA Engineering & Consulting Services, Inc.

ACCURA Geotechnical Laboratory

AASHTO R18

ASTM D422, D1140, C136, C117 / AASHTO T88, T27, T 11, T311
Standard Test Method for Particle-Size Analysis of Soils and Aggregates

PROJECT NUMBER	G05-0033-00	SAMPLE ID	G11991/ISLBSS100505	TECH	AV/VG
PROJECT NAME	CTO-0043 Indian Head	SAMPLE TYPE	Jar	DATE	06/02/05
SAMPLE LOCATION	-	SAMPLE DEPTH	-	CHECK	

AS-RECEIVED MOISTURE CONTENT

Mass of Wet Sample & Tare, g	699.48
Mass of Dry Sample & Tare, g	620.36
Mass of Tare, g	373.53
Moisture Content, %	32.1

HYGROSCOPIC MOISTURE CONTENT

Mass of Wet Sample & Tare, g	
Mass of Dry Sample & Tare, g	
Mass of Tare, g	
Moisture Content, %	NA

Mass of Wet Sample & Tare, g	699.48
Mass of Tare, g	373.53
Mass of Dry Sample, g	246.83

REMARKS

SIEVE ANALYSIS*

PORTION OF SAMPLE RETAINED ON # 4 SIEVE

Mass of Tare, g: 0.00

Sieve Size		Sample & Tare, g	% RETAINED	% PASSING
12"	COBBLES		0.0	100.0
3"	COARSE GRAVEL		0.0	100.0
2.5"			0.0	100.0
2"			0.0	100.0
1.5"			0.0	100.0
1"			0.0	100.0
.75"	FINE GRAVEL		0.0	100.0
.5"			0.0	100.0
.375"		0.00	0.0	100.0
#4	COARSE SAND	0.72	0.3	99.7

PORTION OF SAMPLE PASSING # 4 SIEVE

Sieve Size		Cumulative Mass retained, g	% PASSING
#10	MEDIUM SAND	2.99	98.8
#20		7.78	96.8
#40	FINE SAND	20.73	91.6
#60		34.43	86.1
#100		47.62	80.7
#200	FINES	60.58	75.5

* - ASTM Definitions of Classification
** - AASHTO Definitions of Classification

Oven ID #	109/399
Balance ID#	105/398/297
Sieve Shaker ID #	119/1529

PARTICLE-SIZE ANALYSIS*

% COBBLES	0.0	% MEDIUM Sand	7.2
% COARSE Gravel	0.0	% FINE Sand	16.1
% FINE Gravel	0.3	% FINES	75.5
% COARSE Sand	0.9	% TOTAL SAMPLE	100.0

PARTICLE-SIZE ANALYSIS**

% COBBLES	0.0	% COARSE Sand	7.2
% COARSE Gravel (Stone)	0.0	% FINE Sand	16.1
% MEDIUM Gravel (Stone)	0.0	% FINES (Silt-Clay)	75.5
% FINE Gravel (Stone)	1.2	% TOTAL SAMPLE	100.0

DESCRIPTION: NA

USCS (ASTM D2487; D2488): NA AASHTO (M 145): NA

3342 International Park Drive Atlanta, GA 30316 Phone: (404) 241-8722 Fax: (404) 241-4577

ACCURA Engineering & Consulting Services, Inc.

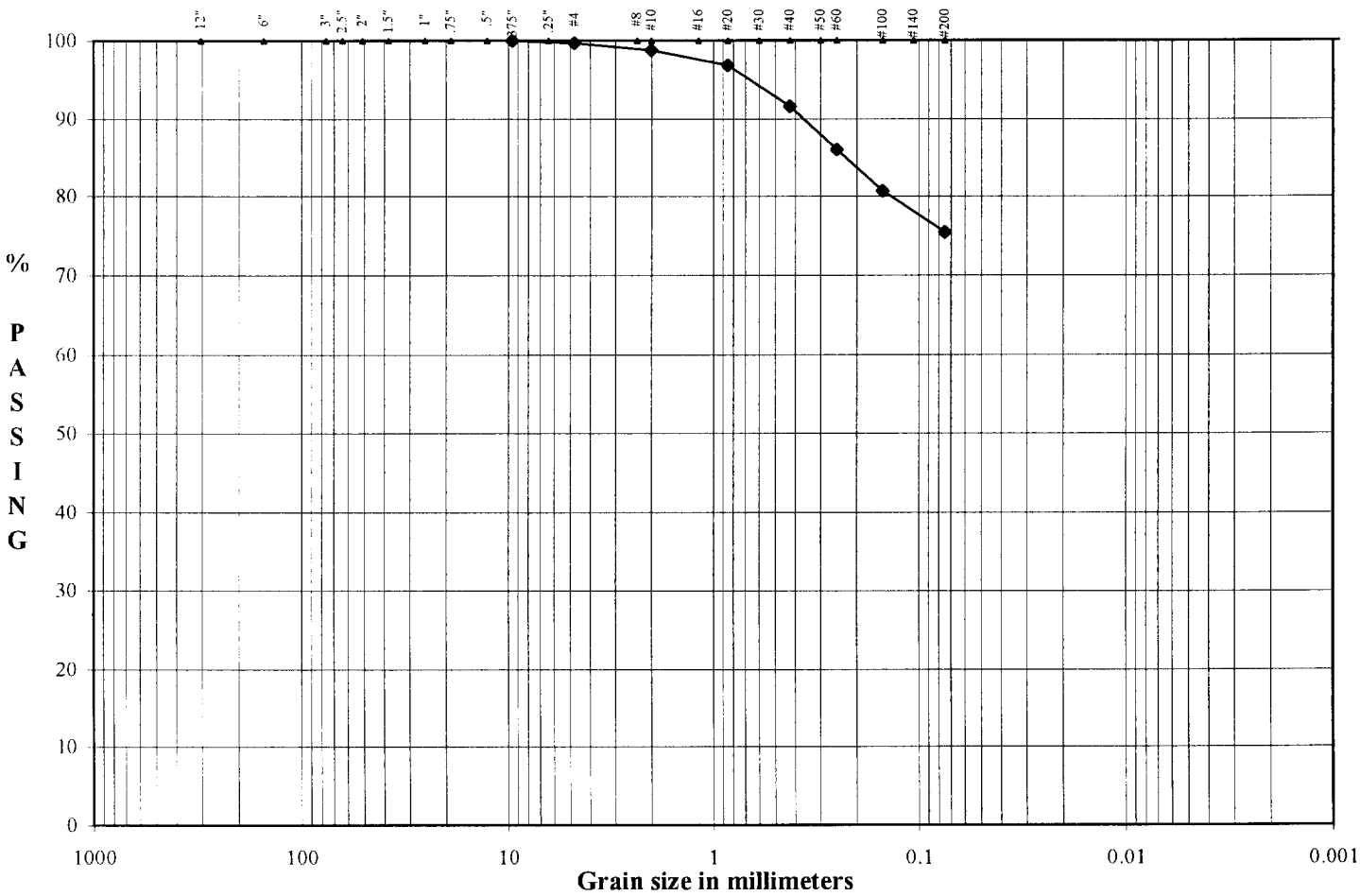
ACCURA Geotechnical Laboratory

AASHTO R18

ASTM D422, D1140, C136, C117 / AASHTO T88, T27, T 11, T311
Standard Test Method for Particle-Size Analysis of Soils and Aggregates

PROJECT #	G05-0033-00	SAMPLE ID	G11991/ISLBSS100505	TECH	AV/VG
PR. NAME	CTO-0043 Indian Head	SAMPLE TYPE	Jar	DATE	06/02/05
LOCATION	-	SAMPLE DEPTH	-	CHECK	

Particle-Size Analysis



Boulders	Cobbles	Coarse	Fine	Coarse	Medium	Fine	Silt-Clay
		Gravel		Sand			Fines

D_{10}	NA	mm
D_{30}	NA	mm
D_{60}	NA	mm
Cu	NA	
Cc	NA	

SOIL 3.xls [Particle-Size Graph], REV. 2; 07/21/04

3342 International Park Drive Atlanta, GA 30316 Phone: (404) 241-8722 Fax: (404) 241-4577

ACCURA Engineering & Consulting Services, Inc.

ACCURA Geotechnical Laboratory

AASHTO R18

ASTM D422, D1140, C136, C117 / AASHTO T88, T27, T 11, T311
Standard Test Method for Particle-Size Analysis of Soils and Aggregates

PROJECT NUMBER	G05-0033-00	SAMPLE ID	G11992/ISLBSS050505	TECH	AV/VG
PROJECT NAME	CTO-0043 Indian Head	SAMPLE TYPE	Jar	DATE	06/02/05
SAMPLE LOCATION	-	SAMPLE DEPTH	-	CHECK	

AS-RECEIVED MOISTURE CONTENT

Mass of Wet Sample & Tare, g	784.06
Mass of Dry Sample & Tare, g	687.50
Mass of Tare, g	320.08
Moisture Content, %	26.3

HYGROSCOPIC MOISTURE CONTENT

Mass of Wet Sample & Tare, g	
Mass of Dry Sample & Tare, g	
Mass of Tare, g	
Moisture Content, %	NA

Mass of Wet Sample & Tare, g	784.06
Mass of Tare, g	320.08
Mass of Dry Sample, g	367.42

REMARKS

SIEVE ANALYSIS*

PORTION OF SAMPLE RETAINED ON # 4 SIEVE

Mass of Tare, g: 0.00

Sieve Size		Sample & Tare, g	% RETAINED	% PASSING
12"	COBBLES		0.0	100.0
3"	COARSE GRAVEL		0.0	100.0
2.5"			0.0	100.0
2"			0.0	100.0
1.5"			0.0	100.0
1"			0.0	100.0
.75"	FINE GRAVEL	0.00	0.0	100.0
.5"		19.77	5.4	94.6
.375"		34.26	9.3	90.7
#4	COARSE SAND	50.99	13.9	86.1

PORTION OF SAMPLE PASSING # 4 SIEVE

Sieve Size		Cumulative Mass retained, g	% PASSING
#10	MEDIUM SAND	56.88	84.5
#20		62.81	82.9
#40	FINE SAND	75.22	79.5
#60		90.38	75.4
#100		109.95	70.1
#200	FINES	134.40	63.4

* - ASTM Definitions of Classification
** - AASHTO Definitions of Classification

Oven ID #	109/399
Balance ID#	105/398/297
Sieve Shaker ID #	119/1529

PARTICLE-SIZE ANALYSIS*

% COBBLES	0.0	% MEDIUM Sand	5.0
% COARSE Gravel	0.0	% FINE Sand	16.1
% FINE Gravel	13.9	% FINES	63.4
% COARSE Sand	1.6	% TOTAL SAMPLE	100.0

PARTICLE-SIZE ANALYSIS**

% COBBLES	0.0	% COARSE Sand	5.0
% COARSE Gravel (Stone)	0.0	% FINE Sand	16.1
% MEDIUM Gravel (Stone)	9.3	% FINES (Silt-Clay)	63.4
% FINE Gravel (Stone)	6.2	% TOTAL SAMPLE	100.0

DESCRIPTION: NA

USCS (ASTM D2487; D2488): NA AASHTO (M 145): NA

3342 International Park Drive Atlanta, GA 30316 Phone: (404) 241-8722 Fax: (404) 241-4577

ACCURA Engineering & Consulting Services, Inc.

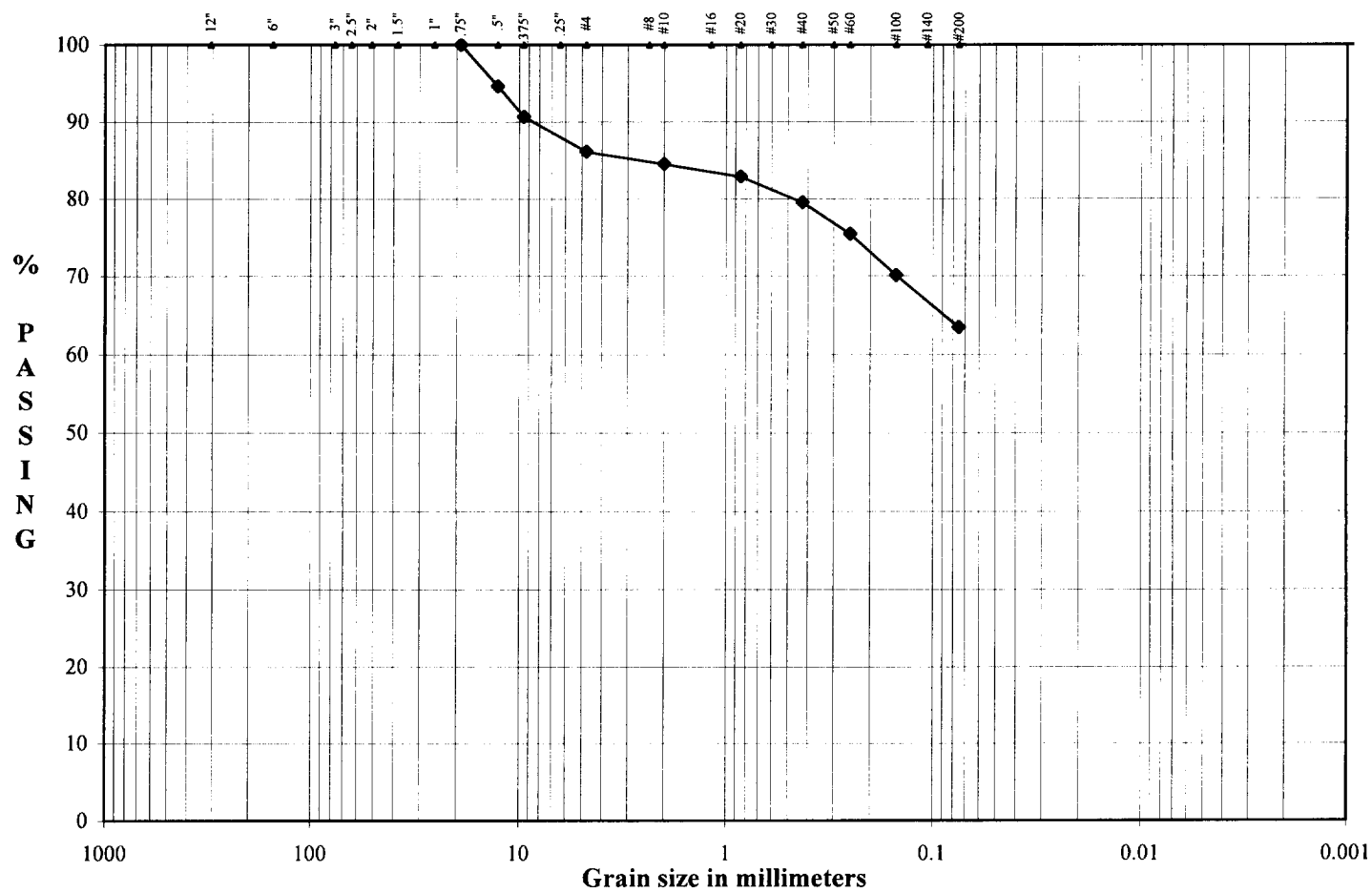
ACCURA Geotechnical Laboratory

AASHTO R18

ASTM D422, D1140, C136, C117 / AASHTO T88, T27, T 11, T311
Standard Test Method for Particle-Size Analysis of Soils and Aggregates

PROJECT #	G05-0033-00	SAMPLE ID	G11992/ISLBSS050505	TECH	AV/VG
PR. NAME	CTO-0043 Indian Head	SAMPLE TYPE	Jar	DATE	06/02/05
LOCATION	-	SAMPLE DEPTH	-	CHECK	

Particle-Size Analysis



Boulders	Cobbles	Coarse	Fine	Coarse	Medium	Fine	Silt-Clay
		Gravel		Sand			Fines

D_{10}	NA	mm
D_{30}	NA	mm
D_{60}	NA	mm
Cu	NA	
Cc	NA	

SOIL 3.xls [Particle-Size Graph], REV. 2; 07/21/04

3342 International Park Drive Atlanta, GA 30316 Phone: (404) 241-8722 Fax: (404) 241-4577

ACCURA Engineering & Consulting Services, Inc.

ACCURA Geotechnical Laboratory

AASHTO R18

ASTM D422, D1140, C136, C117 / AASHTO T88, T27, T 11, T311
Standard Test Method for Particle-Size Analysis of Soils and Aggregates

PROJECT NUMBER	G05-0033-00	SAMPLE ID	G11993/ISLBSS080505	TECH	AV/VG
PROJECT NAME	CTO-0043 Indian Head	SAMPLE TYPE	Jar	DATE	06/02/05
SAMPLE LOCATION	-	SAMPLE DEPTH	-	CHECK	

AS-RECEIVED MOISTURE CONTENT

Mass of Wet Sample & Tare, g	543.38
Mass of Dry Sample & Tare, g	493.27
Mass of Tare, g	301.18
Moisture Content, %	26.1

HYGROSCOPIC MOISTURE CONTENT

Mass of Wet Sample & Tare, g	
Mass of Dry Sample & Tare, g	
Mass of Tare, g	
Moisture Content, %	NA

Mass of Wet Sample & Tare, g	543.38
Mass of Tare, g	301.18
Mass of Dry Sample, g	192.09

REMARKS

SIEVE ANALYSIS*

PORTION OF SAMPLE RETAINED ON # 4 SIEVE

Mass of Tare, g: 0.00

Sieve Size		Sample & Tare, g	% RETAINED	% PASSING
12"	COBBLES		0.0	100.0
3"	COARSE GRAVEL		0.0	100.0
2.5"			0.0	100.0
2"			0.0	100.0
1.5"			0.0	100.0
1"			0.0	100.0
.75"	FINE GRAVEL		0.0	100.0
.5"			0.0	100.0
.375"		0.00	0.0	100.0
#4	COARSE SAND	1.10	0.6	99.4

PORTION OF SAMPLE PASSING # 4 SIEVE

Sieve Size		Cumulative Mass retained, g	% PASSING
#10	MEDIUM SAND	4.71	97.5
#20		9.87	94.9
#40	FINE SAND	16.56	91.4
#60		23.63	87.7
#100		35.95	81.3
#200	FINES	51.76	73.1

* - ASTM Definitions of Classification
** - AASHTO Definitions of Classification

Oven ID #	109/399
Balance ID#	105/398/297
Sieve Shaker ID #	119/1529

PARTICLE-SIZE ANALYSIS*

% COBBLES	0.0	% MEDIUM Sand	6.2
% COARSE Gravel	0.0	% FINE Sand	18.3
% FINE Gravel	0.6	% FINES	73.1
% COARSE Sand	1.9	% TOTAL SAMPLE	100.0

PARTICLE-SIZE ANALYSIS**

% COBBLES	0.0	% COARSE Sand	6.2
% COARSE Gravel (Stone)	0.0	% FINE Sand	18.3
% MEDIUM Gravel (Stone)	0.0	% FINES (Silt-Clay)	73.1
% FINE Gravel (Stone)	2.5	% TOTAL SAMPLE	100.0

DESCRIPTION: NA

USCS (ASTM D2487; D2488): NA AASHTO (M 145): NA

3342 International Park Drive Atlanta, GA 30316 Phone: (404) 241-8722 Fax: (404) 241-4577

ACCURA Engineering & Consulting Services, Inc.

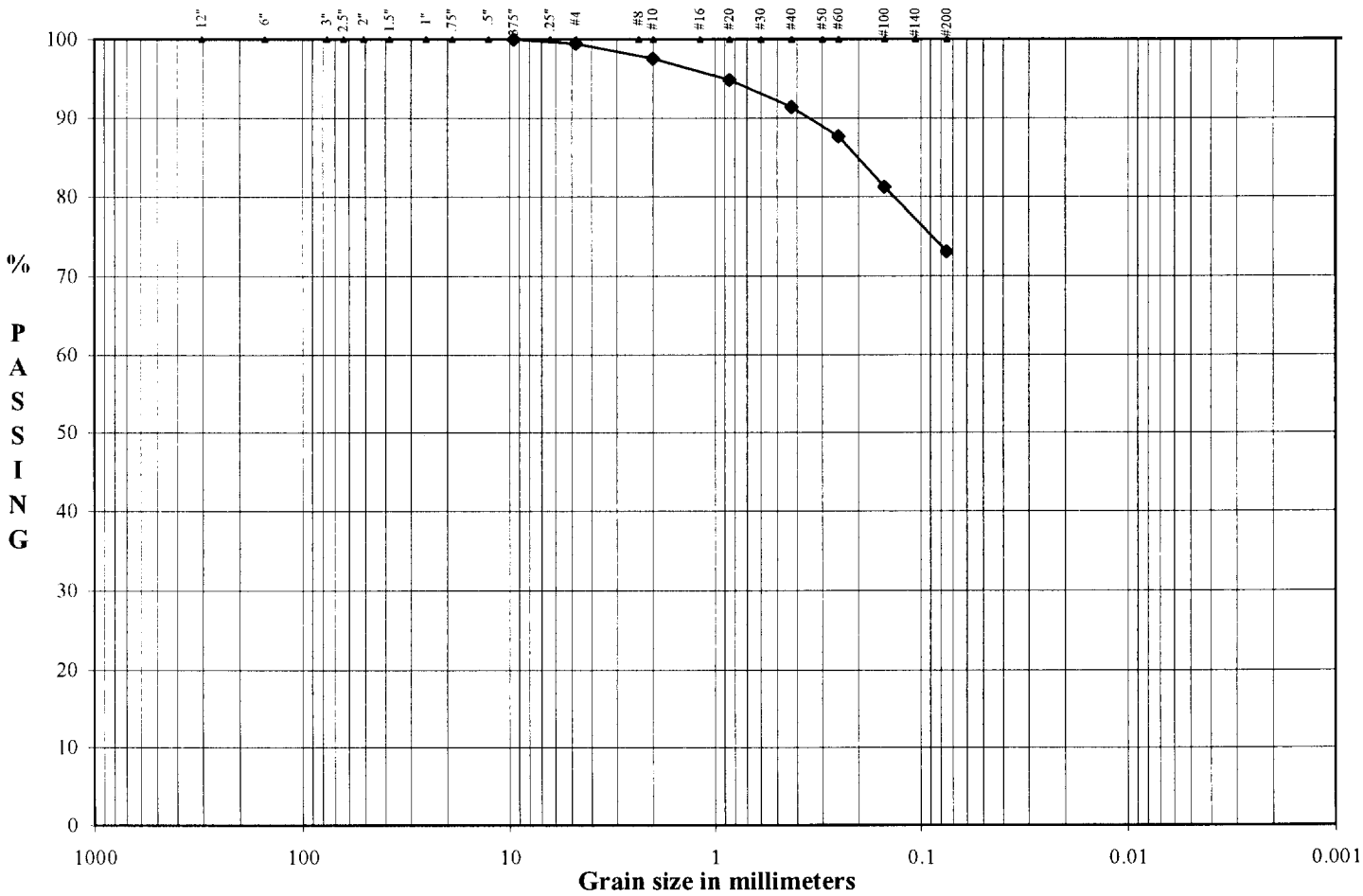
ACCURA Geotechnical Laboratory

AASHTO R18

ASTM D422, D1140, C136, C117 / AASHTO T88, T27, T 11, T311
Standard Test Method for Particle-Size Analysis of Soils and Aggregates

PROJECT #	G05-0033-00	SAMPLE ID	G11993/ISLBSS080505	TECH	AV/VG
PR. NAME	CTO-0043 Indian Head	SAMPLE TYPE	Jar	DATE	06/02/05
LOCATION	-	SAMPLE DEPTH	-	CHECK	

Particle-Size Analysis



Boulders	Cobbles	Gravel		Sand			Fines
		Coarse	Fine	Coarse	Medium	Fine	Silt-Clay

D_{10}	NA	mm
D_{30}	NA	mm
D_{60}	NA	mm
Cu	NA	
Cc	NA	

SOIL 3.xls [Particle-Size Graph], REV. 2; 07/21/04

3342 International Park Drive Atlanta, GA 30316 Phone: (404) 241-8722 Fax: (404) 241-4577

ACCURA Engineering & Consulting Services, Inc.

ACCURA Geotechnical Laboratory

AASHTO R18

ASTM D422, D1140, C136, C117 / AASHTO T88, T27, T 11, T311
Standard Test Method for Particle-Size Analysis of Soils and Aggregates

PROJECT NUMBER	G05-0033-00	SAMPLE ID	G11994/ISLBSS060505	TECH	AV/VG
PROJECT NAME	CTO-0043 Indian Head	SAMPLE TYPE	Jar	DATE	06/02/05
SAMPLE LOCATION	-	SAMPLE DEPTH	-	CHECK	

AS-RECEIVED MOISTURE CONTENT

Mass of Wet Sample & Tare, g	612.33
Mass of Dry Sample & Tare, g	567.63
Mass of Tare, g	372.95
Moisture Content, %	23.0

HYGROSCOPIC MOISTURE CONTENT

Mass of Wet Sample & Tare, g	
Mass of Dry Sample & Tare, g	
Mass of Tare, g	
Moisture Content, %	NA

Mass of Wet Sample & Tare, g	612.33
Mass of Tare, g	372.95
Mass of Dry Sample, g	194.68

REMARKS

SIEVE ANALYSIS*

PORTION OF SAMPLE RETAINED ON # 4 SIEVE

Mass of Tare, g: 0.00

Sieve Size		Sample & Tare, g	% RETAINED	% PASSING
12"	COBBLES		0.0	100.0
3"	COARSE GRAVEL		0.0	100.0
2.5"			0.0	100.0
2"			0.0	100.0
1.5"			0.0	100.0
1"			0.0	100.0
.75"	FINE GRAVEL		0.0	100.0
.5"		0.00	0.0	100.0
.375"		8.49	4.4	95.6
#4	COARSE SAND	12.53	6.4	93.6

PORTION OF SAMPLE PASSING # 4 SIEVE

Sieve Size		Cumulative Mass retained, g	% PASSING
#10	MEDIUM SAND	14.65	92.5
#20		22.86	88.3
#40	FINE SAND	46.85	75.9
#60		69.33	64.4
#100		86.61	55.5
#200	FINES	102.18	47.5

* - ASTM Definitions of Classification
** - AASHTO Definitions of Classification

Oven ID #	109/399
Balance ID#	105/398/297
Sieve Shaker ID #	119/1529

PARTICLE-SIZE ANALYSIS*

% COBBLES	0.0	% MEDIUM Sand	16.5
% COARSE Gravel	0.0	% FINE Sand	28.4
% FINE Gravel	6.4	% FINES	47.5
% COARSE Sand	1.1	% TOTAL SAMPLE	100.0

PARTICLE-SIZE ANALYSIS**

% COBBLES	0.0	% COARSE Sand	16.5
% COARSE Gravel (Stone)	0.0	% FINE Sand	28.4
% MEDIUM Gravel (Stone)	4.4	% FINES (Silt-Clay)	47.5
% FINE Gravel (Stone)	3.2	% TOTAL SAMPLE	100.0

DESCRIPTION: NA

USCS (ASTM D2487; D2488): NA AASHTO (M 145): NA

3342 International Park Drive Atlanta, GA 30316 Phone: (404) 241-8722 Fax: (404) 241-4577

ACCURA Engineering & Consulting Services, Inc.

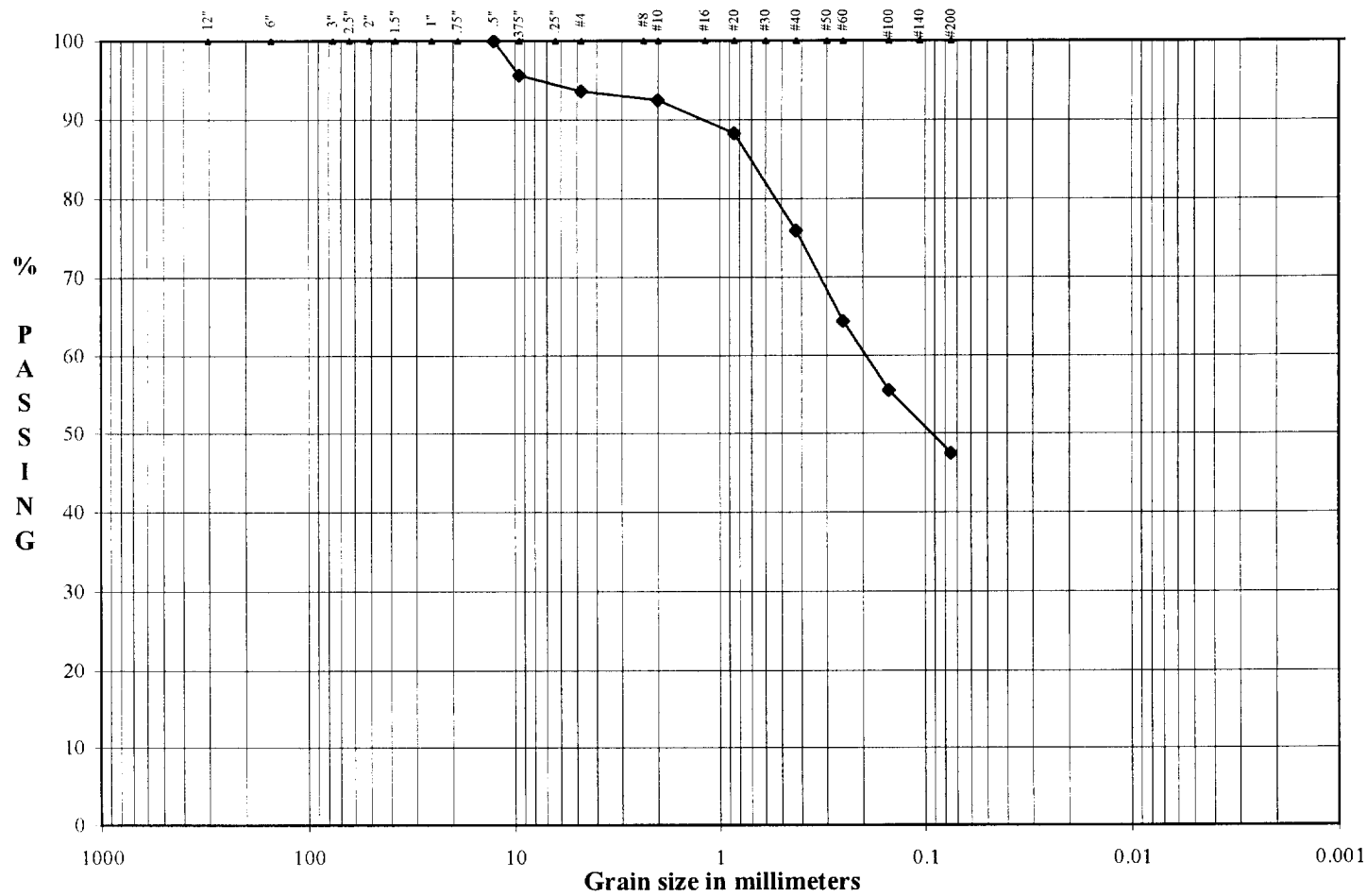
ACCURA Geotechnical Laboratory

AASHTO R18

ASTM D422, D1140, C136, C117 / AASHTO T88, T27, T 11, T311
Standard Test Method for Particle-Size Analysis of Soils and Aggregates

PROJECT #	G05-0033-00	SAMPLE ID	G11994/ISLBSS060505	TECH	AV/VG
PR. NAME	CTO-0043 Indian Head	SAMPLE TYPE	Jar	DATE	06/02/05
LOCATION	-	SAMPLE DEPTH	-	CHECK	KB

Particle-Size Analysis



Boulders	Cobbles	Coarse	Fine	Coarse	Medium	Fine	Silt-Clay
		Gravel		Sand			Fines

D_{10}	NA	mm
D_{30}	NA	mm
D_{60}	NA	mm
Cu	NA	
Cc	NA	

SOIL 3.xls [Particle-Size Graph], REV. 2; 07/21/04

3342 International Park Drive Atlanta, GA 30316 Phone: (404) 241-8722 Fax: (404) 241-4577

ACCURA Engineering & Consulting Services, Inc.

ACCURA Geotechnical Laboratory

AASHTO R18

ASTM D422, D1140, C136, C117 / AASHTO T88, T27, T 11, T311
Standard Test Method for Particle-Size Analysis of Soils and Aggregates

PROJECT NUMBER	G05-0033-00	SAMPLE ID	G11995/ISLBSS020505	TECH	AV/VG
PROJECT NAME	CTO-0043 Indian Head	SAMPLE TYPE	Jar	DATE	06/02/05
SAMPLE LOCATION	-	SAMPLE DEPTH	-	CHECK	

AS-RECEIVED MOISTURE CONTENT

Mass of Wet Sample & Tare, g	632.20
Mass of Dry Sample & Tare, g	591.80
Mass of Tare, g	371.42
Moisture Content, %	18.3

HYGROSCOPIC MOISTURE CONTENT

Mass of Wet Sample & Tare, g	
Mass of Dry Sample & Tare, g	
Mass of Tare, g	
Moisture Content, %	NA

Mass of Wet Sample & Tare, g	632.20
Mass of Tare, g	371.42
Mass of Dry Sample, g	220.38

REMARKS

SIEVE ANALYSIS*

PORTION OF SAMPLE RETAINED ON # 4 SIEVE

Mass of Tare, g: 0.00

Sieve Size		Sample & Tare, g	% RETAINED	% PASSING
12"	COBBLES		0.0	100.0
3"	COARSE GRAVEL		0.0	100.0
2.5"			0.0	100.0
2"			0.0	100.0
1.5"			0.0	100.0
1"			0.0	100.0
.75"	FINE GRAVEL		0.0	100.0
.5"		0.00	0.0	100.0
.375"		24.22	11.0	89.0
#4	COARSE SAND	43.90	19.9	80.1

PORTION OF SAMPLE PASSING # 4 SIEVE

Sieve Size		Cumulative Mass retained, g	% PASSING
#10	MEDIUM SAND	58.12	73.6
#20		70.38	68.1
#40	FINE SAND	92.73	57.9
#60		114.94	47.8
#100		133.91	39.2
#200	FINES	149.29	32.3

* - ASTM Definitions of Classification
** - AASHTO Definitions of Classification

Oven ID #	109/399
Balance ID#	105/398/297
Sieve Shaker ID #	119/1529

PARTICLE-SIZE ANALYSIS*

% COBBLES	0.0	% MEDIUM Sand	15.7
% COARSE Gravel	0.0	% FINE Sand	25.7
% FINE Gravel	19.9	% FINES	32.3
% COARSE Sand	6.5	% TOTAL SAMPLE	100.0

PARTICLE-SIZE ANALYSIS**

% COBBLES	0.0	% COARSE Sand	15.7
% COARSE Gravel (Stone)	0.0	% FINE Sand	25.7
% MEDIUM Gravel (Stone)	11.0	% FINES (Silt-Clay)	32.3
% FINE Gravel (Stone)	15.4	% TOTAL SAMPLE	100.0

DESCRIPTION: NA

USCS (ASTM D2487; D2488): NA AASHTO (M 145): NA

3342 International Park Drive Atlanta, GA 30316 Phone: (404) 241-8722 Fax: (404) 241-4577

ACCURA Engineering & Consulting Services, Inc.

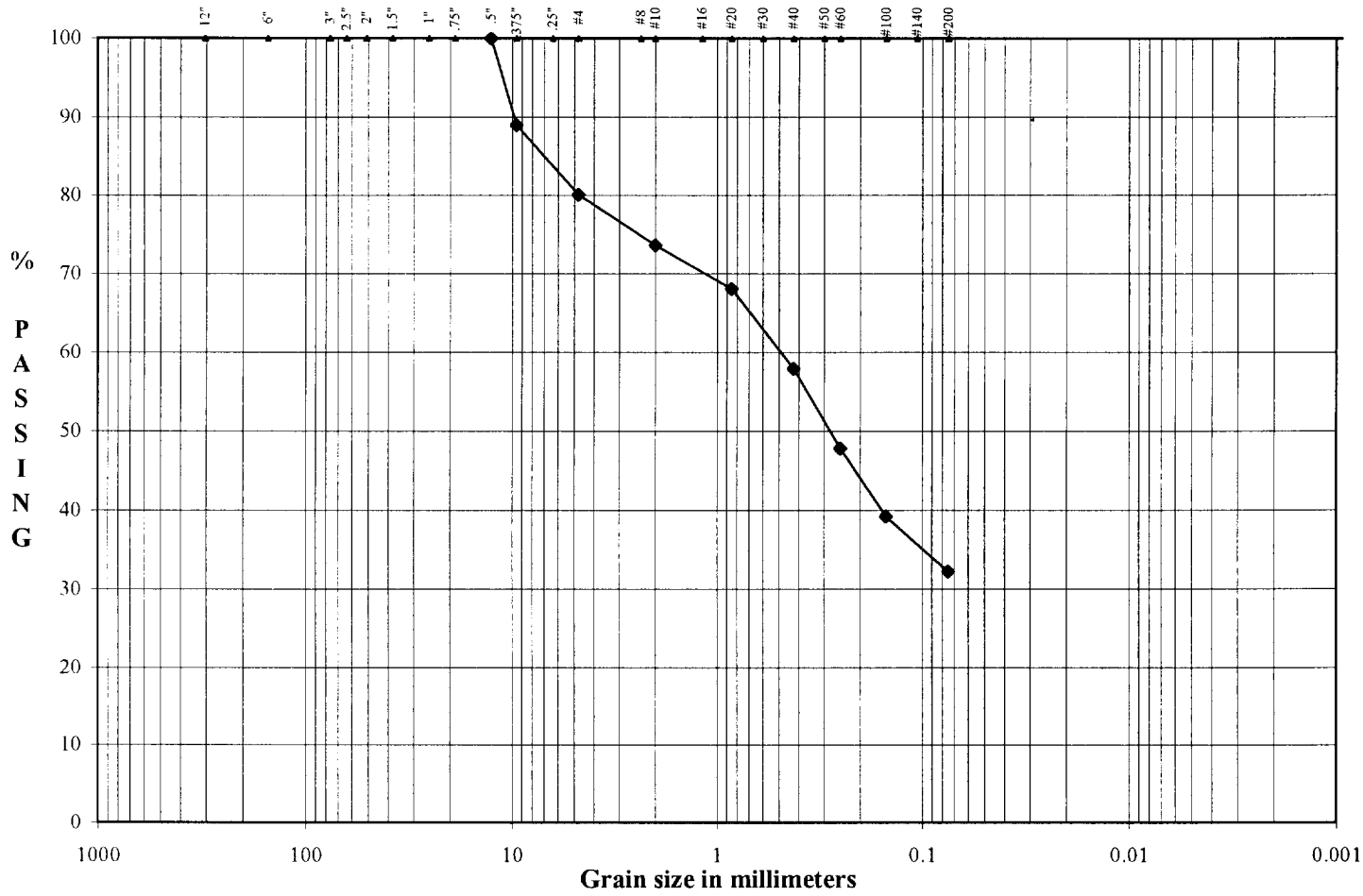
ACCURA Geotechnical Laboratory

AASHTO R18

ASTM D422, D1140, C136, C117 / AASHTO T88, T27, T 11, T311
Standard Test Method for Particle-Size Analysis of Soils and Aggregates

PROJECT #	G05-0033-00	SAMPLE ID	G11995/ISLBSS020505	TECH	AV/VG
PR. NAME	CTO-0043 Indian Head	SAMPLE TYPE	Jar	DATE	06/02/05
LOCATION	-	SAMPLE DEPTH	-	CHECK	LO

Particle-Size Analysis



Boulders	Cobbles	Coarse	Fine	Coarse	Medium	Fine	Silt-Clay
		Gravel		Sand			Fines

D_{10}	NA	mm
D_{30}	NA	mm
D_{60}	NA	mm
Cu	NA	
Cc	NA	

SOIL 3.xls [Particle-Size Graph], REV. 2; 07/21/04

3342 International Park Drive Atlanta, GA 30316 Phone: (404) 241-8722 Fax: (404) 241-4577

ACCURA Engineering & Consulting Services, Inc.

ACCURA Geotechnical Laboratory

AASHTO R18

ASTM D422, D1140, C136, C117 / AASHTO T88, T27, T 11, T311
Standard Test Method for Particle-Size Analysis of Soils and Aggregates

PROJECT NUMBER	G05-0033-00	SAMPLE ID	G11996/ISLBSS110505	TECH	AV/VG
PROJECT NAME	CTO-0043 Indian Head	SAMPLE TYPE	Jar	DATE	06/02/05
SAMPLE LOCATION	-	SAMPLE DEPTH	-	CHECK	LS

AS-RECEIVED MOISTURE CONTENT

Mass of Wet Sample & Tare, g	537.61
Mass of Dry Sample & Tare, g	488.96
Mass of Tare, g	315.51
Moisture Content, %	28.0

HYGROSCOPIC MOISTURE CONTENT

Mass of Wet Sample & Tare, g	
Mass of Dry Sample & Tare, g	
Mass of Tare, g	
Moisture Content, %	NA

Mass of Wet Sample & Tare, g	537.61
Mass of Tare, g	315.51
Mass of Dry Sample, g	173.45

REMARKS

SIEVE ANALYSIS*

PORTION OF SAMPLE RETAINED ON # 4 SIEVE

Mass of Tare, g: 0.00

Sieve Size		Sample & Tare, g	% RETAINED	% PASSING
12"	COBBLES		0.0	100.0
3"	COARSE GRAVEL		0.0	100.0
2.5"			0.0	100.0
2"			0.0	100.0
1.5"			0.0	100.0
1"			0.0	100.0
.75"	FINE GRAVEL		0.0	100.0
.5"		0.00	0.0	100.0
.375"		3.17	1.8	98.2
#4	COARSE SAND	4.08	2.4	97.6

PORTION OF SAMPLE PASSING # 4 SIEVE

Sieve Size		Cumulative Mass retained, g	% PASSING
#10	MEDIUM SAND	6.76	96.1
#20		14.50	91.6
#40	FINE SAND	23.73	86.3
#60		32.63	81.2
#100		44.19	74.5
#200	FINES	59.57	65.7

* - ASTM Definitions of Classification
** - AASHTO Definitions of Classification

Oven ID #	109/399
Balance ID#	105/398/297
Sieve Shaker ID #	119/1529

PARTICLE-SIZE ANALYSIS*

% COBBLES	0.0	% MEDIUM Sand	9.8
% COARSE Gravel	0.0	% FINE Sand	20.7
% FINE Gravel	2.4	% FINES	65.7
% COARSE Sand	1.5	% TOTAL SAMPLE	100.0

PARTICLE-SIZE ANALYSIS**

% COBBLES	0.0	% COARSE Sand	9.8
% COARSE Gravel (Stone)	0.0	% FINE Sand	20.7
% MEDIUM Gravel (Stone)	1.8	% FINES (Silt-Clay)	65.7
% FINE Gravel (Stone)	2.1	% TOTAL SAMPLE	100.0

DESCRIPTION: NA

USCS (ASTM D2487; D2488): NA AASHTO (M 145): NA

3342 International Park Drive Atlanta, GA 30316 Phone: (404) 241-8722 Fax: (404) 241-4577

ACCURA Engineering & Consulting Services, Inc.

ACCURA Geotechnical Laboratory

AASHTO R18

ASTM D422, D1140, C136, C117 / AASHTO T88, T27, T 11, T311
Standard Test Method for Particle-Size Analysis of Soils and Aggregates

PROJECT NUMBER	G05-0033-00	SAMPLE ID	G11997/ISLBSS090505	TECH	AV/VG
PROJECT NAME	CTO-0043 Indian Head	SAMPLE TYPE	Jar	DATE	06/02/05
SAMPLE LOCATION	-	SAMPLE DEPTH	-	CHECK	

AS-RECEIVED MOISTURE CONTENT

Mass of Wet Sample & Tare, g	534.82
Mass of Dry Sample & Tare, g	496.87
Mass of Tare, g	316.56
Moisture Content, %	21.0

HYGROSCOPIC MOISTURE CONTENT

Mass of Wet Sample & Tare, g	
Mass of Dry Sample & Tare, g	
Mass of Tare, g	
Moisture Content, %	NA

Mass of Wet Sample & Tare, g	534.82
Mass of Tare, g	316.56
Mass of Dry Sample, g	180.31

REMARKS

SIEVE ANALYSIS*

PORTION OF SAMPLE RETAINED ON # 4 SIEVE

Mass of Tare, g: 0.00

Sieve Size		Sample & Tare, g	% RETAINED	% PASSING
12"	COBBLES		0.0	100.0
3"			0.0	100.0
2.5"	COARSE		0.0	100.0
2"	GRAVEL		0.0	100.0
1.5"			0.0	100.0
1"			0.0	100.0
.75"			0.0	100.0
.5"	FINE GRAVEL		0.0	100.0
.375"		0.00	0.0	100.0
#4	COARSE SAND	1.29	0.7	99.3

PORTION OF SAMPLE PASSING # 4 SIEVE

Sieve Size		Cumulative Mass retained, g	% PASSING
#10	MEDIUM	4.53	97.5
#20	SAND	9.20	94.9
#40		17.38	90.4
#60	FINE SAND	28.11	84.4
#100		45.49	74.8
#200	FINES	63.58	64.7

* - ASTM Definitions of Classification
** - AASHTO Definitions of Classification

Oven ID #	109/399
Balance ID#	105/398/297
Sieve Shaker ID #	119/1529

PARTICLE-SIZE ANALYSIS*

% COBBLES	0.0	% MEDIUM Sand	7.1
% COARSE Gravel	0.0	% FINE Sand	25.6
% FINE Gravel	0.7	% FINES	64.7
% COARSE Sand	1.8	% TOTAL SAMPLE	100.0

PARTICLE-SIZE ANALYSIS**

% COBBLES	0.0	% COARSE Sand	7.1
% COARSE Gravel (Stone)	0.0	% FINE Sand	25.6
% MEDIUM Gravel (Stone)	0.0	% FINES (Silt-Clay)	64.7
% FINE Gravel (Stone)	2.5	% TOTAL SAMPLE	100.0

DESCRIPTION: NA

USCS (ASTM D2487; D2488): NA AASHTO (M 145): NA

3342 International Park Drive Atlanta, GA 30316 Phone: (404) 241-8722 Fax: (404) 241-4577

ACCURA Engineering & Consulting Services, Inc.

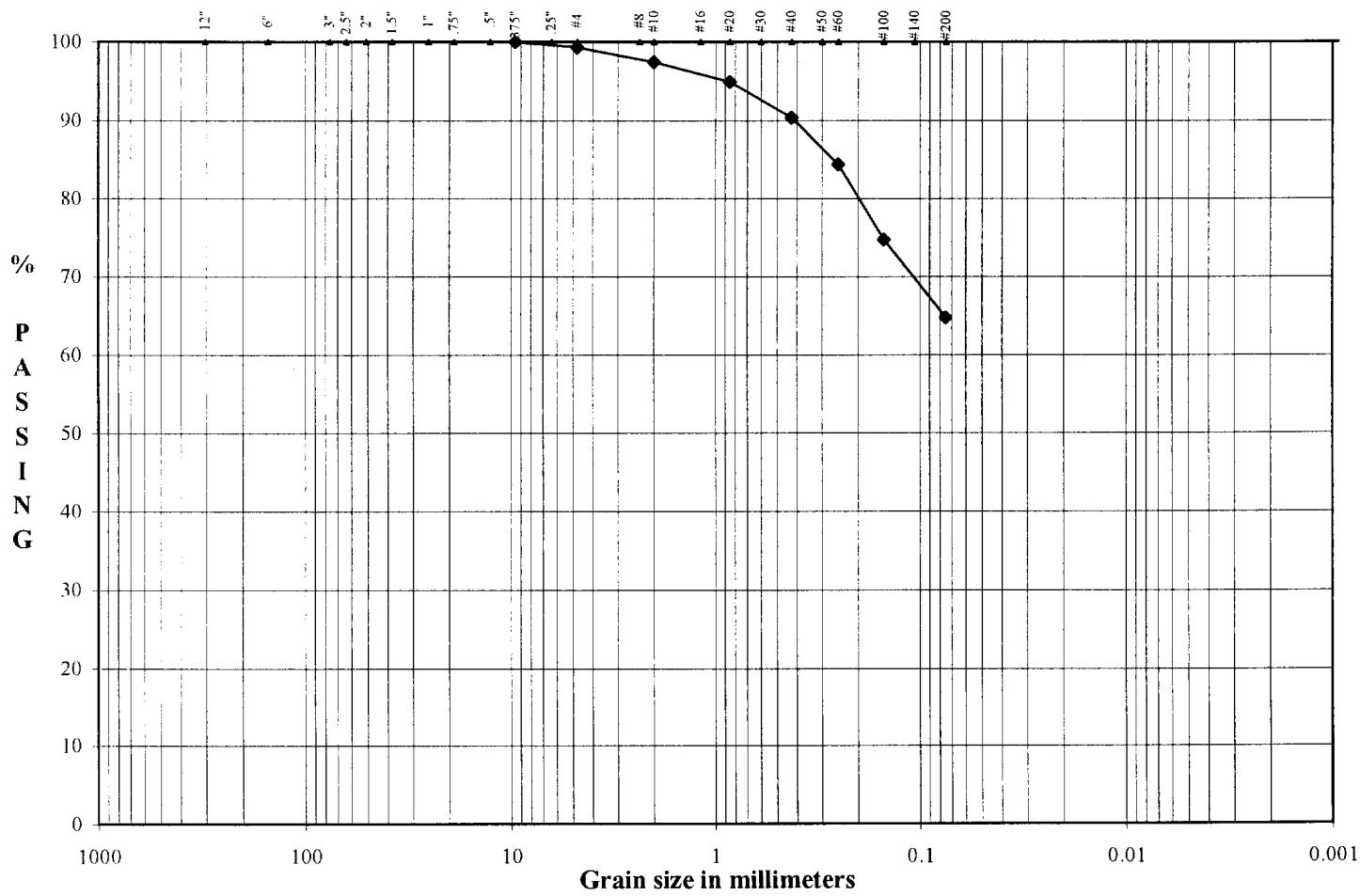
ACCURA Geotechnical Laboratory

AASHTO R18

ASTM D422, D1140, C136, C117 / AASHTO T88, T27, T 11, T311
Standard Test Method for Particle-Size Analysis of Soils and Aggregates

PROJECT #	G05-0033-00	SAMPLE ID	G11997/ISLBSS090505	TECH	AV/VG
PR. NAME	CTO-0043 Indian Head	SAMPLE TYPE	Jar	DATE	06/02/05
LOCATION	-	SAMPLE DEPTH	-	CHECK	

Particle-Size Analysis



Boulders	Cobbles	Coarse	Fine	Coarse	Medium	Fine	Silt-Clay
		Gravel		Sand			Fines

D_{10}	NA	mm
D_{30}	NA	mm
D_{60}	NA	mm
Cu	NA	
Cc	NA	

SOIL 3.xls [Particle-Size Graph], REV. 2; 07/21/04

3342 International Park Drive Atlanta, GA 30316 Phone: (404) 241-8722 Fax: (404) 241-4577

ACCURA Engineering & Consulting Services, Inc.

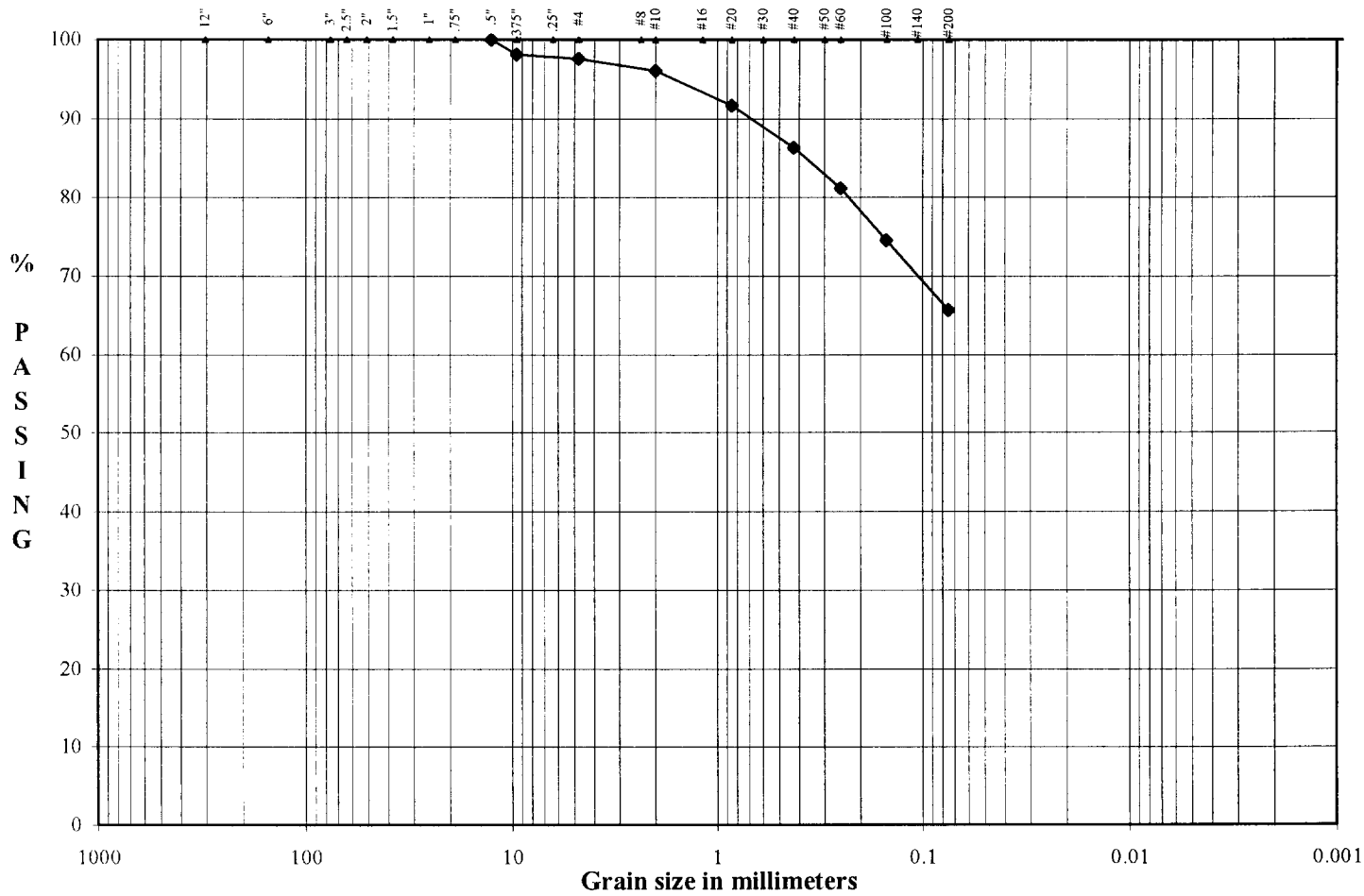
ACCURA Geotechnical Laboratory

AASHTO R18

ASTM D422, D1140, C136, C117 / AASHTO T88, T27, T 11, T311
Standard Test Method for Particle-Size Analysis of Soils and Aggregates

PROJECT #	G05-0033-00	SAMPLE ID	G11996/ISLBSS110505	TECH	AV/VG
PR. NAME	CTO-0043 Indian Head	SAMPLE TYPE	Jar	DATE	06/02/05
LOCATION	-	SAMPLE DEPTH	-	CHECK	

Particle-Size Analysis



Boulders	Cobbles	Coarse	Fine	Coarse	Medium	Fine	Silt-Clay
		Gravel		Sand			Fines

D_{10}	NA	mm
D_{30}	NA	mm
D_{60}	NA	mm
Cu	NA	
Cc	NA	

SOIL 3.xls [Particle-Size Graph], REV. 2; 07/21/04

3342 International Park Drive Atlanta, GA 30316 Phone: (404) 241-8722 Fax: (404) 241-4577

ACCURA Engineering & Consulting Services, Inc.

ACCURA Geotechnical Laboratory

AASHTO R18

ASTM D422, D1140, C136, C117 / AASHTO T88, T27, T 11, T311
Standard Test Method for Particle-Size Analysis of Soils and Aggregates

PROJECT NUMBER	G05-0033-00	SAMPLE ID	G11998/ISLBSSREF1	TECH	AV/VG
PROJECT NAME	CTO-0043 Indian Head	SAMPLE TYPE	Jar	DATE	06/02/05
SAMPLE LOCATION	-	SAMPLE DEPTH	-	CHECK	

AS-RECEIVED MOISTURE CONTENT

Mass of Wet Sample & Tare, g	595.07
Mass of Dry Sample & Tare, g	532.32
Mass of Tare, g	374.12
Moisture Content, %	39.7

HYGROSCOPIC MOISTURE CONTENT

Mass of Wet Sample & Tare, g	
Mass of Dry Sample & Tare, g	
Mass of Tare, g	
Moisture Content, %	NA

Mass of Wet Sample & Tare, g	595.07
Mass of Tare, g	374.12
Mass of Dry Sample, g	158.20

REMARKS

SIEVE ANALYSIS*

PORTION OF SAMPLE RETAINED ON # 4 SIEVE

Mass of Tare, g: 0.00

Sieve Size		Sample & Tare, g	% RETAINED	% PASSING
12"	COBBLES		0.0	100.0
3"	COARSE GRAVEL		0.0	100.0
2.5"			0.0	100.0
2"			0.0	100.0
1.5"			0.0	100.0
1"			0.0	100.0
.75"	FINE GRAVEL		0.0	100.0
.5"			0.0	100.0
.375"			0.0	100.0
#4	COARSE SAND	0.00	0.0	100.0

PORTION OF SAMPLE PASSING # 4 SIEVE

Sieve Size		Cumulative Mass retained, g	% PASSING
#10	MEDIUM SAND	1.07	99.3
#20		4.25	97.3
#40	FINE SAND	17.28	89.1
#60		37.38	76.4
#100		48.61	69.3
#200	FINES	59.78	62.2

* - ASTM Definitions of Classification
** - AASHTO Definitions of Classification

Oven ID #	109/399
Balance ID#	105/398/297
Sieve Shaker ID #	119/1529

PARTICLE-SIZE ANALYSIS*

% COBBLES	0.0	% MEDIUM Sand	10.2
% COARSE Gravel	0.0	% FINE Sand	26.9
% FINE Gravel	0.0	% FINES	62.2
% COARSE Sand	0.7	% TOTAL SAMPLE	100.0

PARTICLE-SIZE ANALYSIS**

% COBBLES	0.0	% COARSE Sand	10.2
% COARSE Gravel (Stone)	0.0	% FINE Sand	26.9
% MEDIUM Gravel (Stone)	0.0	% FINES (Silt-Clay)	62.2
% FINE Gravel (Stone)	0.7	% TOTAL SAMPLE	100.0

DESCRIPTION: NA

USCS (ASTM D2487; D2488): NA AASHTO (M 145): NA

3342 International Park Drive Atlanta, GA 30316 Phone: (404) 241-8722 Fax: (404) 241-4577

ACCURA Engineering & Consulting Services, Inc.

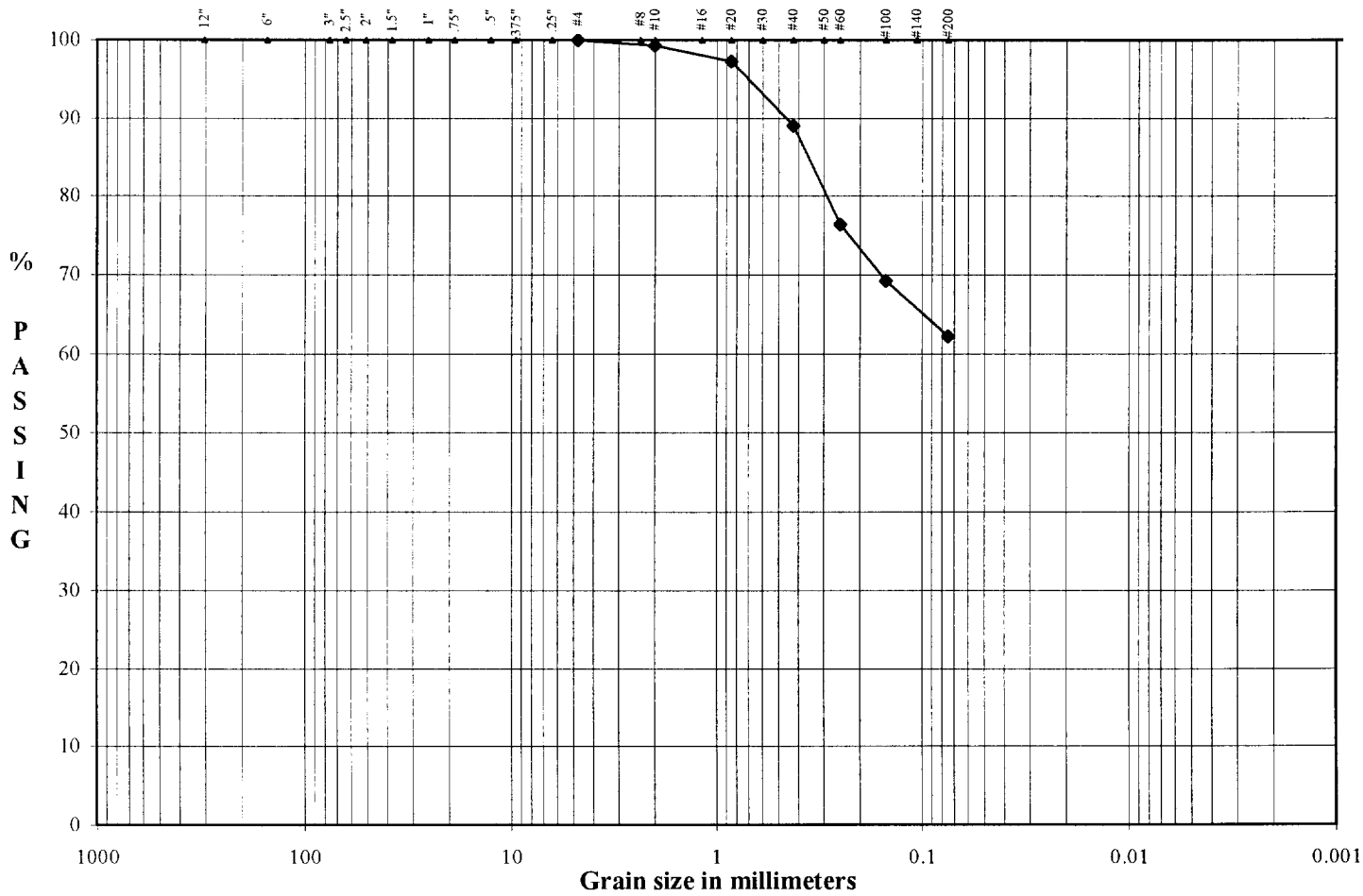
ACCURA Geotechnical Laboratory

AASHTO R18

ASTM D422, D1140, C136, C117 / AASHTO T88, T27, T 11, T311
Standard Test Method for Particle-Size Analysis of Soils and Aggregates

PROJECT #	G05-0033-00	SAMPLE ID	G11998/ISLBSSREF1	TECH	AV/VG
PR. NAME	CTO-0043 Indian Head	SAMPLE TYPE	Jar	DATE	06/02/05
LOCATION	-	SAMPLE DEPTH	-	CHECK	LB

Particle-Size Analysis



Boulders	Cobbles	Coarse	Fine	Coarse	Medium	Fine	Silt-Clay
		Gravel		Sand			Fines

D_{10}	NA	mm
D_{30}	NA	mm
D_{60}	NA	mm
Cu	NA	
Cc	NA	

SOIL 3.xls [Particle-Size Graph], REV. 2; 07/21/04

Appendix B

Lab Area Chemistry Results: Soil and Tissue

Table B-1
Surface Soil Results
BERA Report for Lab Area
NSF-IH, Indian Head, Maryland

	ISLBSS01	ISLBSS02	ISLBSS03	ISLBSS04	ISLBSS05	ISLBSS06	ISLBSS07	ISLBSS08		ISLBSS09	ISLBSS10	ISLBSSREF1
	ISLBSS010505	ISLBSS020505	ISLBSS030505	ISLBSS040505	ISLBSS050505	ISLBSS060505	ISLBSS070505	ISLBSS080505	ISLBSS080505-Dup	ISLBSS090505	ISLBSS100505	ISLBSSREF1
Sample Date	5/23/05	5/24/05	5/23/05	5/23/05	5/24/05	5/24/05	5/23/05	5/24/05	5/24/05	5/24/05	5/23/05	5/24/05
Semivolatile Organic Compounds (µg/kg)												
1-METHYLNAPHTHALENE	10 U	5.1 J	9.4 U	15	11 U	10 U	10 U	11 U	11 U	5.9 J	5.6 J	12 U
ACENAPHTHENE	10 U	8.6 J	9.4 U	21	18	10 U	7.9 J	11 U	11 U	6.2 J	17	12
ACENAPHTHYLENE	6.3 B	100	4.9 B	110	25	48	56	11 U	11 U	24	92	27
ACETOPHENONE	400 U	400 U	380 U	400 U	420 U	400 U	530	450	410 J	390 U	430 U	460 U
ANTHRACENE	13	70	11	72	110	38	58	5.4 J	4.8 J	27	75	29
BENZO(A)ANTHRACENE	55	220	86	130	790	140	120	6.9 J	8.2 J	71	250	63
BENZO(A)PYRENE	61	260	82	210	510	220	120	7 J	8.1 J	75	290	66
BENZO(B)FLUORANTHENE	82	450	110	130	880 J	390 J	190	18 J	15	81	350	57
BENZO(G,H,I)PERYLENE	43	140	51	140	300	140	97	8.5 J	8.7 J	58	210	46
BENZO(K)FLUORANTHENE	57	460	89	130	900 J	140	150	18 J	9 J	63	260	84
CARBAZOLE	400 U	400 U	380 U	400 U	420 U	400 U	410 U	420 U	430 U	390 U	430 U	460 U
CHRYSENE	71	260	110	160	910	250	160	11	13	85	340	76
DIBENZO(A,H)ANTHRACENE	16 B	57	21	41	110	75	38	4.6 J	11 U	21	71	17
DIBENZOFURAN	400 U	400 U	380 U	400 U	420 U	400 U	410 U	420 U	430 U	390 U	430 U	460 U
FLUORANTHENE	120	430	200	230	1,400	350	290	11	15	140	530	150
FLUORENE	10 U	13	9.4 U	24	21	6.2 J	9.7 J	11 U	11 U	6.4 J	12	10 J
INDENO(1,2,3-CD)PYRENE	38	120	48	98	270	110	82	7 J	7.4 J	46	150	41
NAPHTHALENE	10 U	9 J	9.4 U	48	11 U	10 U	10 J	11 U	11 U	9.8 U	8.8 J	12 U
PHENANTHRENE	46	140	49	150	600	99	120	7.5 J	8.2 J	71	230	88
PYRENE	100	390	210	300	1,700	320	280	9.6 J	13	140	540	140
Total Metals (mg/kg)												
COPPER	12 J	15.2 J	18.2 J	10.7 J	11 J	15.7 J	127 J	30.2 J	35 J	7.6 J	67.9 J	10.1 J
LEAD	56.9	37.5	39.3	81.1	111	101	659	233	393	32.1	850	26.5
MERCURY	0.96	9.5	0.75	3.2	3.6	36.6	127	12.5	22	3.8	59.6	0.19
ZINC	40.8	79.4	46.1	83.1	103	117	586	126	155	40	412	19.3
Methylmercury (ng/g)	0.307 L	2.49 L	0.418 L	1.08 L	0.856 L	1.14 L	1.42 L	1.48 L	0.562 L	1.81 L	0.982 L	0.048 L
Wet Chemistry												
Percent SOLIDS	82.2	83.0	89.6	84.5	80.2	79.6	78.9	79.3	81	82.2	76.0	73.3
PH	5.14	6.84	6.05	6.69	7.15	4.95	6.08	5.86	6.15	5.29	5.7	4.35
Total organic carbon	11,000 L	34,300 L	10,400 L	26,500 L	12,200 L	18,800 L	26,900 L	19,300 L	26,700 L	4,700 L	25,000 L	28,200 L

Shading indicates a detected value
B-Similar value in associated blank
J-Estimated value
L - Reported value may be biased low
U-Not detected

µg/kg - micrograms per kilogram
mg/kg - milligrams per kilogram
ng/kg - nanograms per gram

Table B-2
Earthworm Tissue Results
BERA Report for Lab Area
NDWIH, Indian Head, Maryland

Sample Date	ISLBTX01 6/30/05	ISLBTX02 6/30/05	ISLBTX03 6/30/05	ISLBTX04 6/30/05	ISLBTX05 6/30/05	ISLBTX06 6/30/05
Chemical Name						
Total Metals (mg/kg)						
COPPER	3.2 J	5.9 J	5 J	2.8 B	3.2 J	3.5 J
LEAD	6.8 J	8.8 J	3.6 J	9.6 J	14.4 J	12.2 J
MERCURY	0.11 J	0.83 J	0.19 J	0.58 J	0.27 J	7.6 J
ZINC	22 J	28 J	18.5 J	25.3 J	30.8 J	28.8 J
Methylmercury (ng/g)	1.8 J	90 J	4.3 J	11 J	26.8 J	30.2 J
Wet Chemistry						
Percent LIPIDS	0.11	0.1	0.07	0.16	0.17	0.17

Sample Date	ISLBTX07 6/30/05	ISLBTX08 6/30/05	ISLBTX08-Dup 6/30/05	ISLBTX09 6/30/05	ISLBTX10 6/30/05	ISLBTXREF1 6/30/05
Chemical Name						
Total Metals (mg/kg)						
COPPER	13.3 J	4.9 J	5.4 J	3.1 J	10 J	2.9 B
LEAD	62.9 J	30.5 J	31.8 J	5 J	133 J	9.2 J
MERCURY	130 J	2.1 J	1.7 J	0.96 J	12.3 J	0.037 UJ
ZINC	63.1 J	28 J	32.9 J	22.9 J	68.6 J	18.1 J
Methylmercury (ng/g)	11 J	9 J	8.1 J	19 J	16.8 J	1.2 UJ
Wet Chemistry						
Percent LIPIDS	0.35	0.16	0.18	0.21	0.21	0.22

Shading indicates a detected value
NA-Not analyzed
B-Similar value in associated blank
J-Estimated value
UJ-Not detected, estimated reporting limit

µg/kg - micrograms per kilogram
ng/kg - nanograms per gram

Appendix C

Soil Toxicity Testing Report

TOXICOLOGICAL EVALUATION OF SOIL SAMPLES

Eisenia fetida Survival, Growth and Reproduction Soil Toxicity Tests Indian Head CTO-043 Ecological Risk Assessment

Prepared For

CH2M Hill, Incorporated
13921 Park Center Road
Herndon, Virginia 20171

By

EnviroSystems, Incorporated
1 Lafayette Road
Hampton, New Hampshire 03842

June 2005
Reference Number 13341-05-06

TABLE OF CONTENTS

1.0 INTRODUCTION 3

2.0 MATERIAL AND METHODS 3

2.1 General Methods, Biological Evaluations 3
2.2 Test Samples 3
2.3 Test Species 4
2.4 *Eisenia fetida* 28 Day Survival and Growth Assay 4
2.5 Statistical Analysis 5
2.6 Quality Control 5
2.7 Protocol Deviations 5

3.0 RESULTS AND DISCUSSION 5

3.1 *Eisenia fetida* 28 Day Survival, Reproduction and Growth Assay 5
3.2 Summary 6

4.0 REFERENCES 6

LIST OF TABLES

Table 1. Summary of Sample Collection Information. 7
Table 2. Summary of Soil Physical Characteristics 7
Table 3. Summary of Day 28 Survival Data and Statistical Analysis Results 8
Table 4. Summary of Day 28 Reproduction Data and Statistical Analysis Results . 9
Table 5. Summary of Day 28 Growth Data and Statistical Analysis Results 10
Table 6. Summary of Reference Toxicant Data 11

APPENDIX A: RAW DATA & SUPPORT 12

TOXICOLOGICAL EVALUATION
OF SOIL SAMPLES
JUNE 2005

Indian Head CTO-043 Ecological Risk Assessment
***E. fetida* 28 Day Soil Evaluation**

1.0 INTRODUCTION

Toxicity tests expose groups of organisms to environmental samples and laboratory controls for a specified period to assess potential impacts. Endpoints evaluated as part of the assays may include survival, growth, and/or reproduction. Analysis of variance techniques are used to determine if differences in a measured endpoint for organisms exposed to a test sample are significantly different from responses obtained from organisms exposed to field reference site or laboratory control materials.

This report presents the results of chronic toxicity tests conducted on twelve soil samples collected from Indian Head, CTO-043 project site. The soil samples were provided by CH2M Hill staff from the Herndon, Virginia office. Testing was based on programs and protocols developed by the ASTM (2001) and US EPA (1989). The toxicity of the samples was assessed by conducting 28 day exposure assays with the earthworm, *Eisenia fetida*. Assays were performed at EnviroSystems, Incorporated (ESI), Hampton, New Hampshire.

2.0 MATERIALS AND METHODS

2.1 General Methods, Biological Evaluations

Toxicological and analytical protocols used in this program follow procedures outlined in *Standard Methods for the Examination of Water and Wastewater*, 20th Edition (APHA 1998), *Standard Guide For Conductiong Laboratory Soil Toxicity or Bioaccumulation Tests With the Lumbricid Earthworm Eisenia Fetida*, *Aquatic Toxicology and Risk Assessment: Volume 11.05* (ASTM 2004), and *Protocol for Short Term Toxicity Screening of Hazardous Waste Sites* (EPA 1989). These protocols provide standard approaches for physical and chemical analysis and for the evaluation of toxicological effects of soils on terrestrial organisms.

2.2 Test Samples

Twelve soil samples collected from Indian Head CTO-043 for *E. fetida* testing were received at ESI on May 25, 2005. One of these samples, ISLBTXREF1 (ESI -012) was identified by CH2M Hill staff as a reference sample. Upon arrival at the laboratory, the samples were given an internal sample reference number and logged into the project sample control system. Prior to testing, samples were placed in a secure refrigerator and stored at a temperature of 2-4°C until test initiation. Sample identification, collection and receipt information is summarized in Table 1.

2.3 Test Species

E. fetida were obtained from EnviroSystems' in-house cultures. Original cultures were obtained from Smith's Worm Supply, Boston, Georgia. Earthworms were cultured in an organic compost composed of peat moss and fine sand. Temperatures within the culture were maintained at approximately 20°C. Worms used in the assays were adults with a well-developed clitellum. Mean wet weights of worms at the start of the assay were 0.567 grams per individual.

2.4 *Eisenia fetida* 28 Day Survival and Growth Assay

The assays were carried out following protocol provided by ASTM (2004). The 28 day earthworm assay was conducted in static exposure mode. Endpoints for the assay were survival, growth, expressed as mean wet weight per surviving worm, and reproduction, expressed as mean cocoon production / replicate.

Samples were sieved through a 12-mm stainless steel screen to remove large stones, sticks, roots, and man-made material. Prior to testing, moisture content, total organic content and pH were determined for each sample. Target moisture content for the samples was 30 to 35%. If necessary, samples were either dried, at room temperature, or hydrated, using deionized water to achieve the target moisture content. As received soil moisture content and pH are summarized in Table 2. Soil pH was within acceptable limits no pH adjustments were made prior to testing.

Soil used as a laboratory control in the earthworm assay was an artificial soil prepared according to protocol developed by the EPA (1989). The soil consisted of 10% sphagnum peat moss, 20% kaolinite clay and 70% fine silica sand (200 mesh) by dry weight. The peat moss was blended and screened prior to use to break-up clods and remove any large sticks and twigs. The moisture content of the control soil was adjusted to approximately 35% using deionized water. The pH of the control soil was checked to insure values were within the range of 7.0±0.5 SU (ASTM 2004).

The assay utilized 4 replicates with 10 worms per replicate. Approximately 700 g of soil was added to each 500 mL glass jar. The jars were covered with laboratory film with a small hole in the top to allow ventilation. Containers were placed in an incubator at 20 ±2°C. Lighting was set at 24 hours illumination. Light intensity was approximately 50 foot candles. During the exposure period, incubator temperature was checked daily for the duration of the assay. Temperature was also monitored on a hourly basis using a data logger housed in a surrogate test vessel. The worms were not fed during the assay.

After 28 days exposure, chambers were uncovered and the contents removed onto trays. Living worms were removed from the soil and counted. Juvenile worms and cocoons recovered from the soil were enumerated. Once counted, the worms were rinsed with deionized water to remove soil particles, blotted dry, and weighed. Weight data was used for statistical comparison of growth. After weight data was recorded the worms from each sample were transferred to glass vials and stored frozen at approximately -18°C.

2.5 Statistical Analysis

Survival, reproduction and growth data were analyzed using CETIS® software to determine significant differences between the test sediments and the laboratory control and the test sediments and the reference sites. Data sets were evaluated to determine homogeneity of sample variances and normality of distribution using Shapiro-Wilk's Test for Normality and the F-Test for Equality of Two Variances, respectively. Data sets were subsequently evaluated using the appropriate parametric or non-parametric Analysis of Variance (ANOVA) statistic. Pair-wise comparisons were analyzed using appropriate statistics. Statistical difference was evaluated at $\alpha=0.05$.

2.6 Quality Control

As part of the laboratory quality control program, reference toxicant evaluations are conducted on a regular basis by ESI for the test species. These results provide relative health and response data while allowing for comparison with historic data collected from ESI-conducted reference toxicity tests. Results of these tests are presented in Table 6.

2.7 Protocol Deviations

Review of data generated during these assays indicated no areas where methods or results deviated from standard protocols.

3.0 RESULTS AND DISCUSSION

Table 1 provides sample collection and receipt information. A summary of the physical and chemical characteristics of the soils is provided in Table 2. Survival, reproduction and growth data from the *E. fetida* assay are summarized in Tables 3, 4 and 5. Table 6 provides historic reference toxicant data for *E. fetida.* Support data, including laboratory bench sheets, are included in Appendix A.

3.1 *Eisenia fetida* 28 Day Survival, Reproduction and Growth Assay

At the end of the 28 day exposure period, the mean worm survival in the laboratory control soil was 100%. Worms recovered from the laboratory control soil had a mean wet weight of 0.415 g/surviving worm. Worms from the laboratory control soil produced an average of 23.8 cocoons per replicate. The minimum acceptable criteria for survival in the laboratory control is 90%. These data indicate that the organisms were healthy and not stressed by handling. Survival in the reference soil, ISLBTXREF1, was 97.5%. Mean wet weight in the reference soil was 0.482 g/surviving worm. Worms from the reference soil produced an average of 8.3 cocoons per replicate.

Daily temperature records indicate that values ranged from 19-21°C during the assay, with a mean value of 19.4 which fall within the acceptable range of 20 ±2°C. Hourly temperature date collected from the data logger, details in Appendix A, documented a mean temperature of 19.5°C with a range of 18.5 to 22.5°C. The mean and range were within the acceptable ranges of 20 ±2°C and 20 ±3°C, respectively.

Tables 3, 4 and 5 provide a summary of survival, reproduction and growth data, respectively, for the laboratory control, reference and project sites. Statistical evaluations are presented against the laboratory control and project reference site.

3.2 Summary

Review of survival data, as compared against laboratory control and project reference site showed no statistically significant reductions in survival at any of the sample sites.

Review of reproduction data showed a total of 2 juveniles being produced between all treatments/replicates. Cocoon production was observed in all samples. Statistical analysis of the sample site data sets showed significant reductions in cocoon production, as compared to the laboratory control for all sites with the exception of sites ISLBTX08 and ISLBTX02. When statistical comparisons were made against the project reference site statistically significant reductions in cocoon production were observed in soils from sites ISLBTX01, ISLBTX03, ISLBTX07 and ISLBTX05.

Review of *E. fetida* growth data, as compared to laboratory control growth, indicates that soil from project site ISLBTX08 exhibited a significant negative impact on worm growth. When statistical comparisons were made against the project reference site statistically significant reduction in growth were observed for worms recovered from all sites with the exception of sites ISLBTX01 and ISLBTX11.

4.0 REFERENCES

APHA. 1998. *Standard Methods for the Examination of Water and Wastewater,* 20th Edition.

ASTM. 2004. Volume 11.05. *Standard Guide for Conducting Laboratory Soil Toxicity or Bioaccumulation Tests With the Lumbricid Earthworm Eisenia Fetida.* E1676-97

US EPA. 1989. *Protocol for Short Term Toxicity Screening of Hazardous Waste Sites*. EPA/600/3-88/029.

TABLE 1. Summary of Sample Collection Information. *E. fetida* Soil Evaluation. Indian Head CTO-043 Ecological Risk Assessment. CH2M Hill. June 2005.

Project Site	ESI Ref	Matrix	Sample Collection Date	Sample Collection Time	Sample Receipt Date	Sample Receipt Time
ISLBTXREF1	012	Soil	05/24/05	1300	05/25/05	1000
ISLBTX01	001	Soil	05/23/05	1445	05/25/05	1000
ISLBTX03	002	Soil	05/23/05	1545	05/25/05	1000
ISLBTX04	003	Soil	05/23/05	1500	05/25/05	1000
ISLBTX07	004	Soil	05/23/05	1515	05/25/05	1000
ISLBTX10	005	Soil	05/23/05	1530	05/25/05	1000
ISLBTX05	006	Soil	05/24/05	0945	05/25/05	1000
ISLBTX08	007	Soil	05/24/05	1015	05/25/05	1000
ISLBTX06	008	Soil	05/24/05	1045	05/25/05	1000
ISLBTX02	009	Soil	05/24/05	1100	05/25/05	1000
ISLBTX11	010	Soil	05/24/05	1030	05/25/05	1000
ISLBTX09	011	Soil	05/24/05	1115	05/25/05	1000

TABLE 2. Summary of Sample Physical Characteristics. *E. fetida* Soil Evaluation. Indian Head CTO-043 Ecological Risk Assessment. CH2M Hill. June 2005.

Project Site	ESI Ref	Matrix	Organic Content (%)	pH (SU)	Moisture Content (%)
ISLBTXREF1	012	Soil	6.3	4.94	28.5
ISLBTX01	001	Soil	3.6	6.02	19.6
ISLBTX03	002	Soil	3.0	5.71	15.8
ISLBTX04	003	Soil	4.2	6.39	17.3
ISLBTX07	004	Soil	7.6	6.36	20.4
ISLBTX10	005	Soil	5.0	6.41	25.5
ISLBTX05	006	Soil	2.5	7.29	19.5
ISLBTX08	007	Soil	5.0	6.92	19.4
ISLBTX06	008	Soil	4.4	6.31	21.3
ISLBTX02	009	Soil	5.6	6.79	18.6
ISLBTX11	010	Soil	5.9	6.89	20.6
ISLBTX09	011	Soil	4.2	6.20	17.7
Lab Control	000	Soil	8.5	NR	29.9

NR - Value not reported.

TABLE 3. Summary of Day 28 Survival Data and Statistical Analysis Results. *E. fetida* Soil Evaluation. Indian Head CTO-043 Ecological Risk Assessment. CH2M Hill. June 2005.

Statistical Comparisons Against Laboratory Control

Project Site	ESI Ref	Mean % Survival	Distribution	Variance	Statistic Summary: Statistic	Statistic Summary: Critical Value	Statistic Summary: p Value	Significant Difference in Survival
Lab Control	000	100.0%						
ISLBTXREF1	012	97.5%	Non-normal	Equal	10.0000		0.3429	NO
ISLBTX01	001	100.0%	-	-	-	-	-	NO
ISLBTX03	002	100.0%	-	-	-	-	-	NO
ISLBTX04	003	100.0%	-	-	-	-	-	NO
ISLBTX07	004	100.0%	-	-	-	-	-	NO
ISLBTX10	005	100.0%	-	-	-	-	-	NO
ISLBTX05	006	100.0%	-	-	-	-	-	NO
ISLBTX08	007	100.0%	-	-	-	-	-	NO
ISLBTX06	008	100.0%	-	-	-	-	-	NO
ISLBTX02	009	100.0%	-	-	-	-	-	NO
ISLBTX11	010	97.5%	Non-normal	Equal	10.0000		0.3429	NO
ISLBTX09	011	100.0%	-	-	-	-	-	NO

Statistical Comparisons Against Project Reference Site

Project Site	ESI Ref	Mean % Survival	Distribution	Variance	Statistic Summary: Statistic	Statistic Summary: Critical Value	Statistic Summary: p Value	Significant Difference in Survival
ISLBTXREF1	012	97.5%						
ISLBTX01	001	100.0%	Non-normal	Equal	6.0000		0.6571	NO
ISLBTX03	002	100.0%	Non-normal	Equal	6.0000		0.6571	NO
ISLBTX04	003	100.0%	Non-normal	Equal	6.0000		0.6571	NO
ISLBTX07	004	100.0%	Non-normal	Equal	6.0000		0.6571	NO
ISLBTX10	005	100.0%	Non-normal	Equal	6.0000		0.6571	NO
ISLBTX05	006	100.0%	Non-normal	Equal	6.0000		0.6571	NO
ISLBTX08	007	100.0%	Non-normal	Equal	6.0000		0.6571	NO
ISLBTX06	008	100.0%	Non-normal	Equal	6.0000		0.6571	NO
ISLBTX02	009	100.0%	Non-normal	Equal	6.0000		0.6571	NO
ISLBTX11	010	97.5%	-	-	-	-	-	NO
ISLBTX09	011	100.0%	Non-normal	Equal	6.0000		0.6571	NO

TABLE 4. Summary of Day 28 Reproduction Data and Statistical Analysis Results. *E. fetida* Soil Evaluation. Indian Head CTO-043 Ecological Risk Assessment. CH2M Hill. June 2005.

Statistical Comparisons Against Laboratory Control

Project Site	ESI Ref	Mean # Cocoons / replicate	Distribution	Variance	Statistic Summary: Statistic	Statistic Summary: Critical Value	Statistic Summary: p Value	Significant Difference in Survival
Lab Control	000	23.8						
ISLBTXREF1	012	8.3	Normal	Equal	5.4378	1.9432	0.0008	YES
ISLBTX01	001	0.8	Normal	Equal	11.3244	1.9432	0.0000	YES
ISLBTX03	002	2.8	Normal	Equal	9.5935	1.9432	0.0000	YES
ISLBTX04	003	9.5	Normal	Equal	5.6717	1.9432	0.0006	YES
ISLBTX07	004	2.0	Normal	Equal	10.0015	1.9432	0.0000	YES
ISLBTX10	005	7.8	Normal	Equal	7.0676	1.9432	0.0002	YES
ISLBTX05	006	2.3	Normal	Equal	9.6554	1.9432	0.0000	YES
ISLBTX08	007	22.5	Normal	Equal	0.3587	1.9432	0.3661	NO
ISLBTX06	008	12.0	Normal	Equal	5.8296	1.9432	0.0006	YES
ISLBTX02	009	20.0	Normal	Equal	1.5667	1.9432	0.0841	NO
ISLBTX11	010	16.0	Normal	Equal	3.6283	1.9432	0.0055	YES
ISLBTX09	011	9.0	Normal	Equal	4.3694	1.9432	0.0024	YES

Statistical Comparisons Against Project Reference Site

Project Site	ESI Ref	Mean # Cocoons / replicate	Distribution	Variance	Statistic Summary: Statistic	Statistic Summary: Critical Value	Statistic Summary: p Value	Significant Difference in Survival
ISLBTXREF1	012	8.3						
ISLBTX01	001	0.8	Normal	Equal	3.5520	1.9432	0.0060	YES
ISLBTX03	002	2.8	Normal	Equal	2.4295	1.9432	0.0256	YES
ISLBTX04	003	9.5	Normal	Equal	-0.4849	1.9432	0.6775	NO
ISLBTX07	004	2.0	Normal	Equal	2.7778	1.9432	0.0160	YES
ISLBTX10	005	7.8	Normal	Equal	0.2140	1.9432	0.4188	NO
ISLBTX05	006	2.3	Normal	Equal	2.6083	1.9432	0.0201	YES
ISLBTX08	007	22.5	Normal	Equal	-4.0339	1.9432	0.9966	NO
ISLBTX06	008	12.0	Normal	Equal	-1.7886	1.9432	0.9381	NO
ISLBTX02	009	20.0	Normal	Equal	-4.7721	1.9432	0.9985	NO
ISLBTX11	010	16.0	Normal	Equal	-3.5026	1.9432	0.9936	NO
ISLBTX09	011	9.0	Normal	Equal	-0.2190	1.9432	0.5830	NO

TABLE 5. Summary of Day 28 Growth Data and Statistical Analysis Results. *E. fetida* Soil Evaluation. Indian Head CTO-043 Ecological Risk Assessment. CH2M Hill. June 2005.

Statistical Comparisons Against Laboratory Control

Project Site	ESI Ref	Mean Wet Weight (g) / Surviving Worm	Distribution	Variance	Statistic Summary			Significant Difference in Survival
					Statistic	Critical Value	p Value	
Lab Control	000	0.415						
ISLBTXREF1	012	0.482	Normal	Equal	-4.9557	1.9432	0.9987	NO
ISLBTX01	001	0.455	Normal	Equal	-1.4942	1.9432	0.9071	NO
ISLBTX03	002	0.435	Normal	Equal	-1.3587	1.9432	0.8885	NO
ISLBTX04	003	0.410	Normal	Equal	0.2056	1.9432	0.4220	NO
ISLBTX07	004	0.410	Normal	Equal	0.2255	1.9432	0.4145	NO
ISLBTX10	005	0.413	Normal	Equal	0.0894	1.9432	0.4658	NO
ISLBTX05	006	0.428	Normal	Equal	-0.6019	1.9432	0.7154	NO
ISLBTX08	007	0.372	Normal	Equal	2.7948	1.9432	0.0157	YES
ISLBTX06	008	0.435	Normal	Equal	-0.9798	1.9432	0.8175	NO
ISLBTX02	009	0.400	Non-normal	Equal	12.5000		0.1000	NO
ISLBTX11	010	0.453	Normal	Equal	-1.7064	1.9432	0.9306	NO
ISLBTX09	011	0.438	Normal	Equal	-1.3833	1.9432	0.8921	NO

Statistical Comparisons Against Project Reference Site

Project Site	ESI Ref	Mean Wet Weight (g) / Surviving Worm	Distribution	Variance	Statistic Summary			Significant Difference in Survival
					Statistic	Critical Value	p Value	
ISLBTXREF1	012	0.482						
ISLBTX01	001	0.455	Normal	Equal	1.0858	1.9432	0.1596	NO
ISLBTX03	002	0.435	Normal	Equal	4.3621	1.9432	0.0024	YES
ISLBTX04	003	0.410	Normal	Equal	3.2474	1.9432	0.0088	YES
ISLBTX07	004	0.410	Normal	Equal	3.6392	1.9432	0.0054	YES
ISLBTX10	005	0.413	Normal	Equal	2.6623	1.9432	0.0187	YES
ISLBTX05	006	0.428	Normal	Equal	2.9952	1.9432	0.0121	YES
ISLBTX08	007	0.372	Normal	Equal	9.5841	1.9432	0.0000	YES
ISLBTX06	008	0.435	Normal	Equal	2.6416	1.9432	0.0192	YES
ISLBTX02	009	0.400	Normal	Equal	5.4733	1.9432	0.0008	YES
ISLBTX11	010	0.453	Normal	Equal	1.4783	1.9432	0.0949	NO
ISLBTX09	011	0.438	Normal	Equal	3.4733	1.9432	0.0066	YES

TABLE 6. Summary of Reference Toxicant Data.
Indian Head CTO-043 Ecological Risk Assessment. CH2M Hill. June 2005.

Results are Expressed as ppm Cadmium

Species	Date	Endpoint	Result	Historic Mean	Number of Tests	±1 STD Deviation	±2 STD Deviations
E. fetida	06/02/05	LC-50	3162.3	1792.8	20	1362	2724

Note: Reference toxicant testing was conducted at ESI. The historic mean for *E. fetida* survival represents the mean determined from the ESI-conducted reference toxicant testing database.

APPENDIX A
RAW DATA AND STATISTICAL SUPPORT

Contents	Number of Pages
E. fetida Daily Temperature and Observations	1
E. fetida 28 Day Recovery Bench Sheets	4
Survival Summary	1
Survival Statistics	2
E. fetida Initial Worm Weight	1
Growth Summary	1
Growth Statistics	26
Reproduction Summary	1
Reproduction Statistics	27
Soil pH	1
Total Organic Content & Percent Moisture Data Sheets	3
Temperature Recorder Data	1
Organism Receipt Record	1
Sample Receipt Record	1
Chain of Custody	2
Total Pages	73

Eisenia fetida Survival Assay

STUDY NUMBER: 13341 **CLIENT:** CH2M Hill

START DATE: 6/2/05

DAY	DATE	TEMP (°C) INC # 1	INITIALS	GENERAL OBSERVATIONS
0	6/2/05	20	BB	
1	6/3/05	19	BB	
2	6/4/05	19	CN	
3	6/5/05	19	TP	
4	6/6/05	20	✓	
5	6/7/05	20	✓	
6	6/8/05	21	TP	
7	6/9/05	20	DHB	
8	6/10/05	20	BB	
9	6/11/05	20	BB	
10	6/12	19	TP	
11	6/13	19	TP	
12	6/14	19	DHB	
13	6/15/05	20	BB	
14	6/16/05	19	BB	
15	6/17/05	20	BB	
16	6/18	20	CN	
17	6/19	19	TP	
18	6/20/05	19	BB	
19	6/21/05	19	DHB	
20	6/22/05	19	TP	
21	6/23/05	20	DHB	
22	6/24/05	19	BB	
23	6/25/05	20	[illegible]	
24	6/26/05	19	DHB	
25	6/27/05	19	TP	
26	6/28	19	TP	
27	6/29/05	19	DHB	
28	6/30/05	19	BB	

NOTES:

Value recorded here is incubator temperature. "Telatemp" unit is continuously recording vessel temperature.

Eisenia fetida Survival Assay

STUDY NUMBER: 13341 **CLIENT:** CH2M Hill

DAY 28

SAMPLE ID	TIME	# LIVE	JUVENILE	COCOON	COMMENTS
LAB A	1222	10		25	3.8g
LAB B	1228	10		27	4.3g
LAB C	1232	10		18	4.3g
LAB D	1237	10		25	4.2g
-001 A	1241	10		1	4.8g
-001 B	1253	10		0	5.1g
-001 C	1257	10		2	4.2g
-001 D	1300	10		0	4.1g
-002 A	1304	10		4	4.2g
-002 B	1308	10		3	4.2g
-002 C	1311	10		0	4.5g
-002 D	1315	10		4	4.5g
-003 A	1320	10		8	4.1g
-003 B	1324	10		9	4.7g
-003 C	1328	10		7	3.8g
-003 D	1333	10	1	14	3.8g

ANALYST: [signature]
DATE: 6/30/05

Eisenia fetida Survival Assay

STUDY NUMBER: 13341 **CLIENT:** CH2M Hill

DAY 28

SAMPLE ID	TIME	# LIVE	JUVENILE	COCOON	COMMENTS
-004A	1337	10		1	3.6g
-004B	1345	10		3	4.5g
-004C	1349	10		4	4.1g
-004D	1354	10		0	4.2g
-005A	1400	10		7	4.7g
-005B	1404	10		7	3.7g
-005C	1409	10		11	4.4g
-005D	1413	10		6	3.7g
-006A	1420	10		0	3.8g
-006B	1424	10		1	4.4g
-006C	1428	10		4	4.6g
-006D	1432	10		4	4.3g
-007A	1444	10		18	3.6g
-007B	1450	10		24	3.7g
-007C	1455	10		30	4.0g
-007D	1500	10		18	3.6g

ANALYST: [illegible]

DATE: 6/30/05

Eisenia fetida Survival Assay

STUDY NUMBER: 13341 **CLIENT:** CH2M Hill

DAY 28

SAMPLE ID	TIME	# LIVE	JUVENILE	COCOON	COMMENTS
-008A	1507	10		12	4.3g
-008B	1511	10		13	4.8g
-008C	1519	10		11	4.0g
-008D	1527	10		12	4.3g
-009A	1532	10		22	3.6g
-009B	1537	10		21	4.2g
-009C	1541	10		21	4.1g
-009D	1546	10	1	16	4.1g
-010A	1551	10		16	4.6g
-010B	1555	10		14	4.4g
-010C	1559	9		16	3.7g
-010D	1603	10		18	5.0g
-011A	1607	10		3	4.3g
-011B	1611	10		6	4.1g
-011C	1614	10	1	15	4.5g
-011D	1618	10	1	12	4.6g

ANALYST:
DATE: 6/30/05

Eisenia fetida Survival Assay

STUDY NUMBER: 13341 **CLIENT:** CH2M Hill

DAY 28

SAMPLE ID	TIME	# LIVE	JUVENILE	COCOON	COMMENTS
-012A	1623	9		13	4.3g
-012B	1627	10		9	5.0g
-012C	1630	10	1	8	4.7g
-012D	1633	10		3	4.8g

ANALYST: [illegible]
DATE: 6/30/05

STUDY: 13341
CLIENT: CH2M Hill
PROJECT: Indian Head CTO-43
TASK: E. fetida 28 day Survival
DATA: Survival Data
START DATE: 06/02/05
DATE ENDED: 06/30/05

Project Site	Replicate	Worms @ Start	Day 28 Surviving Organisms	Percent Survival	Mean % Survival/ Site	Distribution	Variance	Statistic	Critical Value	p Value	Significant Difference in Survival	
Lab Control	A	10	10	100.0%	100.0%							
	B	10	10	100.0%								
	C	10	10	100.0%								
	D	10	10	100.0%								
ISLBTX01	A	10	10	100.0%	100.0%	-	-	-	-	-	NO	Lab
ESI-001	B	10	10	100.0%		Non-normal	Equal	6.0000		0.6571	NO	ISLBTXREF1
	C	10	10	100.0%								
	D	10	10	100.0%								
ISLBTX03	A	10	10	100.0%	100.0%	-	-	-	-	-	NO	Lab
ESI-002	B	10	10	100.0%		Non-normal	Equal	6.0000		0.6571	NO	ISLBTXREF1
	C	10	10	100.0%								
	D	10	10	100.0%								
ISLBTX04	A	10	10	100.0%	100.0%	-	-	-	-	-	NO	Lab
ESI-003	B	10	10	100.0%		Non-normal	Equal	6.0000		0.6571	NO	ISLBTXREF1
	C	10	10	100.0%								
	D	10	10	100.0%								
ISLBTX07	A	10	10	100.0%	100.0%	-	-	-	-	-	NO	Lab
ESI-004	B	10	10	100.0%		Non-normal	Equal	6.0000		0.6571	NO	ISLBTXREF1
	C	10	10	100.0%								
	D	10	10	100.0%								
ISLBTX10	A	10	10	100.0%	100.0%	-	-	-	-	-	NO	Lab
ESI-005	B	10	10	100.0%		Non-normal	Equal	6.0000		0.6571	NO	ISLBTXREF1
	C	10	10	100.0%								
	D	10	10	100.0%								
ISLBTX05	A	10	10	100.0%	100.0%	-	-	-	-	-	NO	Lab
ESI-006	B	10	10	100.0%		Non-normal	Equal	6.0000		0.6571	NO	ISLBTXREF1
	C	10	10	100.0%								
	D	10	10	100.0%								
ISLBTX08	A	10	10	100.0%	100.0%	-	-	-	-	-	NO	Lab
ESI-007	B	10	10	100.0%		Non-normal	Equal	6.0000		0.6571	NO	ISLBTXREF1
	C	10	10	100.0%								
	D	10	10	100.0%								
ISLBTX06	A	10	10	100.0%	100.0%	-	-	-	-	-	NO	Lab
ESI-008	B	10	10	100.0%		Non-normal	Equal	6.0000		0.6571	NO	ISLBTXREF1
	C	10	10	100.0%								
	D	10	10	100.0%								
ISLBTX02	A	10	10	100.0%	100.0%	-	-	-	-	-	NO	Lab
ESI-009	B	10	10	100.0%		Non-normal	Equal	6.0000		0.6571	NO	ISLBTXREF1
	C	10	10	100.0%								
	D	10	10	100.0%								
ISLBTX11	A	10	10	100.0%	97.5%	-	-	-	-	-	NO	Lab
ESI-010	B	10	10	100.0%		Non-normal	Equal	6.0000		0.6571	NO	ISLBTXREF1
	C	10	9	90.0%								
	D	10	10	100.0%								
ISLBTX09	A	10	10	100.0%	100.0%	-	-	-	-	-	NO	Lab
ESI-011	B	10	10	100.0%		Non-normal	Equal	6.0000		0.6571	NO	ISLBTXREF1
	C	10	10	100.0%								
	D	10	10	100.0%								
ISLBTXREF1	A	10	9	90.0%	97.5%	Non-normal	Equal	10.0000		0.3429	NO	Lab
ESI-012	B	10	10	100.0%								
	C	10	10	100.0%								
	D	10	10	100.0%								

CETIS Analysis Detail

Eisenia 28-d Survival and Growth Soil Test — **EnviroSystems, Inc.**

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Proportion Survived	Comparison	09-8237-6756	09-8237-6756	11 Jul-05 10:00 AM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Mann-Whitney U	C > T	Angular (Corrected)				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Modified Levene	1.00000	13.74502	0.35592	Equal Variances
Distribution	Shapiro-Wilk W	0.70640	0.74935	0.00324	Non-normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.0033199	0.0033199	1	1.00	0.35592	Non-Significant Effect
Error	0.0199195	0.0033199	6			
Total	0.02323941	0.0066398	7			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	Ties	Decision(0.05)
13341-000		13341-012	10		0.3429	1	Non-Significant Effect

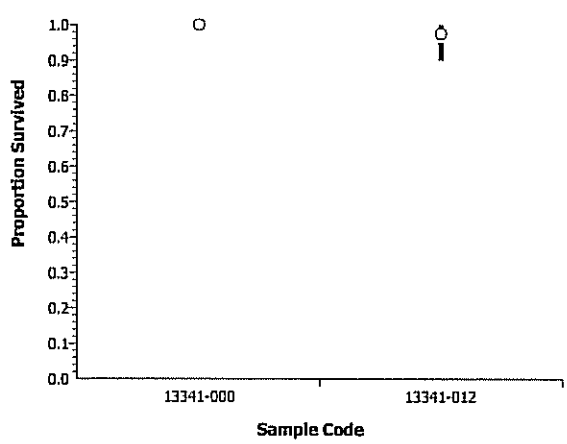
Data Summary

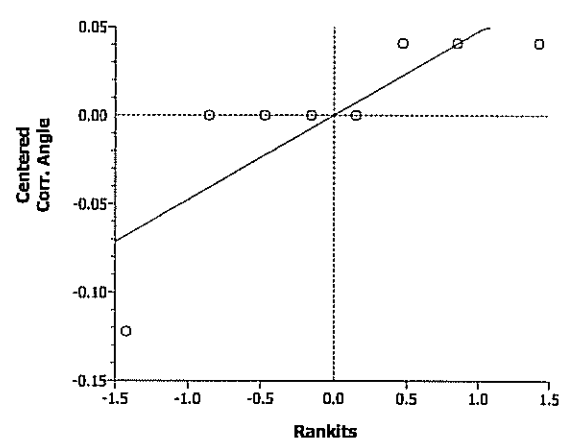
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13341-000	4	1.00000	1.00000	1.00000	0.00000	1.41202	1.41202	1.41202	0.00027
13341-012	4	0.97500	0.90000	1.00000	0.05000	1.37127	1.24905	1.41202	0.08149

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13341-000	1.00000	1.00000	1.00000	1.00000						
13341-012	0.90000	1.00000	1.00000	1.00000						

Graphics





CETIS Analysis Detail

Eisenia 28-d Survival and Growth Soil Test — **EnviroSystems, Inc.**

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Proportion Survived	Comparison	09-8237-6756	09-8237-6756	11 Jul-05 10:00 AM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Mann-Whitney U	C > T	Angular (Corrected)				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Modified Levene	1.00000	13.74502	0.35592	Equal Variances
Distribution	Shapiro-Wilk W	0.70640	0.74935	0.00324	Non-normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.0033199	0.0033199	1	1.00	0.35592	Non-Significant Effect
Error	0.0199195	0.0033199	6			
Total	0.02323941	0.0066398	7			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	Ties	Decision(0.05)
13341-012		13341-001	6		0.6571	1	Non-Significant Effect

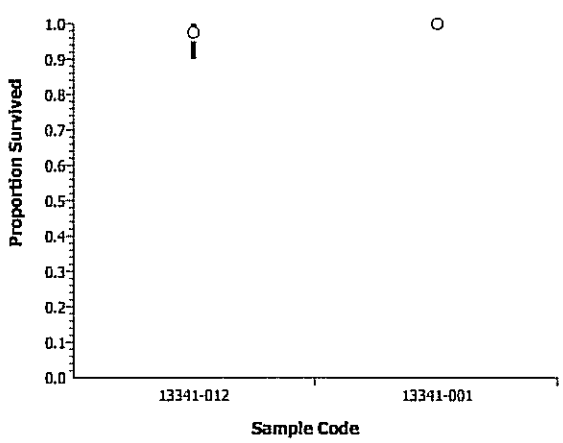
Data Summary

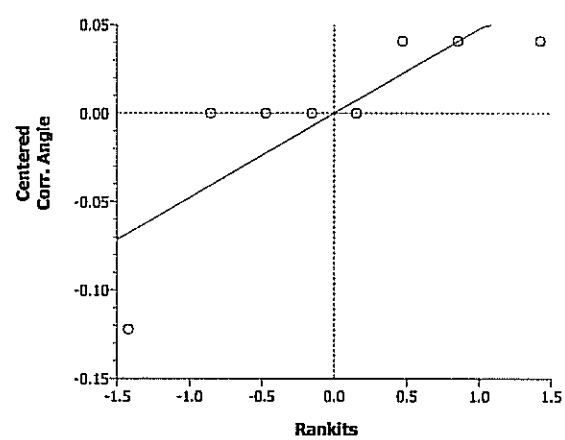
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13341-012	4	0.97500	0.90000	1.00000	0.05000	1.37127	1.24905	1.41202	0.08149
13341-001	4	1.00000	1.00000	1.00000	0.00000	1.41202	1.41202	1.41202	0.00027

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13341-012	0.90000	1.00000	1.00000	1.00000						
13341-001	1.00000	1.00000	1.00000	1.00000						

Graphics





Eisenia fetida Assay
28 DAY SURVIVAL & GROWTH DATA

STUDY NUMBER: 13341 **CLIENT:** CH2MHill
PROJECT: Indian Head **START DATE:** 6/2/05

ESI SAMPLE ID	REP	WET WEIGHT (G)
Start Worms	A	6.0
	B	6.4
	C	5.5
	D	4.8
RECORDED BY:		[illegible]
DATE:		6/2/05

NOTES:

Number Worms per Replicate: 10

Average wet weight per worm: .567 Grams

Average wet weight per replicate: 5.67 Grams

Average wet weight of soil per replicate: _____ Grams

Loading rate (g worm/kg soil): _____ Grams Worm / Kg Soil

STUDY: 13341
CLIENT: CH2M Hill
PROJECT: Indian Head CTO-43
TASK: E. fetida 28 day Survival
DATA: Growth Data
START DATE: 06/02/05
DATE ENDED: 06/30/05

Project Site	Replicate	Wet Weight per Rep (g)	Wet Weight per Surviving Worm (g)	Mean Wet Weight per Surviving Worm (g)	Distribution	Variance	Statistic	Critical Value	p Value	Significant Difference in Survival	
Lab Control	A	3.8	0.380	0.415							
	B	4.3	0.430								
	C	4.3	0.430								
	D	4.2	0.420								
ISLBTX01	A	4.8	0.480	0.455	Normal	Equal	-1.4942	1.9432	0.9071	NO	Lab
ESI-001	B	5.1	0.510		Normal	Equal	1.0858	1.9432	0.1596	NO	ISLBTXREF1
	C	4.2	0.420								
	D	4.1	0.410								
ISLBTX03	A	4.2	0.420	0.435	Normal	Equal	-1.3587	1.9432	0.8885	NO	Lab
ESI-002	B	4.2	0.420		Normal	Equal	4.3621	1.9432	0.0024	YES	ISLBTXREF1
	C	4.5	0.450								
	D	4.5	0.450								
ISLBTX04	A	4.1	0.410	0.410	Normal	Equal	0.2056	1.9432	0.4220	NO	Lab
ESI-003	B	4.7	0.470		Normal	Equal	3.2474	1.9432	0.0088	YES	ISLBTXREF1
	C	3.8	0.380								
	D	3.8	0.380								
ISLBTX07	A	3.6	0.360	0.410	Normal	Equal	0.2255	1.9432	0.4145	NO	Lab
ESI-004	B	4.5	0.450		Normal	Equal	3.6392	1.9432	0.0054	YES	ISLBTXREF1
	C	4.1	0.410								
	D	4.2	0.420								
ISLBTX10	A	4.7	0.470	0.413	Normal	Equal	0.0894	1.9432	0.4658	NO	Lab
ESI-005	B	3.7	0.370		Normal	Equal	2.6623	1.9432	0.0187	YES	ISLBTXREF1
	C	4.4	0.440								
	D	3.7	0.370								
ISLBTX05	A	3.8	0.380	0.428	Normal	Equal	-0.6019	1.9432	0.7154	NO	Lab
ESI-006	B	4.4	0.440		Normal	Equal	2.9952	1.9432	0.0121	YES	ISLBTXREF1
	C	4.6	0.460								
	D	4.3	0.430								
ISLBTX08	A	3.6	0.360	0.372	Normal	Equal	2.7948	1.9432	0.0157	YES	Lab
ESI-007	B	3.7	0.370		Normal	Equal	9.5841	1.9432	0.0000	YES	ISLBTXREF1
	C	4.0	0.400								
	D	3.6	0.360								
ISLBTX06	A	4.3	0.430	0.435	Normal	Equal	-0.9798	1.9432	0.8175	NO	Lab
ESI-008	B	4.8	0.480		Normal	Equal	2.6416	1.9432	0.0192	YES	ISLBTXREF1
	C	4.0	0.400								
	D	4.3	0.430								
ISLBTX02	A	3.6	0.360	0.400	Non-normal	Equal	12.5000		0.1000	NO	Lab
ESI-009	B	4.2	0.420		Normal	Equal	5.4733	1.9432	0.0008	YES	ISLBTXREF1
	C	4.1	0.410								
	D	4.1	0.410								
ISLBTX11	A	4.6	0.460	0.453	Normal	Equal	-1.7064	1.9432	0.9306	NO	Lab
ESI-010	B	4.4	0.440		Normal	Equal	1.4783	1.9432	0.0949	NO	ISLBTXREF1
	C	3.7	0.411								
	D	5.0	0.500								
ISLBTX09	A	4.3	0.430	0.438	Normal	Equal	-1.3833	1.9432	0.8921	NO	Lab
ESI-011	B	4.1	0.410		Normal	Equal	3.4733	1.9432	0.0066	YES	ISLBTXREF1
	C	4.5	0.450								
	D	4.6	0.460								
ISLBTXREF1	A	4.3	0.478	0.482	Normal	Equal	-4.9557	1.9432	0.9987	NO	Lab
ESI-012	B	5.0	0.500								
	C	4.7	0.470								
	D	4.8	0.480								

CETIS Test Summary

Report Date: 12 Jul-05 3:02 PM
Link: 09-8237-6756

Eisenia 28-d Survival and Growth Soil Test — EnviroSystems, Inc.

Test No:	01-7244-1430	Test Type:	Survival-Growth	Duration:	27d 22h
Start Date:	02 Jun-05 02:00 PM	Protocol:	EPA/600/R-92/183 (1992)	Species:	Eisenia fetida
Ending Date:	30 Jun-05 12:00 PM	Dil Water:		Source:	In-House Culture
Setup Date:	02 Jun-05 02:00 PM	Brine:	Not Applicable		

Sample No:	01-6362-5241	Material:	Soil	Client:	CH2M Hill
Sample Date:	02 Jun-05 10:00 AM	Code:	13341-000	Project:	Ecologcal Risk Assessment
Receive Date:	02 Jun-05 10:00 AM	Source:	Indian Head, CTO-43		
Sample Age:	4h	Station:	LAB CONTROL - 000		
Sample No:	01-9758-3788	Material:	Soil	Client:	CH2M Hill
Sample Date:	23 May-05 02:45 PM	Code:	13341-001	Project:	Ecologcal Risk Assessment
Receive Date:	25 May-05 10:00 AM	Source:	Indian Head, CTO-43		
Sample Age:	9d 23h	Station:	ISLBTX01 - 001		
Sample No:	06-0256-9786	Material:	Soil	Client:	CH2M Hill
Sample Date:	23 May-05 03:54 PM	Code:	13341-002	Project:	Ecologcal Risk Assessment
Receive Date:	25 May-05 10:00 AM	Source:	Indian Head, CTO-43		
Sample Age:	9d 22h	Station:	ISLBTX03 - 002		
Sample No:	05-3130-1206	Material:	Soil	Client:	CH2M Hill
Sample Date:	23 May-05 03:00 PM	Code:	13341-003	Project:	Ecologcal Risk Assessment
Receive Date:	25 May-05 10:00 AM	Source:	Indian Head, CTO-43		
Sample Age:	9d 23h	Station:	ISLCTX04 - 003		
Sample No:	08-5250-3187	Material:	Soil	Client:	CH2M Hill
Sample Date:	23 May-05 03:15 PM	Code:	13341-004	Project:	Ecologcal Risk Assessment
Receive Date:	25 May-05 10:00 AM	Source:	Indian Head, CTO-43		
Sample Age:	9d 22h	Station:	ISLCTX07 - 004		
Sample No:	06-8647-2034	Material:	Soil	Client:	CH2M Hill
Sample Date:	23 May-05 03:30 PM	Code:	13341-005	Project:	Ecologcal Risk Assessment
Receive Date:	25 May-05 10:00 AM	Source:	Indian Head, CTO-43		
Sample Age:	9d 22h	Station:	ISLCTX10 - 005		
Sample No:	11-9356-3884	Material:	Soil	Client:	CH2M Hill
Sample Date:	24 May-05 09:45 AM	Code:	13341-006	Project:	Ecologcal Risk Assessment
Receive Date:	25 May-05 10:00 AM	Source:	Indian Head, CTO-43		
Sample Age:	9d 4h	Station:	ISLCTX05 - 006		
Sample No:	06-8070-7540	Material:	Soil	Client:	CH2M Hill
Sample Date:	24 May-05 10:15 AM	Code:	13341-007	Project:	Ecologcal Risk Assessment
Receive Date:	25 May-05 10:00 AM	Source:	Indian Head, CTO-43		
Sample Age:	9d 3h	Station:	ISLCTX08 - 007		
Sample No:	11-6046-3923	Material:	Soil	Client:	CH2M Hill
Sample Date:	24 May-05 10:45 AM	Code:	13341-008	Project:	Ecologcal Risk Assessment
Receive Date:	25 May-05 10:00 AM	Source:	Indian Head, CTO-43		
Sample Age:	9d 3h	Station:	ISLCTX06 - 008		
Sample No:	14-9612-7906	Material:	Soil	Client:	CH2M Hill
Sample Date:	24 May-05 11:00 AM	Code:	13341-009	Project:	Ecologcal Risk Assessment
Receive Date:	25 May-05 10:00 AM	Source:	Indian Head, CTO-43		
Sample Age:	9d 3h	Station:	ISLCTX02 - 009		
Sample No:	03-8621-6496	Material:	Soil	Client:	CH2M Hill
Sample Date:	24 May-05 10:30 AM	Code:	13341-010	Project:	Ecologcal Risk Assessment
Receive Date:	25 May-05 10:00 AM	Source:	Indian Head, CTO-43		
Sample Age:	9d 3h	Station:	ISLCTX11 - 010		

CETIS Data Worksheet

Report Date: 12 Jul-05 3:01 PM
Link: 09-8237-6756

Eisenia 28-d Survival and Growth Soil Test — **EnviroSystems, Inc.**

Start Date:	02 Jun-05 02:00 PM	**Species:**	Eisenia fetida	**Sample Code:**	13341-000
Ending Date:	30 Jun-05 12:00 PM	**Protocol:**	EPA/600/R-92/183 (1992)	**Sample Source:**	Indian Head, CTO-43
Sample Date:	02 Jun-05 10:00 AM	**Material:**	Soil	**Sample Station:**	LAB CONTROL - 000

Sample Code	Rep	Pos	# Exposed	# Survived	Total Weight-mg	Tare Weight-mg	Pan Count	Mean Length-mm	Notes
13341-000	1	9	10	10	3.8	0	10		
13341-000	2	23	10	10	4.3	0	10		
13341-000	3	46	10	10	4.3	0	10		
13341-000	4	47	10	10	4.2	0	10		
13341-012	1	2	10	9	4.3	0	9		
13341-012	2	43	10	10	5	0	10		
13341-012	3	41	10	10	4.7	0	10		
13341-012	4	35	10	10	4.8	0	10		
13341-001	1	15	10	10	4.8	0	10		
13341-001	2	6	10	10	5.1	0	10		
13341-001	3	12	10	10	4.2	0	10		
13341-001	4	27	10	10	4.1	0	10		
13341-002	1	19	10	10	4.2	0	10		
13341-002	2	49	10	10	4.2	0	10		
13341-002	3	16	10	10	4.5	0	10		
13341-002	4	39	10	10	4.5	0	10		
13341-003	1	17	10	10	4.1	0	10		
13341-003	2	3	10	10	4.7	0	10		
13341-003	3	52	10	10	3.8	0	10		
13341-003	4	25	10	10	3.8	0	10		
13341-004	1	33	10	10	3.6	0	10		
13341-004	2	42	10	10	4.5	0	10		
13341-004	3	45	10	10	4.1	0	10		
13341-004	4	14	10	10	4.2	0	10		
13341-005	1	21	10	10	4.7	0	10		
13341-005	2	18	10	10	3.7	0	10		
13341-005	3	48	10	10	4.4	0	10		
13341-005	4	38	10	10	3.7	0	10		
13341-006	1	5	10	10	3.8	0	10		
13341-006	2	24	10	10	4.4	0	10		
13341-006	3	30	10	10	4.6	0	10		
13341-006	4	10	10	10	4.3	0	10		
13341-007	1	51	10	10	3.6	0	10		
13341-007	2	8	10	10	3.7	0	10		
13341-007	3	11	10	10	4	0	10		
13341-007	4	31	10	10	3.6	0	10		
13341-008	1	4	10	10	4.3	0	10		
13341-008	2	7	10	10	4.8	0	10		
13341-008	3	26	10	10	4	0	10		
13341-008	4	44	10	10	4.3	0	10		
13341-009	1	22	10	10	3.6	0	10		
13341-009	2	50	10	10	4.2	0	10		
13341-009	3	20	10	10	4.1	0	10		
13341-009	4	34	10	10	4.1	0	10		
13341-010	1	37	10	10	4.6	0	10		
13341-010	2	28	10	10	4.4	0	10		
13341-010	3	1	10	9	3.7	0	9		
13341-010	4	32	10	10	5	0	10		
13341-011	1	29	10	10	4.3	0	10		
13341-011	2	40	10	10	4.1	0	10		
13341-011	3	13	10	10	4.5	0	10		
13341-011	4	36	10	10	4.6	0	10		

CETIS Test Summary

Report Date: 12 Jul-05 3:02 PM
Link: 09-8237-6756

Sample No:	13-7719-7724	**Material:**	Soil	**Client:**	CH2M Hill
Sample Date:	24 May-05 11:15 AM	**Code:**	13341-011	**Project:**	Ecologcal Risk Assessment
Receive Date:	25 May-05 10:00 AM	**Source:**	Indian Head, CTO-43		
Sample Age:	9d 2h	**Station:**	ISLCTX09 - 011		

Sample No:	04-7729-9498	**Material:**	Soil	**Client:**	CH2M Hill
Sample Date:	24 May-05 01:00 PM	**Code:**	13341-012	**Project:**	Ecologcal Risk Assessment
Receive Date:	25 May-05 10:00 AM	**Source:**	Indian Head, CTO-43		
Sample Age:	9d 1h	**Station:**	ISLCTXREF1 - 012		

Mean Dry Weight-mg Summary

Sample Code	Reps	Mean	Minimum	Maximum	SE	SD	CV
13341-000	4	0.41500	0.38000	0.43000	0.01190	0.02380	5.74%
13341-012	4	0.48194	0.47000	0.50000	0.00639	0.01278	2.65%
13341-001	4	0.45500	0.41000	0.51000	0.02398	0.04796	10.54%
13341-002	4	0.43500	0.42000	0.45000	0.00866	0.01732	3.98%
13341-003	4	0.41000	0.38000	0.47000	0.02121	0.04243	10.35%
13341-004	4	0.41000	0.36000	0.45000	0.01871	0.03742	9.13%
13341-005	4	0.41250	0.37000	0.47000	0.02529	0.05058	12.26%
13341-006	4	0.42750	0.38000	0.46000	0.01702	0.03403	7.96%
13341-007	4	0.37250	0.36000	0.40000	0.00946	0.01893	5.08%
13341-008	4	0.43500	0.40000	0.48000	0.01658	0.03317	7.62%
13341-009	4	0.40000	0.36000	0.42000	0.01354	0.02708	6.77%
13341-010	4	0.45278	0.41111	0.50000	0.01867	0.03733	8.25%
13341-011	4	0.43750	0.41000	0.46000	0.01109	0.02217	5.07%

Mean Dry Weight-mg Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4
13341-000	0.38000	0.43000	0.43000	0.42000
13341-012	0.47778	0.50000	0.47000	0.48000
13341-001	0.48000	0.51000	0.42000	0.41000
13341-002	0.42000	0.42000	0.45000	0.45000
13341-003	0.41000	0.47000	0.38000	0.38000
13341-004	0.36000	0.45000	0.41000	0.42000
13341-005	0.47000	0.37000	0.44000	0.37000
13341-006	0.38000	0.44000	0.46000	0.43000
13341-007	0.36000	0.37000	0.40000	0.36000
13341-008	0.43000	0.48000	0.40000	0.43000
13341-009	0.36000	0.42000	0.41000	0.41000
13341-010	0.46000	0.44000	0.41111	0.50000
13341-011	0.43000	0.41000	0.45000	0.46000

CETIS Analysis Detail

Eisenia 28-d Survival and Growth Soil Test — EnviroSystems, Inc.

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Mean Dry Weight-mg	Comparison	09-8237-6756	09-8237-6756	12 Jul-05 1:48 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	4.05882	47.46723	0.28003	Equal Variances
Distribution	Shapiro-Wilk W	0.91650	0.74935	0.37605	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.0032	0.0032	1	2.23	0.18575	Non-Significant Effect
Error	0.0086000	0.0014333	6			
Total	0.01180000	0.0046333	7			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13341-000		13341-001	-1.4942	1.94318	0.9071	0.05202	Non-Significant Effect

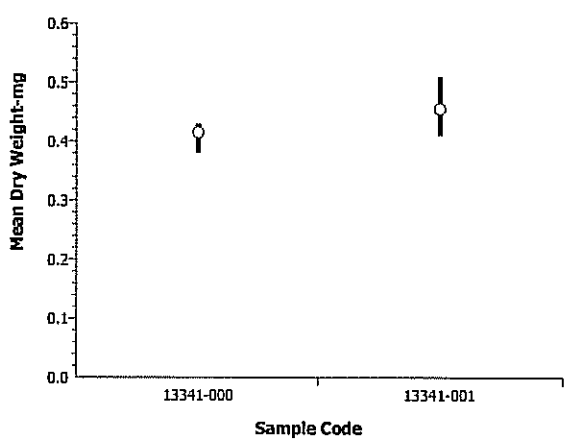
Data Summary

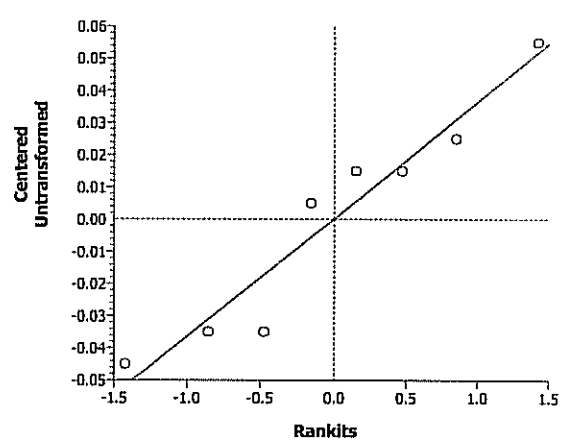
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13341-000	4	0.41500	0.38000	0.43000	0.02380				
13341-001	4	0.45500	0.41000	0.51000	0.04796				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13341-000	0.38000	0.43000	0.43000	0.42000						
13341-001	0.48000	0.51000	0.42000	0.41000						

Graphics





CETIS Analysis Detail

Eisenia 28-d Survival and Growth Soil Test — **EnviroSystems, Inc.**

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Mean Dry Weight-mg	Comparison	09-8237-6756	09-8237-6756	12 Jul-05 1:48 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	1.88889	47.46723	0.61451	Equal Variances
Distribution	Shapiro-Wilk W	0.79772	0.74935	0.03154	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.0008	0.0008	1	1.85	0.22309	Non-Significant Effect
Error	0.0026000	0.0004333	6			
Total	0.0034	0.0012333	7			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13341-000		13341-002	-1.3587	1.94318	0.8885	0.02860	Non-Significant Effect

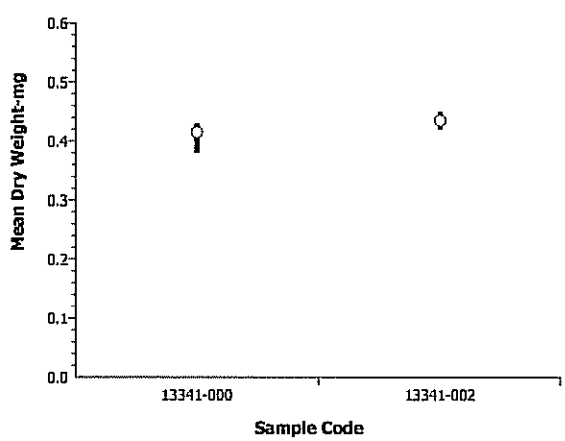
Data Summary

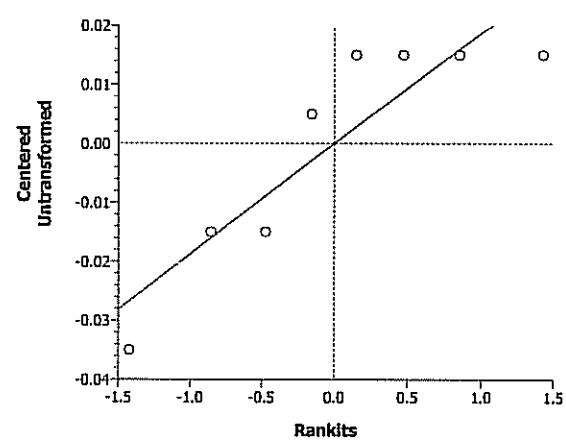
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13341-000	4	0.41500	0.38000	0.43000	0.02380				
13341-002	4	0.43500	0.42000	0.45000	0.01732				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13341-000	0.38000	0.43000	0.43000	0.42000						
13341-002	0.42000	0.42000	0.45000	0.45000						

Graphics





CETIS Analysis Detail

Eisenia 28-d Survival and Growth Soil Test — **EnviroSystems, Inc.**

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Mean Dry Weight-mg	Comparison	09-8237-6756	09-8237-6756	12 Jul-05 1:48 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	3.17647	47.46723	0.36787	Equal Variances
Distribution	Shapiro-Wilk W	0.89817	0.74935	0.26420	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	5.000E-05	5.000E-05	1	0.04	0.84393	Non-Significant Effect
Error	0.0071	0.0011833	6			
Total	0.00715	0.0012333	7			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13341-000		13341-003	0.20556	1.94318	0.4220	0.04727	Non-Significant Effect

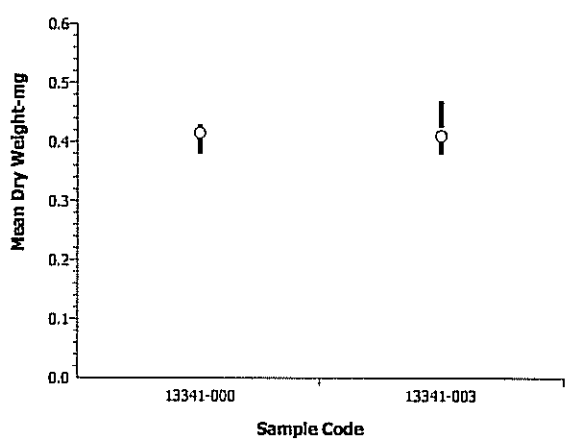
Data Summary

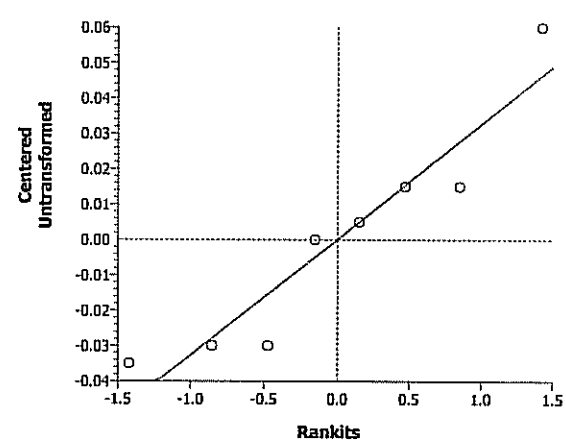
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13341-000	4	0.41500	0.38000	0.43000	0.02380				
13341-003	4	0.41000	0.38000	0.47000	0.04243				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13341-000	0.38000	0.43000	0.43000	0.42000						
13341-003	0.41000	0.47000	0.38000	0.38000						

Graphics





CETIS Analysis Detail

Eisenia 28-d Survival and Growth Soil Test — **EnviroSystems, Inc.**

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Mean Dry Weight-mg	Comparison	09-8237-6756	09-8237-6756	12 Jul-05 1:48 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	2.47059	47.46723	0.47710	Equal Variances
Distribution	Shapiro-Wilk W	0.90775	0.74935	0.31837	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	5.000E-05	5.000E-05	1	0.05	0.82908	Non-Significant Effect
Error	0.0059000	0.0009833	6			
Total	0.00595000	0.0010333	7			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13341-000		13341-004	0.22549	1.94318	0.4145	0.04309	Non-Significant Effect

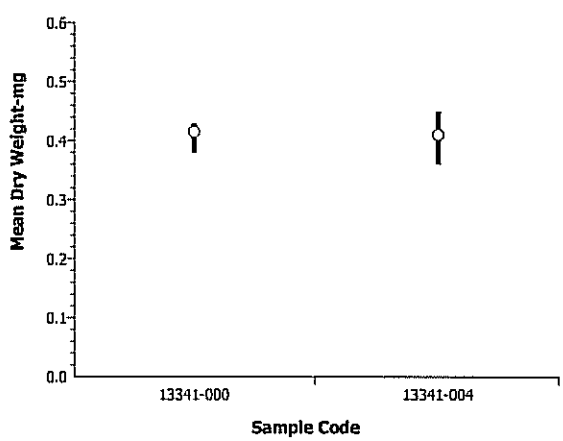
Data Summary

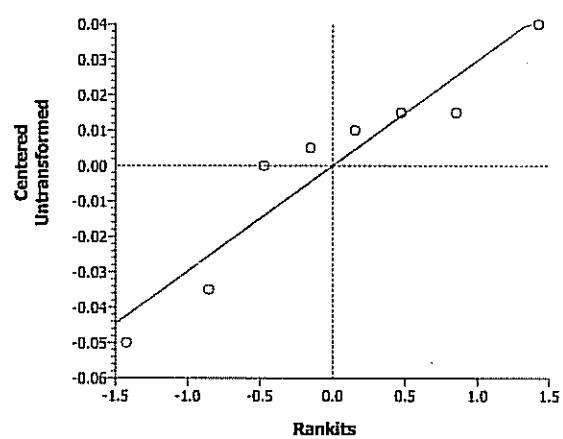
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13341-000	4	0.41500	0.38000	0.43000	0.02380				
13341-004	4	0.41000	0.36000	0.45000	0.03742				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13341-000	0.38000	0.43000	0.43000	0.42000						
13341-004	0.36000	0.45000	0.41000	0.42000						

Graphics





CETIS Analysis Detail

Eisenia 28-d Survival and Growth Soil Test — EnviroSystems, Inc.

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Mean Dry Weight-mg	Comparison	09-8237-6756	09-8237-6756	12 Jul-05 1:48 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	4.51470	47.46723	0.24742	Equal Variances
Distribution	Shapiro-Wilk W	0.90173	0.74935	0.28327	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	1.250E-05	1.250E-05	1	0.01	0.93164	Non-Significant Effect
Error	0.009375	0.0015625	6			
Total	0.0093875	0.001575	7			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13341-000		13341-005	0.08944	1.94318	0.4658	0.05431	Non-Significant Effect

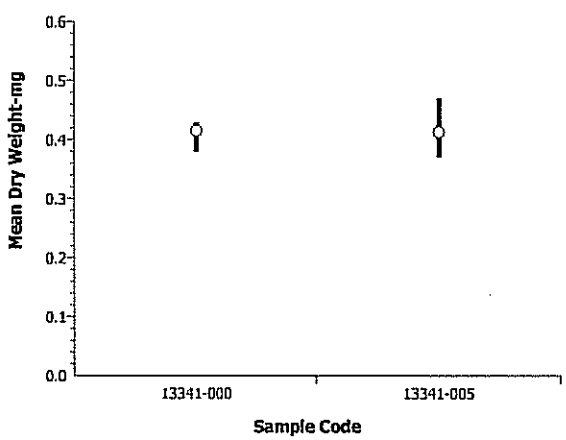
Data Summary

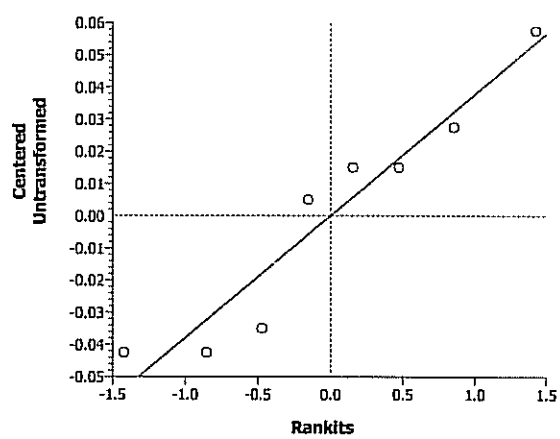
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13341-000	4	0.41500	0.38000	0.43000	0.02380				
13341-005	4	0.41250	0.37000	0.47000	0.05058				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13341-000	0.38000	0.43000	0.43000	0.42000						
13341-005	0.47000	0.37000	0.44000	0.37000						

Graphics





CETIS Analysis Detail

Eisenia 28-d Survival and Growth Soil Test — EnviroSystems, Inc.

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Mean Dry Weight-mg	Comparison	09-8237-6756	09-8237-6756	12 Jul-05 1:48 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	2.04412	47.46723	0.57201	Equal Variances
Distribution	Shapiro-Wilk W	0.86319	0.74935	0.13029	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.0003125	0.0003125	1	0.36	0.56925	Non-Significant Effect
Error	0.005175	0.0008625	6			
Total	0.0054875	0.001175	7			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13341-000		13341-006	-0.6019	1.94318	0.7154	0.04035	Non-Significant Effect

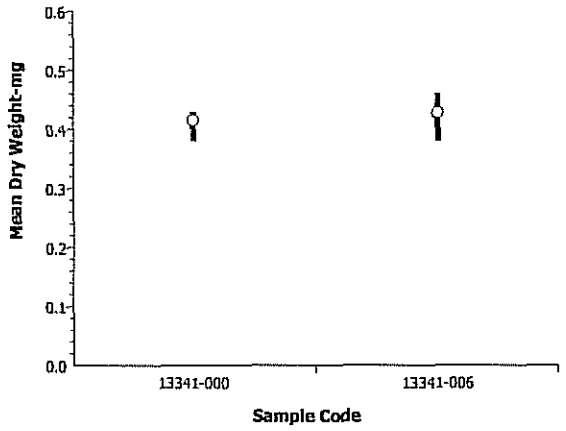
Data Summary

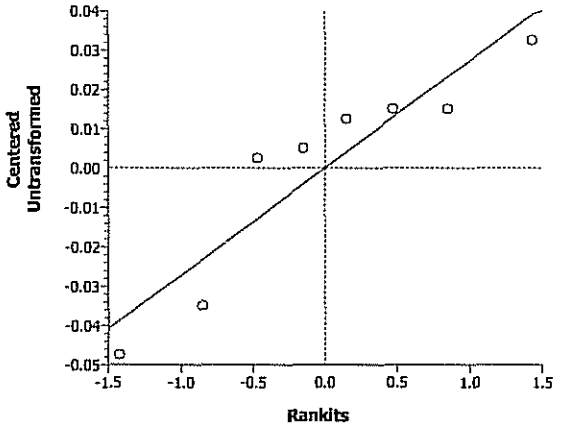
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13341-000	4	0.41500	0.38000	0.43000	0.02380				
13341-006	4	0.42750	0.38000	0.46000	0.03403				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13341-000	0.38000	0.43000	0.43000	0.42000						
13341-006	0.38000	0.44000	0.46000	0.43000						

Graphics





CETIS Analysis Detail

Eisenia 28-d Survival and Growth Soil Test — EnviroSystems, Inc.

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Mean Dry Weight-mg	Comparison	09-8237-6756	09-8237-6756	12 Jul-05 1:48 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	1.58139	47.46723	0.71568	Equal Variances
Distribution	Shapiro-Wilk W	0.96469	0.74935	0.83015	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.0036125	0.0036125	1	7.81	0.03138	Significant Effect
Error	0.0027750	0.0004625	6			
Total	0.00638750	0.0040750	7			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13341-000		13341-007	2.79478	1.94318	0.0157	0.02955	Significant Effect

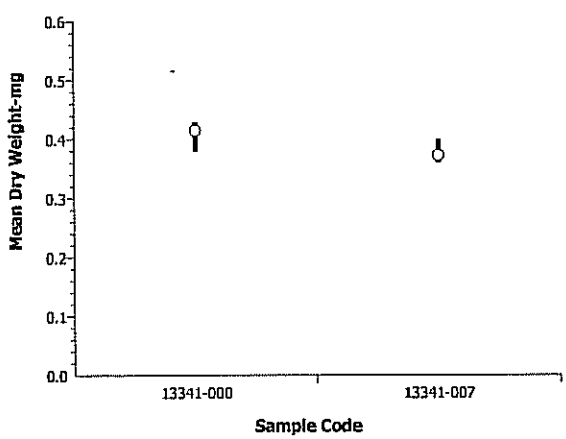
Data Summary

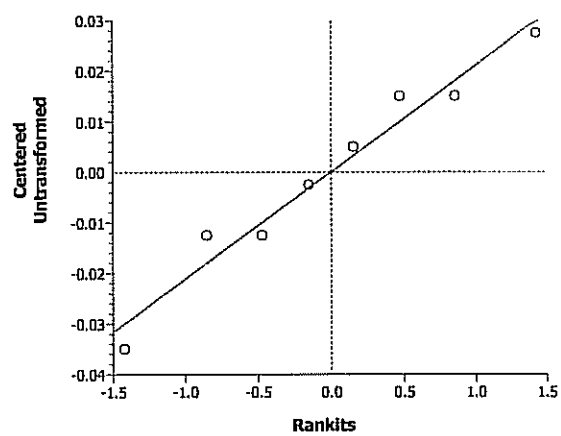
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13341-000	4	0.41500	0.38000	0.43000	0.02380				
13341-007	4	0.37250	0.36000	0.40000	0.01893				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13341-000	0.38000	0.43000	0.43000	0.42000						
13341-007	0.36000	0.37000	0.40000	0.36000						

Graphics





CETIS Analysis Detail

Eisenia 28-d Survival and Growth Soil Test — EnviroSystems, Inc.

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Mean Dry Weight-mg	Comparison	09-8237-6756	09-8237-6756	12 Jul-05 1:49 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	1.94118	47.46723	0.59963	Equal Variances
Distribution	Shapiro-Wilk W	0.93251	0.74935	0.50405	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.0008000	0.0008000	1	0.96	0.36503	Non-Significant Effect
Error	0.0050000	0.0008333	6			
Total	0.00580000	0.0016333	7			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13341-000		13341-008	-0.9798	1.94318	0.8175	0.03967	Non-Significant Effect

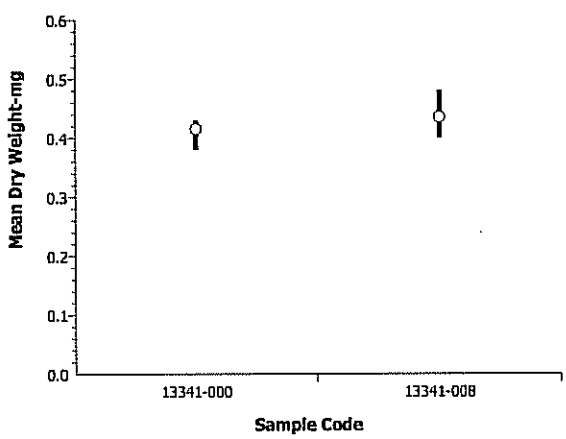
Data Summary

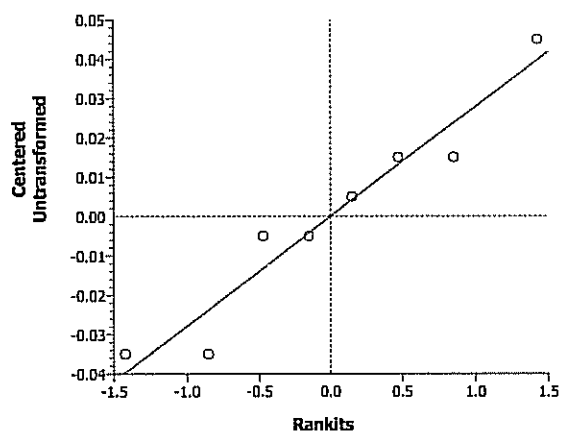
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13341-000	4	0.41500	0.38000	0.43000	0.02380				
13341-008	4	0.43500	0.40000	0.48000	0.03317				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13341-000	0.38000	0.43000	0.43000	0.42000						
13341-008	0.43000	0.48000	0.40000	0.43000						

Graphics





CETIS Analysis Detail

Eisenia 28-d Survival and Growth Soil Test — EnviroSystems, Inc.

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Mean Dry Weight-mg	Comparison	09-8237-6756	09-8237-6756	12 Jul-05 1:49 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Mann-Whitney U	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	1.29412	47.46723	0.83721	Equal Variances
Distribution	Shapiro-Wilk W	0.74423	0.74935	0.00880	Non-normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.0004500	0.0004500	1	0.69	0.43724	Non-Significant Effect
Error	0.0039000	0.0006500	6			
Total	0.00435000	0.0011000	7			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	Ties	Decision(0.05)
13341-000		13341-009	12.5		0.1000	3	Non-Significant Effect

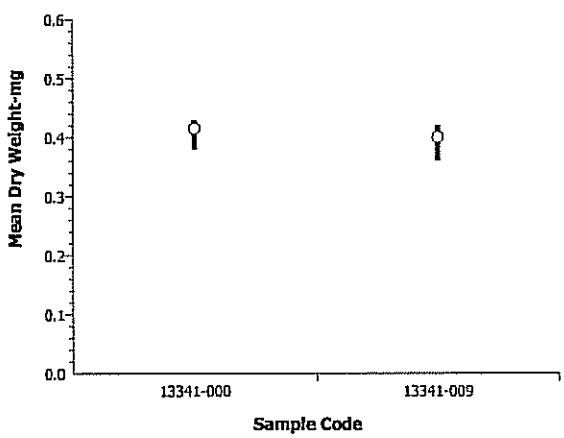
Data Summary

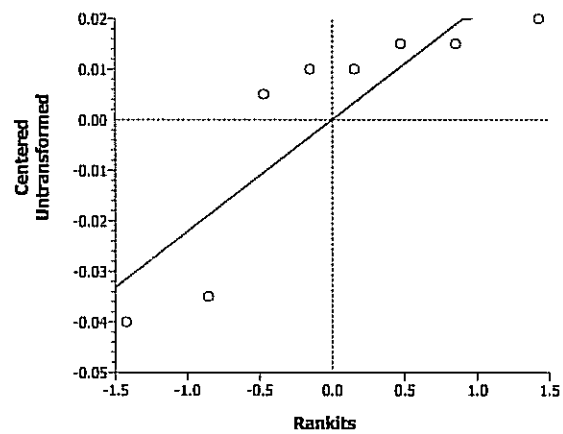
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13341-000	4	0.41500	0.38000	0.43000	0.02380				
13341-009	4	0.40000	0.36000	0.42000	0.02708				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13341-000	0.38000	0.43000	0.43000	0.42000						
13341-009	0.36000	0.42000	0.41000	0.41000						

Graphics





CETIS Analysis Detail

Eisenia 28-d Survival and Growth Soil Test — EnviroSystems, Inc.

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Mean Dry Weight-mg	Comparison	09-8237-6756	09-8237-6756	12 Jul-05 3:01 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	2.45969	47.46723	0.47920	Equal Variances
Distribution	Shapiro-Wilk W	0.94576	0.74935	0.63130	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.0028543	0.0028543	1	2.91	0.13881	Non-Significant Effect
Error	0.0058815	0.0009802	6			
Total	0.00873580	0.0038346	7			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13341-000		13341-010	-1.7064	1.94318	0.9306	0.04302	Non-Significant Effect

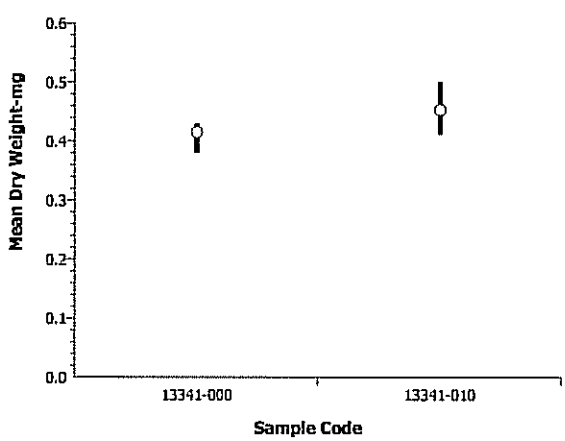
Data Summary

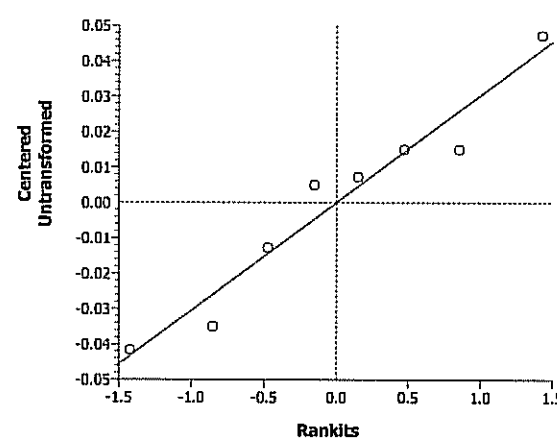
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13341-000	4	0.41500	0.38000	0.43000	0.02380				
13341-010	4	0.45278	0.41111	0.50000	0.03733				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13341-000	0.38000	0.43000	0.43000	0.42000						
13341-010	0.46000	0.44000	0.41111	0.50000						

Graphics





CETIS Analysis Detail

Eisenia 28-d Survival and Growth Soil Test — EnviroSystems, Inc.

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Mean Dry Weight-mg	Comparison	09-8237-6756	09-8237-6756	12 Jul-05 1:49 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	1.15254	47.46723	0.90985	Equal Variances
Distribution	Shapiro-Wilk W	0.87104	0.74935	0.15318	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.0010125	0.0010125	1	1.91	0.21586	Non-Significant Effect
Error	0.003175	0.0005292	6			
Total	0.0041875	0.0015417	7			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13341-000		13341-011	-1.3833	1.94318	0.8921	0.03161	Non-Significant Effect

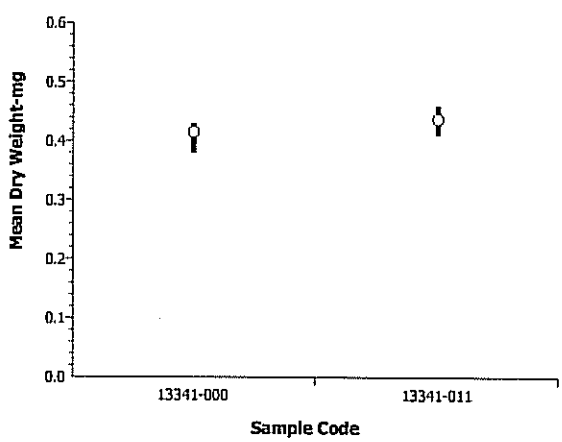
Data Summary

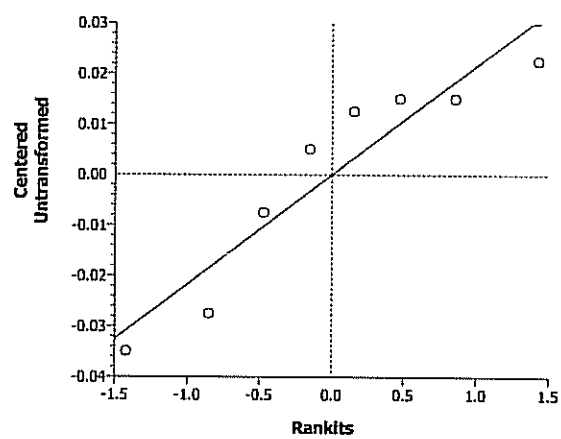
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13341-000	4	0.41500	0.38000	0.43000	0.02380				
13341-011	4	0.43750	0.41000	0.46000	0.02217				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13341-000	0.38000	0.43000	0.43000	0.42000						
13341-011	0.43000	0.41000	0.45000	0.46000						

Graphics





CETIS Analysis Detail

Eisenia 28-d Survival and Growth Soil Test — EnviroSystems, Inc.

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Mean Dry Weight-mg	Comparison	09-8237-6756	09-8237-6756	12 Jul-05 1:48 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	3.47070	47.46723	0.33402	Equal Variances
Distribution	Shapiro-Wilk W	0.89881	0.74935	0.26757	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.0089631	0.0089631	1	24.56	0.00256	Significant Effect
Error	0.0021898	0.000365	6			
Total	0.01115293	0.0093281	7			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13341-000		13341-012	-4.9557	1.94318	0.9987	0.02625	Non-Significant Effect

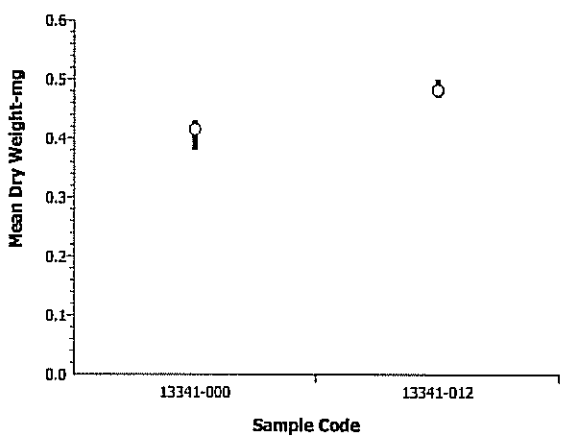
Data Summary

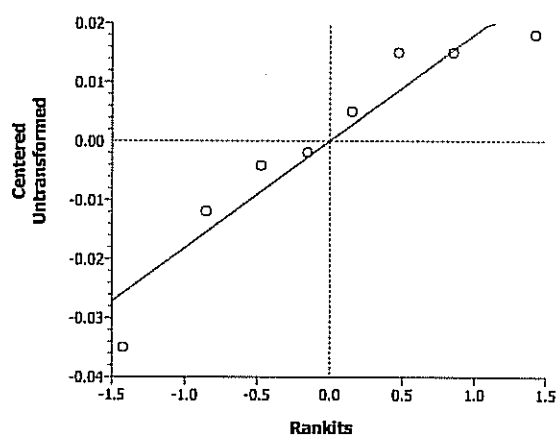
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13341-000	4	0.41500	0.38000	0.43000	0.02380				
13341-012	4	0.48194	0.47000	0.50000	0.01278				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13341-000	0.38000	0.43000	0.43000	0.42000						
13341-012	0.47778	0.50000	0.47000	0.48000						

Graphics





CETIS Analysis Detail

Eisenia 28-d Survival and Growth Soil Test — EnviroSystems, Inc.

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Mean Dry Weight-mg	Comparison	09-8237-6756	09-8237-6756	12 Jul-05 3:23 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	14.08695	47.46723	0.05677	Equal Variances
Distribution	Shapiro-Wilk W	0.97443	0.74935	0.92045	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.0014520	0.0014520	1	1.18	0.31926	Non-Significant Effect
Error	0.0073898	0.0012316	6			
Total	0.00884182	0.0026836	7			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13341-012		13341-001	1.08578	1.94318	0.1596	0.04822	Non-Significant Effect

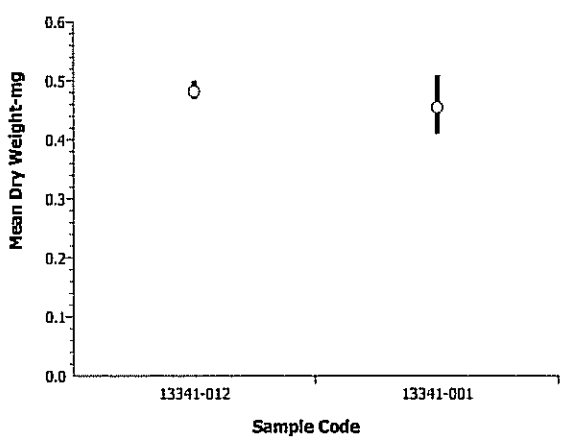
Data Summary

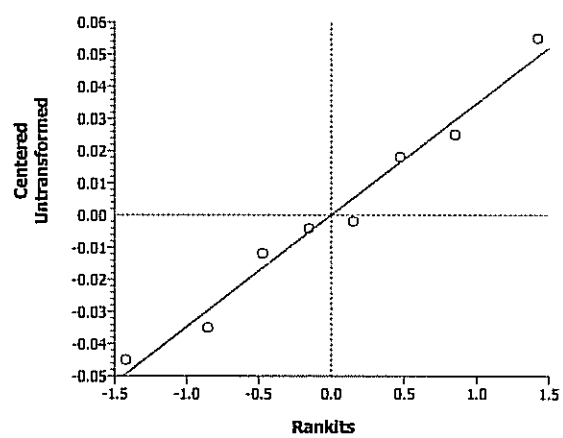
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13341-012	4	0.48194	0.47000	0.50000	0.01278				
13341-001	4	0.45500	0.41000	0.51000	0.04796				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13341-012	0.47778	0.50000	0.47000	0.48000						
13341-001	0.48000	0.51000	0.42000	0.41000						

Graphics





CETIS Analysis Detail

Eisenia 28-d Survival and Growth Soil Test — **EnviroSystems, Inc.**

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Mean Dry Weight-mg	Comparison	09-8237-6756	09-8237-6756	12 Jul-05 3:23 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	1.83743	47.46723	0.62975	Equal Variances
Distribution	Shapiro-Wilk W	0.84741	0.74935	0.09364	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.0044076	0.0044076	1	19.03	0.00476	Significant Effect
Error	0.0013898	0.0002316	6			
Total	0.00579738	0.0046392	7			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13341-012		13341-002	4.36211	1.94318	0.0024	0.02091	Significant Effect

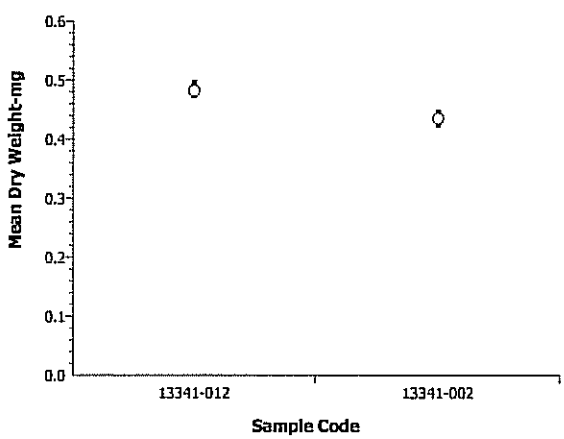
Data Summary

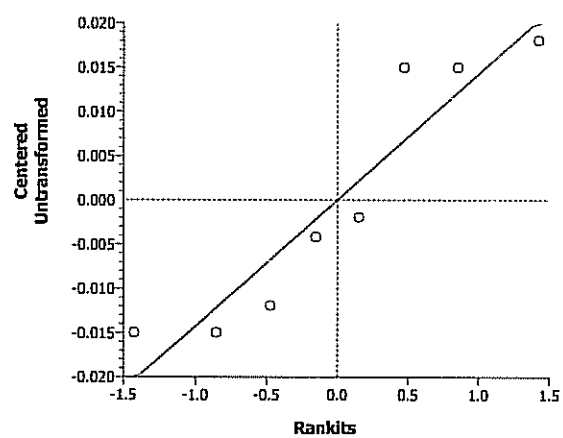
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13341-012	4	0.48194	0.47000	0.50000	0.01278				
13341-002	4	0.43500	0.42000	0.45000	0.01732				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13341-012	0.47778	0.50000	0.47000	0.48000						
13341-002	0.42000	0.42000	0.45000	0.45000						

Graphics





CETIS Analysis Detail

Eisenia 28-d Survival and Growth Soil Test — EnviroSystems, Inc.

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Mean Dry Weight-mg	Comparison	09-8237-6756	09-8237-6756	12 Jul-05 3:23 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	11.02456	47.46723	0.07937	Equal Variances
Distribution	Shapiro-Wilk W	0.87722	0.74935	0.17377	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.0103520	0.0103520	1	10.55	0.01752	Significant Effect
Error	0.0058898	0.0009816	6			
Total	0.01624182	0.0113336	7			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13341-012		13341-003	3.24741	1.94318	0.0088	0.04305	Significant Effect

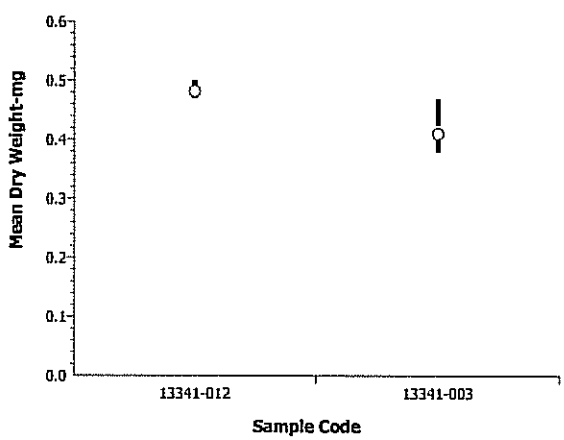
Data Summary

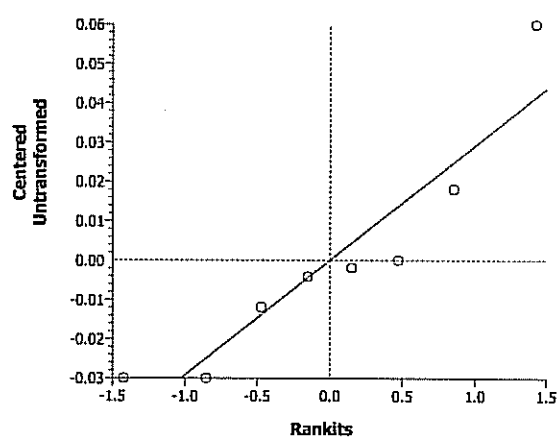
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13341-012	4	0.48194	0.47000	0.50000	0.01278				
13341-003	4	0.41000	0.38000	0.47000	0.04243				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13341-012	0.47778	0.50000	0.47000	0.48000						
13341-003	0.41000	0.47000	0.38000	0.38000						

Graphics





CETIS Analysis Detail

Eisenia 28-d Survival and Growth Soil Test — EnviroSystems, Inc.

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Mean Dry Weight-mg	Comparison	09-8237-6756	09-8237-6756	12 Jul-05 3:23 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	8.57466	47.46723	0.11094	Equal Variances
Distribution	Shapiro-Wilk W	0.94404	0.74935	0.61381	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.0103520	0.0103520	1	13.24	0.01084	Significant Effect
Error	0.0046898	0.0007816	6			
Total	0.01504183	0.0111336	7			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13341-012		13341-004	3.63924	1.94318	0.0054	0.03841	Significant Effect

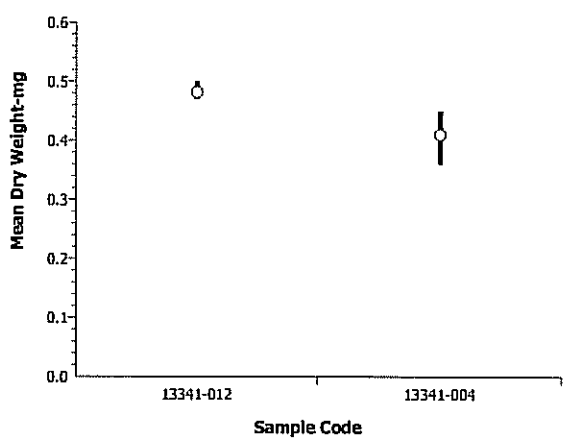
Data Summary

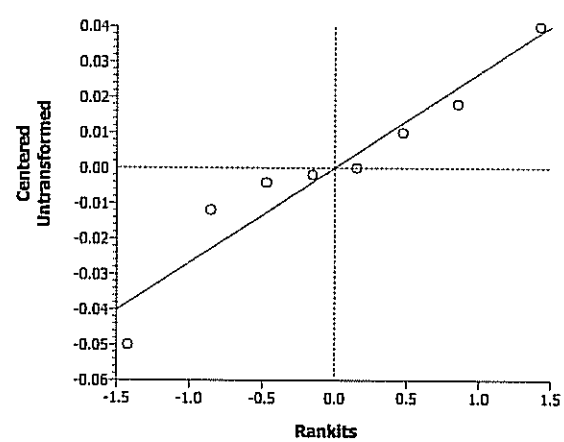
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13341-012	4	0.48194	0.47000	0.50000	0.01278				
13341-004	4	0.41000	0.36000	0.45000	0.03742				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13341-012	0.47778	0.50000	0.47000	0.48000						
13341-004	0.36000	0.45000	0.41000	0.42000						

Graphics





CETIS Analysis Detail

Eisenia 28-d Survival and Growth Soil Test — EnviroSystems, Inc.

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Mean Dry Weight-mg	Comparison	09-8237-6756	09-8237-6756	12 Jul-05 3:24 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	15.66916	47.46723	0.04898	Equal Variances
Distribution	Shapiro-Wilk W	0.94893	0.74935	0.66405	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.0096451	0.0096451	1	7.09	0.03741	Significant Effect
Error	0.0081648	0.0013608	6			
Total	0.01780988	0.0110059	7			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13341-012		13341-005	2.66229	1.94318	0.0187	0.05069	Significant Effect

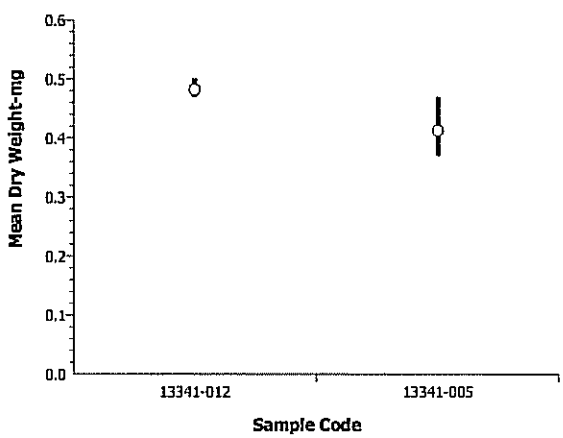
Data Summary

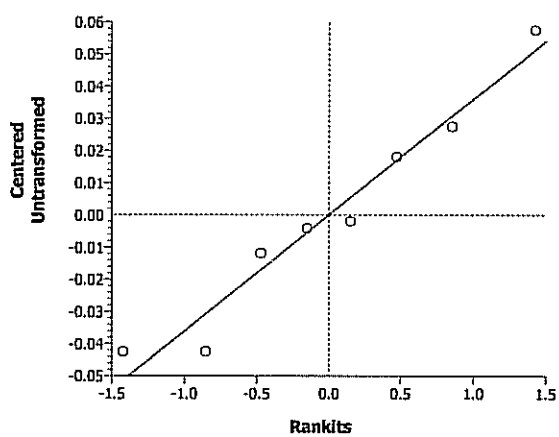
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13341-012	4	0.48194	0.47000	0.50000	0.01278				
13341-005	4	0.41250	0.37000	0.47000	0.05058				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13341-012	0.47778	0.50000	0.47000	0.48000						
13341-005	0.47000	0.37000	0.44000	0.37000						

Graphics





CETIS Analysis Detail

Eisenia 28-d Survival and Growth Soil Test — EnviroSystems, Inc.

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Mean Dry Weight-mg	Comparison	09-8237-6756	09-8237-6756	12 Jul-05 3:24 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	7.09451	47.46723	0.14184	Equal Variances
Distribution	Shapiro-Wilk W	0.94042	0.74935	0.57798	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.0059284	0.0059284	1	8.97	0.02416	Significant Effect
Error	0.0039648	0.0006608	6			
Total	0.00989321	0.0065892	7			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13341-012		13341-006	2.99525	1.94318	0.0121	0.03532	Significant Effect

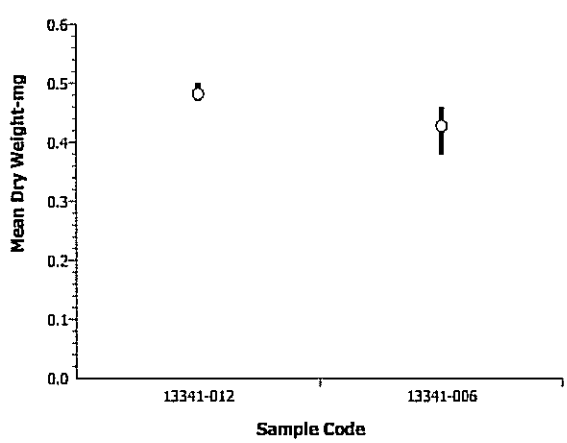
Data Summary

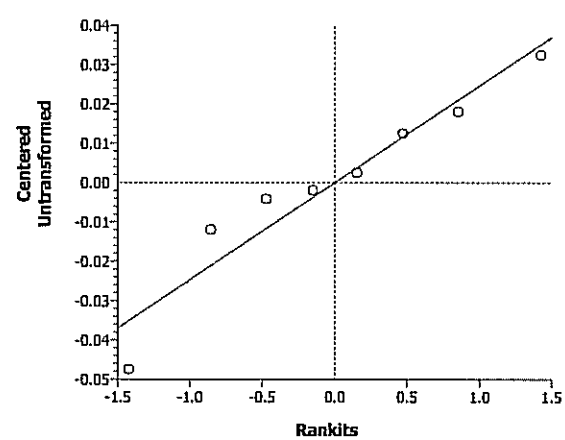
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13341-012	4	0.48194	0.47000	0.50000	0.01278				
13341-006	4	0.42750	0.38000	0.46000	0.03403				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13341-012	0.47778	0.50000	0.47000	0.48000						
13341-006	0.38000	0.44000	0.46000	0.43000						

Graphics





CETIS Analysis Detail

Eisenia 28-d Survival and Growth Soil Test — EnviroSystems, Inc.

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Mean Dry Weight-mg	Comparison	09-8237-6756	09-8237-6756	12 Jul-05 3:24 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	2.19471	47.46723	0.53520	Equal Variances
Distribution	Shapiro-Wilk W	0.81503	0.74935	0.04649	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.0239562	0.0239562	1	91.86	0.00007	Significant Effect
Error	0.0015648	0.0002608	6			
Total	0.02552099	0.024217	7			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13341-012		13341-007	9.58413	1.94318	0.0000	0.02219	Significant Effect

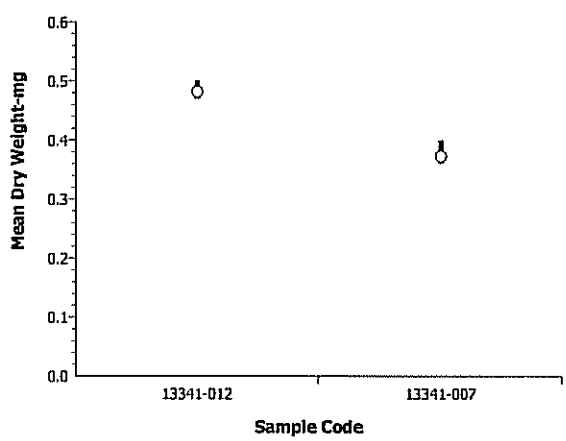
Data Summary

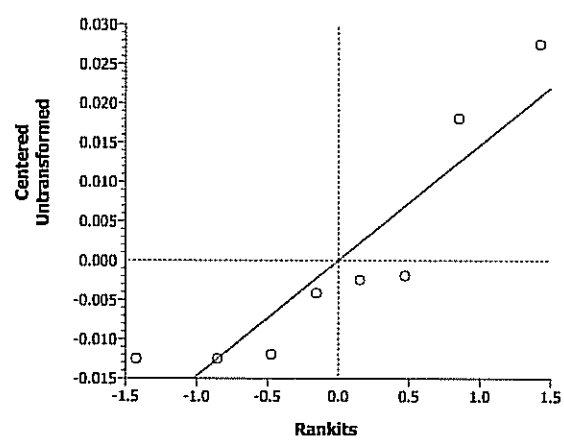
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13341-012	4	0.48194	0.47000	0.50000	0.01278				
13341-007	4	0.37250	0.36000	0.40000	0.01893				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13341-012	0.47778	0.50000	0.47000	0.48000						
13341-007	0.36000	0.37000	0.40000	0.36000						

Graphics





CETIS Analysis Detail

Eisenia 28-d Survival and Growth Soil Test — EnviroSystems, Inc.

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Mean Dry Weight-mg	Comparison	09-8237-6756	09-8237-6756	12 Jul-05 3:24 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	6.73724	47.46723	0.15150	Equal Variances
Distribution	Shapiro-Wilk W	0.90262	0.74935	0.28825	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.0044076	0.0044076	1	6.98	0.03846	Significant Effect
Error	0.0037898	0.0006316	6			
Total	0.00819738	0.0050392	7			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13341-012		13341-008	2.64159	1.94318	0.0192	0.03453	Significant Effect

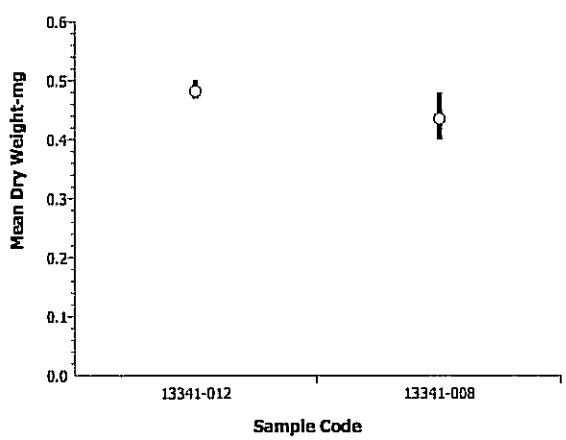
Data Summary

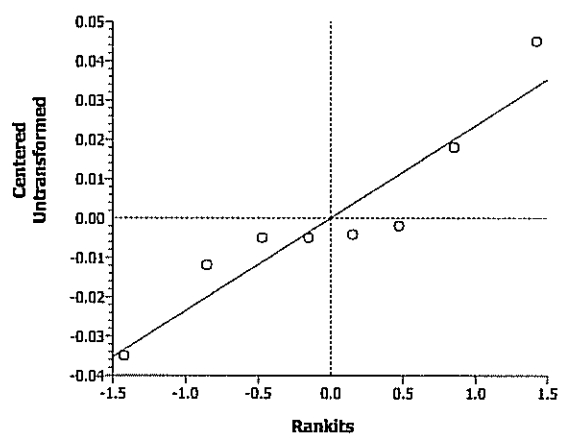
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13341-012	4	0.48194	0.47000	0.50000	0.01278				
13341-008	4	0.43500	0.40000	0.48000	0.03317				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13341-012	0.47778	0.50000	0.47000	0.48000						
13341-008	0.43000	0.48000	0.40000	0.43000						

Graphics





CETIS Analysis Detail

Eisenia 28-d Survival and Growth Soil Test — **EnviroSystems, Inc.**

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Mean Dry Weight-mg	Comparison	09-8237-6756	09-8237-6756	12 Jul-05 3:24 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	4.49149	47.46723	0.24892	Equal Variances
Distribution	Shapiro-Wilk W	0.89056	0.74935	0.22731	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.0134298	0.0134298	1	29.96	0.00155	Significant Effect
Error	0.0026898	0.0004483	6			
Total	0.01611960	0.0138781	7			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13341-012		13341-009	5.4733	1.94318	0.0008	0.02909	Significant Effect

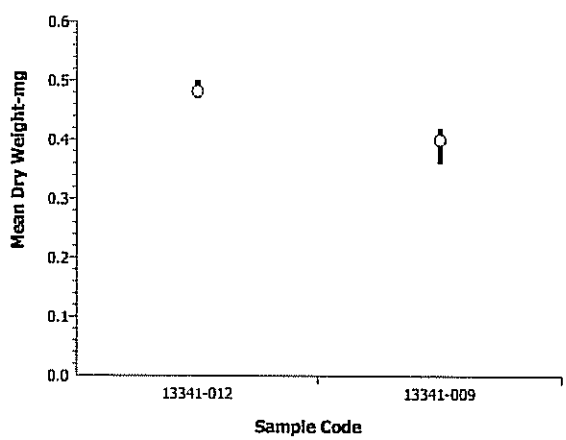
Data Summary

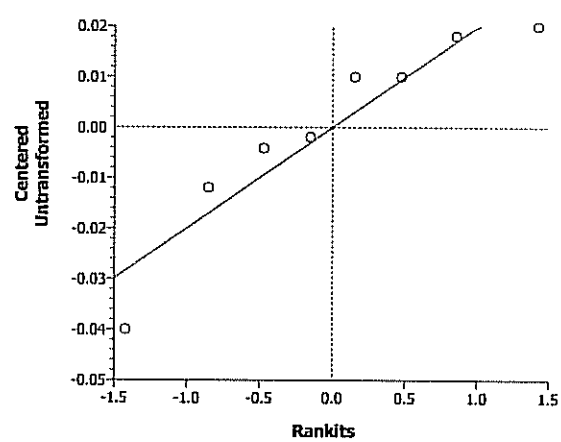
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13341-012	4	0.48194	0.47000	0.50000	0.01278				
13341-009	4	0.40000	0.36000	0.42000	0.02708				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13341-012	0.47778	0.50000	0.47000	0.48000						
13341-009	0.36000	0.42000	0.41000	0.41000						

Graphics





CETIS Analysis Detail

Eisenia 28-d Survival and Growth Soil Test — EnviroSystems, Inc.

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Mean Dry Weight-mg	Comparison	09-8237-6756	09-8237-6756	12 Jul-05 3:24 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	8.53685	47.46723	0.11159	Equal Variances
Distribution	Shapiro-Wilk W	0.96145	0.74935	0.79665	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.0017014	0.0017014	1	2.19	0.18981	Non-Significant Effect
Error	0.0046713	0.0007785	6			
Total	0.00637269	0.0024799	7			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13341-012		13341-010	1.47829	1.94318	0.0949	0.03834	Non-Significant Effect

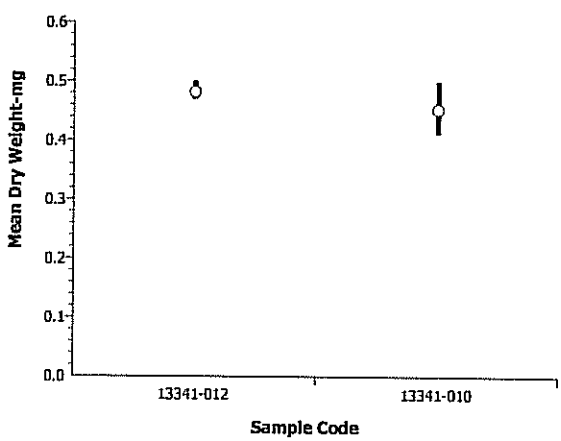
Data Summary

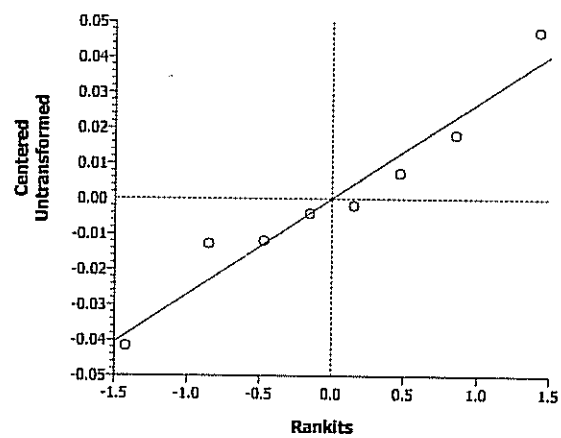
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13341-012	4	0.48194	0.47000	0.50000	0.01278				
13341-010	4	0.45278	0.41111	0.50000	0.03733				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13341-012	0.47778	0.50000	0.47000	0.48000						
13341-010	0.46000	0.44000	0.41111	0.50000						

Graphics





CETIS Analysis Detail

Eisenia 28-d Survival and Growth Soil Test — **EnviroSystems, Inc.**

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Mean Dry Weight-mg	Comparison	09-8237-6756	09-8237-6756	12 Jul-05 3:24 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	3.01134	47.46723	0.38944	Equal Variances
Distribution	Shapiro-Wilk W	0.95700	0.74935	0.74950	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.0039506	0.0039506	1	12.06	0.01325	Significant Effect
Error	0.0019648	0.0003275	6			
Total	0.00591543	0.0042781	7			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13341-012		13341-011	3.47334	1.94318	0.0066	0.02486	Significant Effect

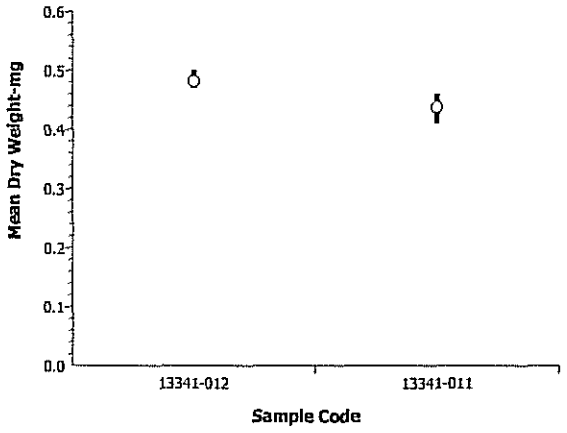
Data Summary

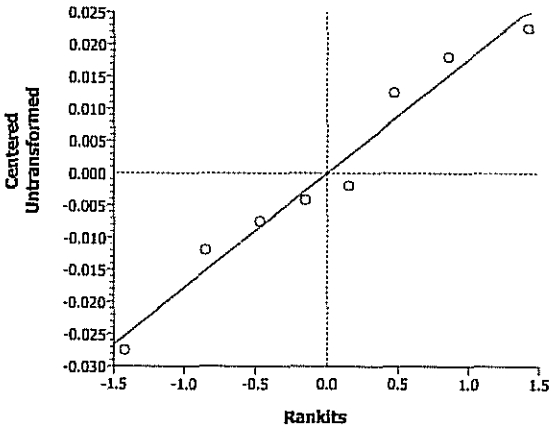
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13341-012	4	0.48194	0.47000	0.50000	0.01278				
13341-011	4	0.43750	0.41000	0.46000	0.02217				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13341-012	0.47778	0.50000	0.47000	0.48000						
13341-011	0.43000	0.41000	0.45000	0.46000						

Graphics





STUDY: 13341
CLIENT: CH2M Hill
PROJECT: Indian Head CTO-43
TASK: E. fetida 28 day Survival
DATA: Reproduction Data
START DATE: 06/02/05
DATE ENDED: 06/30/05

Project Site	Replicate	Number Cocoons	Mean Cocoons/ Replicate	Distribution	Variance	Statistic	Critical Value	p Value	Significant Difference in Survival	
Lab Control	A	25	23.8							
	B	27								
	C	18								
	D	25								
ISLBTX01	A	1	0.8	Normal	Equal	11.3244	1.9432	0.0000	YES	Lab
ESI-001	B	0		Normal	Equal	3.5520	1.9432	0.0060	YES	ISLBTXREF1
	C	2								
	D	0								
ISLBTX03	A	4	2.8	Normal	Equal	9.5935	1.9432	0.0000	YES	Lab
ESI-002	B	3		Normal	Equal	2.4295	1.9432	0.0256	YES	ISLBTXREF1
	C	0								
	D	4								
ISLBTX04	A	8	9.5	Normal	Equal	5.6717	1.9432	0.0006	YES	Lab
ESI-003	B	9		Normal	Equal	-0.4849	1.9432	0.6775	NO	ISLBTXREF1
	C	7								
	D	14								
ISLBTX07	A	1	2.0	Normal	Equal	10.0015	1.9432	0.0000	YES	Lab
ESI-004	B	3		Normal	Equal	2.7778	1.9432	0.0160	YES	ISLBTXREF1
	C	4								
	D	0								
ISLBTX10	A	7	7.8	Normal	Equal	7.0676	1.9432	0.0002	YES	Lab
ESI-005	B	7		Normal	Equal	0.2140	1.9432	0.4188	NO	ISLBTXREF1
	C	11								
	D	6								
ISLBTX05	A	0	2.3	Normal	Equal	9.6554	1.9432	0.0000	YES	Lab
ESI-006	B	1		Normal	Equal	2.6083	1.9432	0.0201	YES	ISLBTXREF1
	C	4								
	D	4								
ISLBTX08	A	18	22.5	Normal	Equal	0.3587	1.9432	0.3661	NO	Lab
ESI-007	B	24		Normal	Equal	-4.0339	1.9432	0.9966	NO	ISLBTXREF1
	C	30								
	D	18								
ISLBTX06	A	12	12.0	Normal	Equal	5.8296	1.9432	0.0006	YES	Lab
ESI-008	B	13		Normal	Equal	-1.7886	1.9432	0.9381	NO	ISLBTXREF1
	C	11								
	D	12								
ISLBTX02	A	22	20.0	Normal	Equal	1.5667	1.9432	0.0841	NO	Lab
ESI-009	B	21		Normal	Equal	-4.7721	1.9432	0.9985	NO	ISLBTXREF1
	C	21								
	D	16								
ISLBTX11	A	16	16.0	Normal	Equal	3.6283	1.9432	0.0055	YES	Lab
ESI-010	B	14		Normal	Equal	-3.5026	1.9432	0.9936	NO	ISLBTXREF1
	C	16								
	D	18								
ISLBTX09	A	3	9.0	Normal	Equal	4.3694	1.9432	0.0024	YES	Lab
ESI-011	B	6		Normal	Equal	-0.2190	1.9432	0.5830	NO	ISLBTXREF1
	C	15								
	D	12								
ISLBTXREF1	A	13	8.3	Normal	Equal	5.4378	1.9432	0.0008	YES	Lab
ESI-012	B	9								
	C	8								
	D	3								

CETIS Test Summary

Report Date: 11 Jul-05 2:34 PM
Link: 17-7775-6836

Sample No:	13-7719-7724	Material:	Soil	Client:	CH2M Hill
Sample Date:	24 May-05 11:15 AM	Code:	13341-011	Project:	Ecologcal Risk Assessment
Receive Date:	25 May-05 10:00 AM	Source:	Indian Head, CTO-43		
Sample Age:	9d 2h	Station:	ISLCTX09 - 011		

Sample No:	04-7729-9498	Material:	Soil	Client:	CH2M Hill
Sample Date:	24 May-05 01:00 PM	Code:	13341-012	Project:	Ecologcal Risk Assessment
Receive Date:	25 May-05 10:00 AM	Source:	Indian Head, CTO-43		
Sample Age:	9d 1h	Station:	ISLCTXREF1 - 012		

Reproduction Summary

Sample Code	Reps	Mean	Minimum	Maximum	SE	SD	CV
13341-000	4	23.75	18	27	1.9738	3.9476	16.62%
13341-012	4	8.25	3	13	2.0565	4.113	49.85%
13341-001	4	0.75	0	2	0.4787	0.9574	127.66
13341-002	4	2.75	0	4	0.9465	1.893	68.84%
13341-003	4	9.5	7	14	1.5546	3.1091	32.73%
13341-004	4	2	0	4	0.9129	1.8257	91.29%
13341-005	4	7.75	6	11	1.1087	2.2174	28.61%
13341-006	4	2.25	0	4	1.0308	2.0616	91.62%
13341-007	4	22.5	18	30	2.8723	5.7446	25.53%
13341-008	4	12	11	13	0.4082	0.8165	6.80%
13341-009	4	20	16	22	1.3540	2.7080	13.54%
13341-010	4	16	14	18	0.8165	1.633	10.21%
13341-011	4	9	3	15	2.7386	5.4772	60.86%

Reproduction Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4
13341-000	25	27	18	25
13341-012	13	9	8	3
13341-001	1	0	2	0
13341-002	4	3	0	4
13341-003	8	9	7	14
13341-004	1	3	4	0
13341-005	7	7	11	6
13341-006	0	1	4	4
13341-007	18	24	30	18
13341-008	12	13	11	12
13341-009	22	21	21	16
13341-010	16	14	16	18
13341-011	3	6	15	12

CETIS Data Worksheet

Report Date: 11 Jul-05 9:55 AM
Link: 17-7775-6836

Eisenia 28-d Survival and Growth Soil Test — EnviroSystems, Inc.

Start Date:	02 Jun-05 02:00 PM	**Species:**	Eisenia fetida	**Sample Code:**	13341-000
Ending Date:	30 Jun-05 12:00 PM	**Protocol:**	EPA/600/R-92/183 (1992)	**Sample Source:**	Indian Head, CTO-43
Sample Date:	02 Jun-05 10:00 AM	**Material:**	Soil	**Sample Station:**	LAB CONTROL - 000

Conc-NA	Rep	Pos	# Young	Notes
13341-000	1	45	25	
13341-000	2	34	27	
13341-000	3	20	18	
13341-000	4	39	25	
13341-012	1	2	13	
13341-012	2	29	9	
13341-012	3	4	8	
13341-012	4	1	3	
13341-001	1	26	1	
13341-001	2	25	0	
13341-001	3	5	2	
13341-001	4	40	0	
13341-002	1	30	4	
13341-002	2	18	3	
13341-002	3	37	0	
13341-002	4	46	4	
13341-003	1	28	8	
13341-003	2	35	9	
13341-003	3	23	7	
13341-003	4	49	14	
13341-004	1	27	1	
13341-004	2	21	3	
13341-004	3	16	4	
13341-004	4	3	0	
13341-005	1	33	7	
13341-005	2	36	7	
13341-005	3	8	11	
13341-005	4	38	6	
13341-006	1	12	0	
13341-006	2	7	1	
13341-006	3	47	4	
13341-006	4	52	4	
13341-007	1	13	18	
13341-007	2	10	24	
13341-007	3	31	30	
13341-007	4	24	18	
13341-008	1	19	12	
13341-008	2	48	13	
13341-008	3	17	11	
13341-008	4	11	12	
13341-009	1	32	22	
13341-009	2	6	21	
13341-009	3	51	21	
13341-009	4	44	16	
13341-010	1	41	16	
13341-010	2	43	14	
13341-010	3	22	16	
13341-010	4	50	18	
13341-011	1	14	3	
13341-011	2	15	6	
13341-011	3	9	15	
13341-011	4	42	12	

CETIS Analysis Detail

Eisenia 28-d Survival and Growth Soil Test — EnviroSystems, Inc.

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Reproduction	Comparison	17-7775-6836	17-7775-6836	11 Jul-05 9:56 AM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	1.08556	47.46723	0.94778	Equal Variances
Distribution	Shapiro-Wilk W	0.89348	0.74935	0.24086	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	480.5	480.5	1	29.57	0.00161	Significant Effect
Error	97.5	16.25	6			
Total	578	496.75	7			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13341-000		13341-012	5.43776	1.94318	0.0008	5.53892	Significant Effect

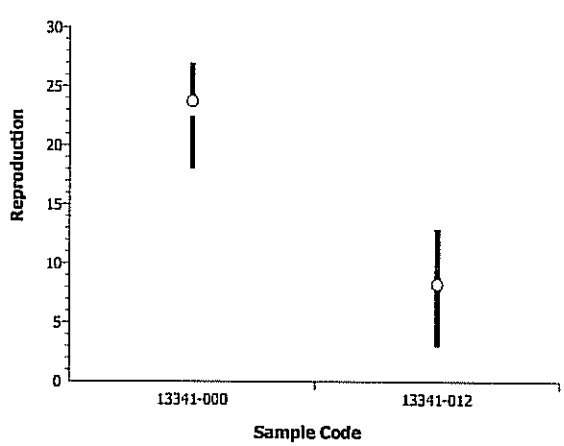
Data Summary

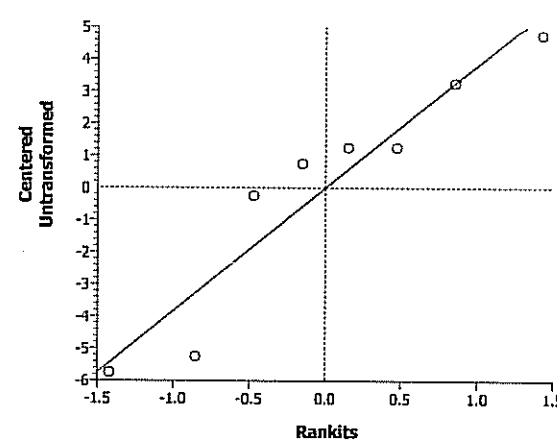
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13341-000	4	23.75	18	27	3.9476				
13341-012	4	8.25	3	13	4.113				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13341-000	25	27	18	25						
13341-012	13	9	8	3						

Graphics





CETIS Analysis Detail

Eisenia 28-d Survival and Growth Soil Test — **EnviroSystems, Inc.**

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Reproduction	Comparison	17-7775-6836	17-7775-6836	11 Jul-05 9:56 AM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	17.00000	47.46723	0.04371	Equal Variances
Distribution	Shapiro-Wilk W	0.84942	0.74935	0.09770	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	1058	1058	1	128.24	0.00003	Significant Effect
Error	49.5	8.25	6			
Total	1107.5	1066.25	7			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13341-000		13341-001	11.3244	1.94318	0.0000	3.94662	Significant Effect

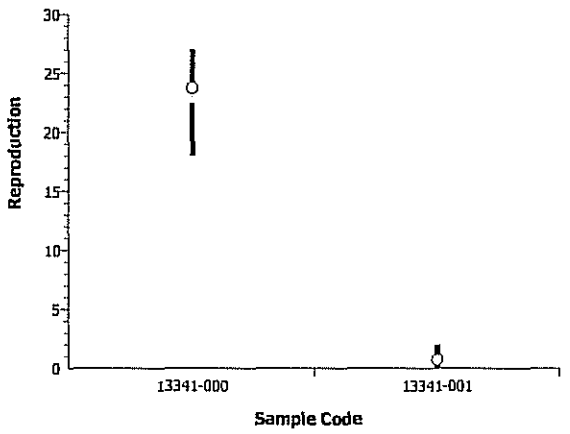
Data Summary

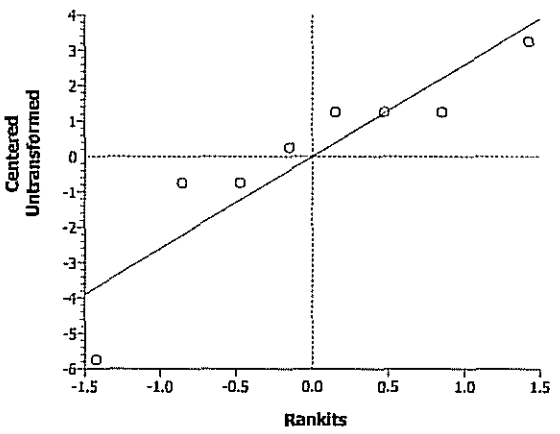
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13341-000	4	23.75	18	27	3.9476				
13341-001	4	0.75	0	2	0.9574				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13341-000	25	27	18	25						
13341-001	1	0	2	0						

Graphics





CETIS Analysis Detail

Eisenia 28-d Survival and Growth Soil Test — **EnviroSystems, Inc.**

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Reproduction	Comparison	17-7775-6836	17-7775-6836	11 Jul-05 9:56 AM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	4.34884	47.46723	0.25852	Equal Variances
Distribution	Shapiro-Wilk W	0.82481	0.74935	0.05764	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	882	882	1	92.03	0.00007	Significant Effect
Error	57.5	9.583333	6			
Total	939.5	891.58333	7			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13341-000		13341-002	9.59348	1.94318	0.0000	4.2536	Significant Effect

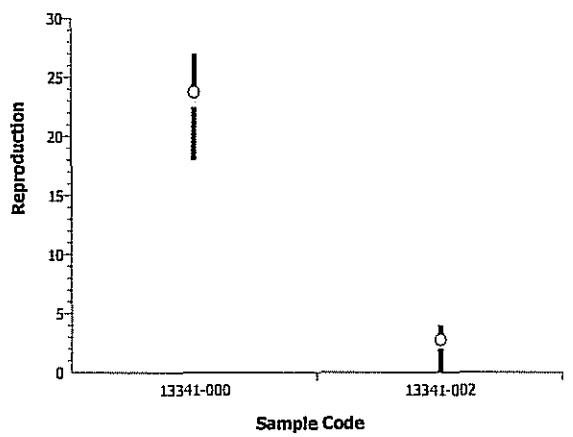
Data Summary

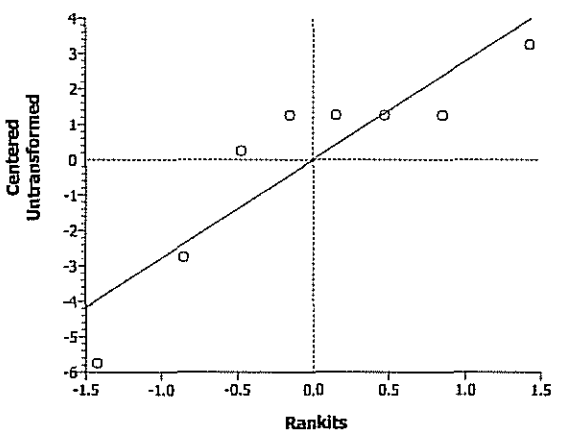
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13341-000	4	23.75	18	27	3.9476				
13341-002	4	2.75	0	4	1.893				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13341-000	25	27	18	25						
13341-002	4	3	0	4						

Graphics





CETIS Analysis Detail

Eisenia 28-d Survival and Growth Soil Test — **EnviroSystems, Inc.**

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Reproduction	Comparison	17-7775-6836	17-7775-6836	11 Jul-05 9:56 AM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	1.61207	47.46723	0.70440	Equal Variances
Distribution	Shapiro-Wilk W	0.97639	0.74935	0.93568	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	406.125	406.125	1	32.17	0.00129	Significant Effect
Error	75.75	12.625	6			
Total	481.875	418.75	7			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13341-000		13341-003	5.67171	1.94318	0.0006	4.88218	Significant Effect

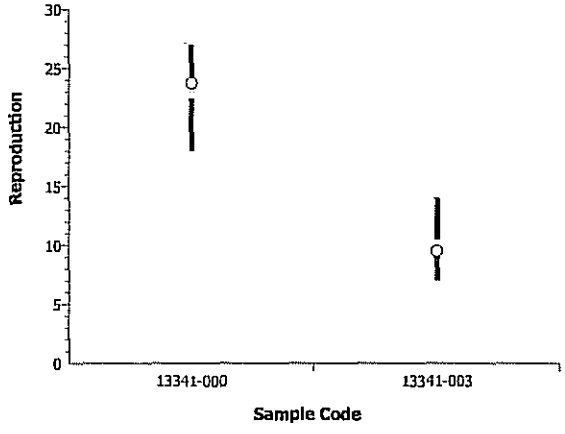
Data Summary

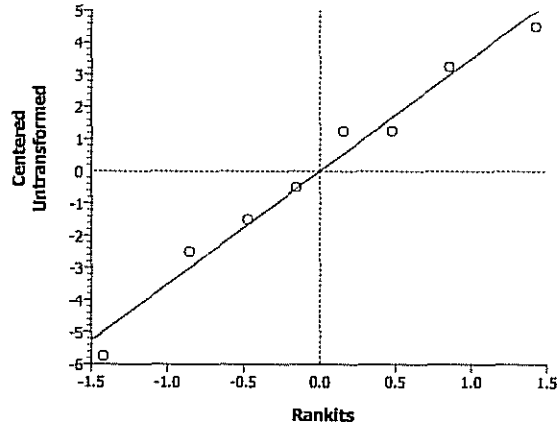
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13341-000	4	23.75	18	27	3.9476				
13341-003	4	9.5	7	14	3.1091				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13341-000	25	27	18	25						
13341-003	8	9	7	14						

Graphics





CETIS Analysis Detail

Eisenia 28-d Survival and Growth Soil Test — EnviroSystems, Inc.

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Reproduction	Comparison	17-7775-6836	17-7775-6836	11 Jul-05 9:56 AM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	4.67500	47.46723	0.23742	Equal Variances
Distribution	Shapiro-Wilk W	0.89294	0.74935	0.23831	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	946.125	946.125	1	100.03	0.00006	Significant Effect
Error	56.75	9.458333	6			
Total	1002.875	955.58333	7			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13341-000		13341-004	10.0015	1.94318	0.0000	4.22577	Significant Effect

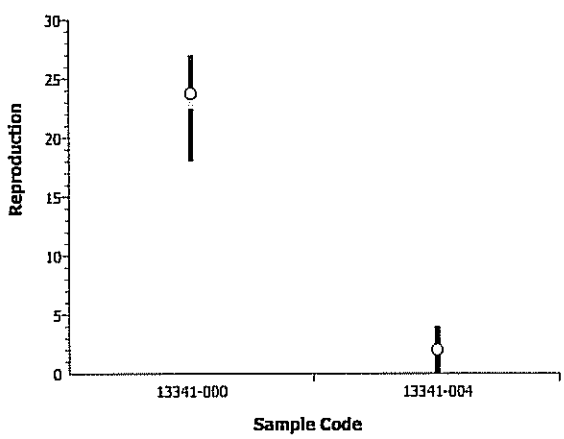
Data Summary

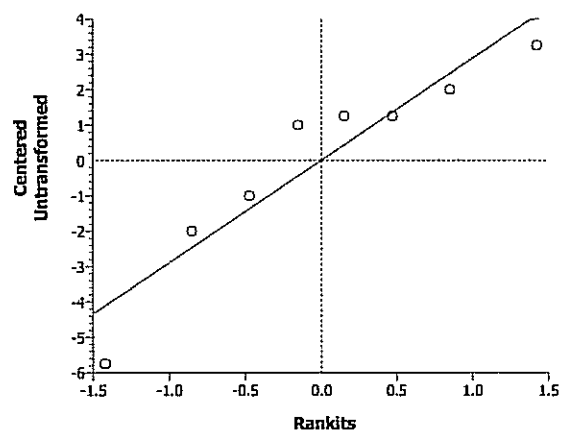
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13341-000	4	23.75	18	27	3.9476				
13341-004	4	2	0	4	1.8257				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13341-000	25	27	18	25						
13341-004	1	3	4	0						

Graphics





CETIS Analysis Detail

Eisenia 28-d Survival and Growth Soil Test — **EnviroSystems, Inc.**

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Reproduction	Comparison	17-7775-6836	17-7775-6836	11 Jul-05 9:56 AM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	3.16949	47.46723	0.36875	Equal Variances
Distribution	Shapiro-Wilk W	0.91210	0.74935	0.34599	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	512	512	1	49.95	0.00040	Significant Effect
Error	61.5	10.25	6			
Total	573.5	522.25	7			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13341-000		13341-005	7.06762	1.94318	0.0002	4.39906	Significant Effect

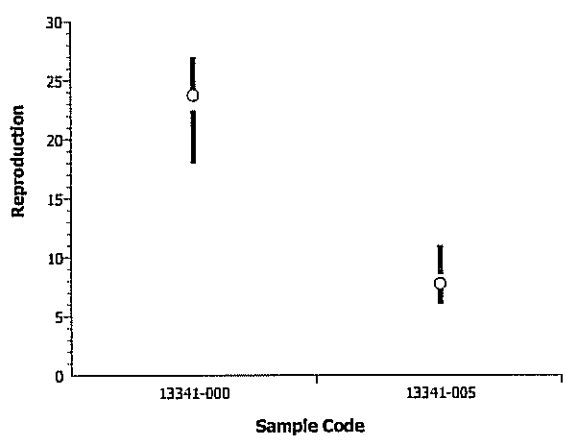
Data Summary

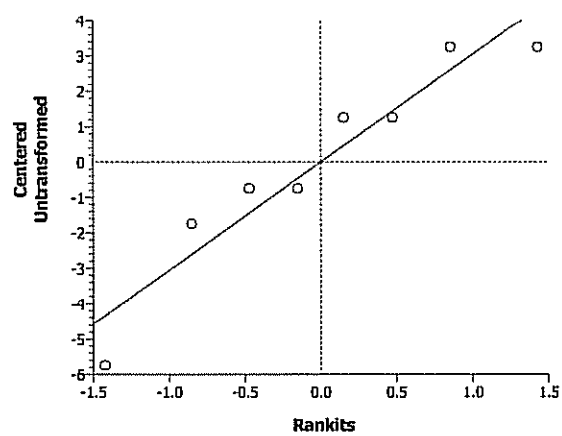
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13341-000	4	23.75	18	27	3.9476				
13341-005	4	7.75	6	11	2.2174				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13341-000	25	27	18	25						
13341-005	7	7	11	6						

Graphics





CETIS Analysis Detail

Eisenia 28-d Survival and Growth Soil Test — **EnviroSystems, Inc.**

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Reproduction	Comparison	17-7775-6836	17-7775-6836	11 Jul-05 9:56 AM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	3.66667	47.46723	0.31424	Equal Variances
Distribution	Shapiro-Wilk W	0.87982	0.74935	0.18321	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	924.5	924.5	1	93.23	0.00007	Significant Effect
Error	59.5	9.916667	6			
Total	984	934.41667	7			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13341-000		13341-006	9.65541	1.94318	0.0000	4.32694	Significant Effect

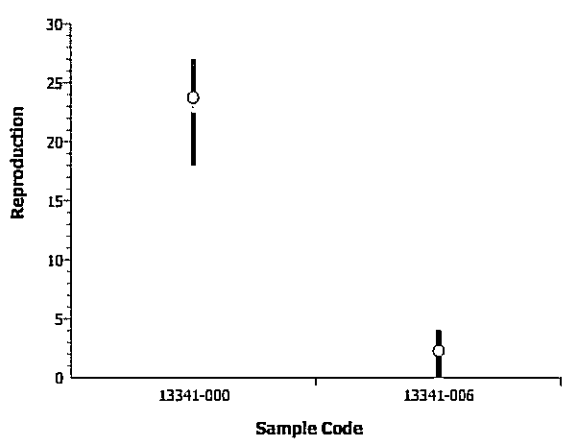
Data Summary

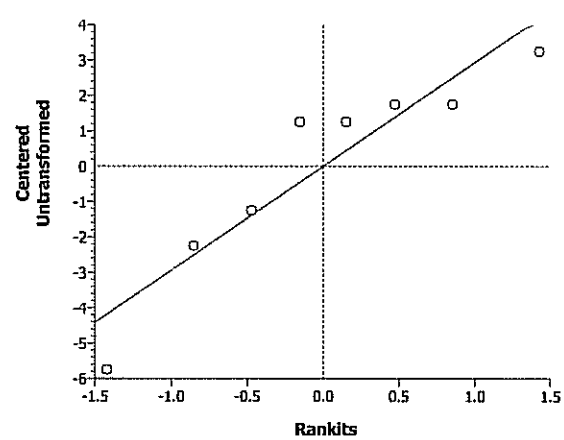
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13341-000	4	23.75	18	27	3.9476				
13341-006	4	2.25	0	4	2.0616				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13341-000	25	27	18	25						
13341-006	0	1	4	4						

Graphics





CETIS Analysis Detail

Eisenia 28-d Survival and Growth Soil Test — EnviroSystems, Inc.

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Reproduction	Comparison	17-7775-6836	17-7775-6836	11 Jul-05 9:56 AM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	2.11765	47.46723	0.55353	Equal Variances
Distribution	Shapiro-Wilk W	0.91003	0.74935	0.33258	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	3.125	3.125	1	0.13	0.73212	Non-Significant Effect
Error	145.75	24.29167	6			
Total	148.875	27.416666	7			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13341-000		13341-007	0.35867	1.94318	0.3661	6.77215	Non-Significant Effect

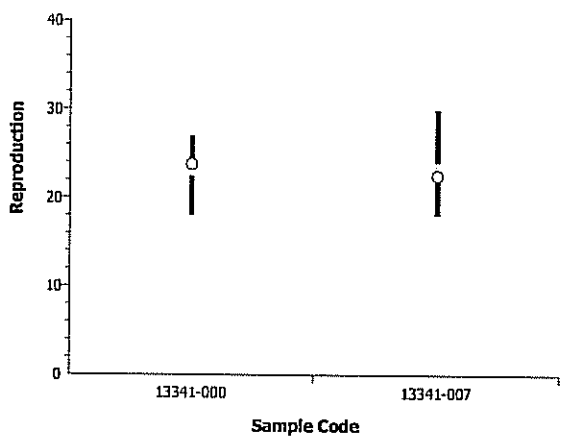
Data Summary

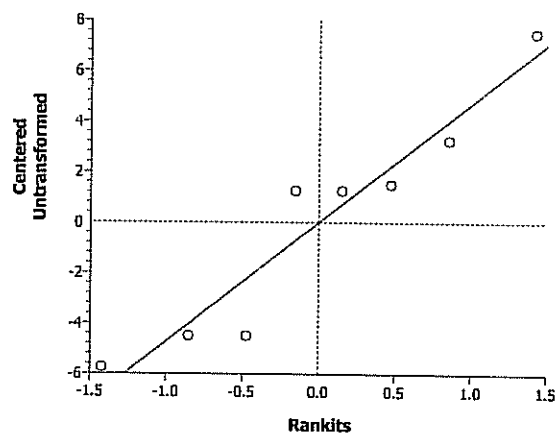
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13341-000	4	23.75	18	27	3.9476				
13341-007	4	22.5	18	30	5.7446				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13341-000	25	27	18	25						
13341-007	18	24	30	18						

Graphics





CETIS Analysis Detail

Eisenia 28-d Survival and Growth Soil Test — **EnviroSystems, Inc.**

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Reproduction	Comparison	17-7775-6836	17-7775-6836	11 Jul-05 9:56 AM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	23.37500	47.46723	0.02786	Equal Variances
Distribution	Shapiro-Wilk W	0.84881	0.74935	0.09644	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	276.125	276.125	1	33.98	0.00112	Significant Effect
Error	48.75	8.125	6			
Total	324.875	284.25	7			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13341-000		13341-008	5.82963	1.94318	0.0006	3.91661	Significant Effect

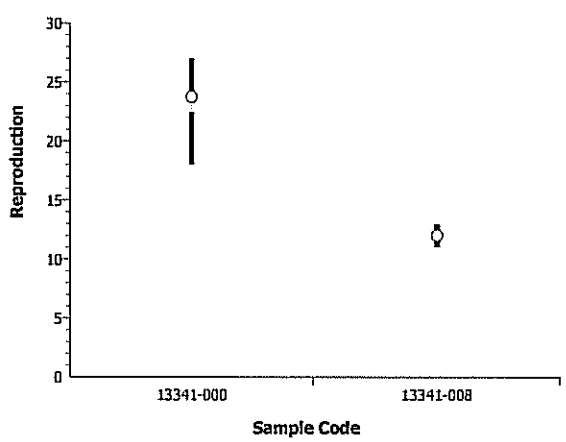
Data Summary

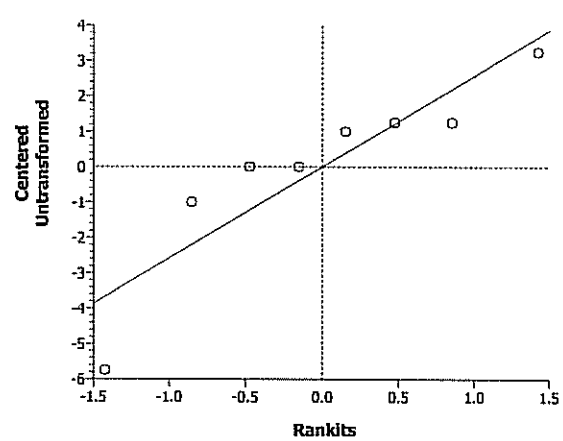
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13341-000	4	23.75	18	27	3.9476				
13341-008	4	12	11	13	0.8165				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13341-000	25	27	18	25						
13341-008	12	13	11	12						

Graphics





CETIS Analysis Detail

Eisenia 28-d Survival and Growth Soil Test — EnviroSystems, Inc.

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Reproduction	Comparison	17-7775-6836	17-7775-6836	11 Jul-05 9:57 AM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	2.12500	47.46723	0.55174	Equal Variances
Distribution	Shapiro-Wilk W	0.79711	0.74935	0.03111	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	28.125	28.125	1	2.45	0.16823	Non-Significant Effect
Error	68.75	11.45833	6			
Total	96.875	39.583333	7			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13341-000		13341-009	1.5667	1.94318	0.0841	4.65113	Non-Significant Effect

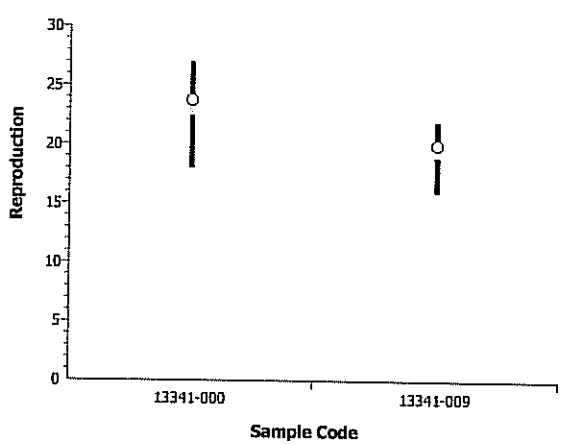
Data Summary

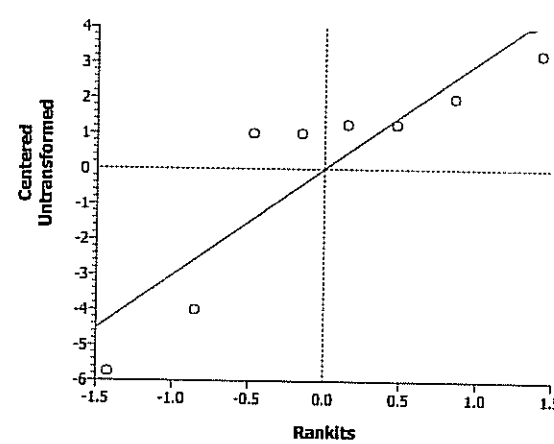
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13341-000	4	23.75	18	27	3.9476				
13341-009	4	20	16	22	2.7080				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13341-000	25	27	18	25						
13341-009	22	21	21	16						

Graphics





CETIS Analysis Detail

Eisenia 28-d Survival and Growth Soil Test — EnviroSystems, Inc.

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Reproduction	Comparison	17-7775-6836	17-7775-6836	11 Jul-05 9:57 AM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	5.84375	47.46723	0.18110	Equal Variances
Distribution	Shapiro-Wilk W	0.89508	0.74935	0.24861	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	120.125	120.125	1	13.16	0.01099	Significant Effect
Error	54.75	9.125	6			
Total	174.875	129.25	7			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13341-000		13341-010	3.62828	1.94318	0.0055	4.15064	Significant Effect

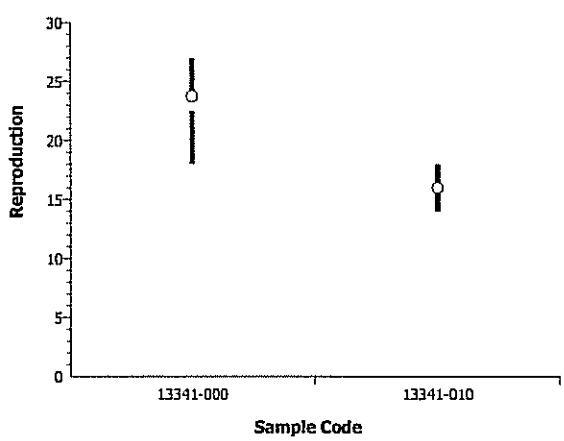
Data Summary

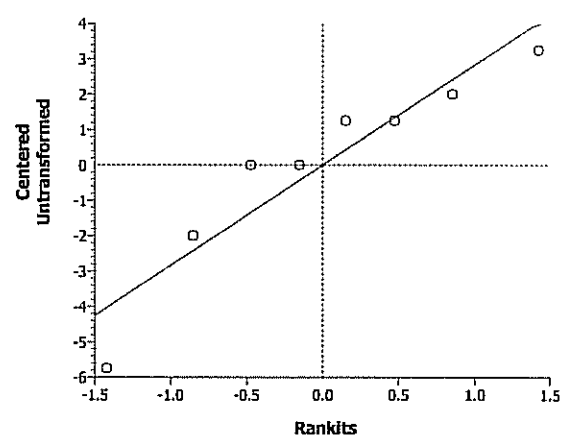
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13341-000	4	23.75	18	27	3.9476				
13341-010	4	16	14	18	1.633				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13341-000	25	27	18	25						
13341-010	16	14	16	18						

Graphics





CETIS Analysis Detail

Eisenia 28-d Survival and Growth Soil Test — EnviroSystems, Inc.

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Reproduction	Comparison	17-7775-6836	17-7775-6836	11 Jul-05 9:57 AM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	1.92513	47.46723	0.60413	Equal Variances
Distribution	Shapiro-Wilk W	0.91007	0.74935	0.33283	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	435.125	435.125	1	19.09	0.00472	Significant Effect
Error	136.75	22.79167	6			
Total	571.875	457.91667	7			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13341-000		13341-011	4.36937	1.94318	0.0024	6.55973	Significant Effect

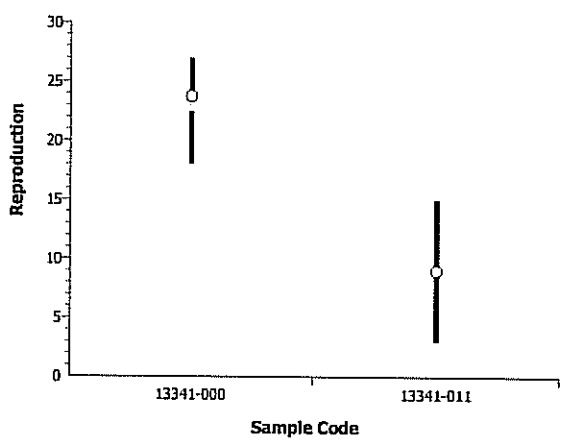
Data Summary

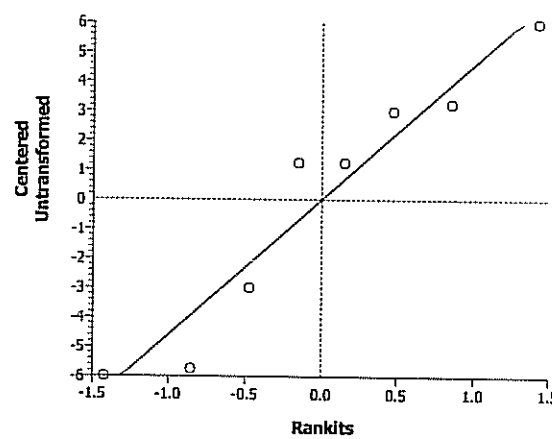
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13341-000	4	23.75	18	27	3.9476				
13341-011	4	9	3	15	5.4772				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13341-000	25	27	18	25						
13341-011	3	6	15	12						

Graphics





CETIS Test Summary

Report Date: 11 Jul-05 10:01 AM
Link: 17-7775-6836

Eisenia 28-d Survival and Growth Soil Test — **EnviroSystems, Inc.**

Test No:	08-0126-6992	**Test Type:**	Reproduction	**Duration:**	27d 22h
Start Date:	02 Jun-05 02:00 PM	**Protocol:**	EPA/600/R-92/183 (1992)	**Species:**	Eisenia fetida
Ending Date:	30 Jun-05 12:00 PM	**Dil Water:**		**Source:**	In-House Culture
Setup Date:	02 Jun-05 02:00 PM	**Brine:**	Not Applicable		

Sample No:	01-6362-5241	**Material:**	Soil	**Client:**	CH2M Hill
Sample Date:	02 Jun-05 10:00 AM	**Code:**	13341-000	**Project:**	Ecologcal Risk Assessment
Receive Date:	02 Jun-05 10:00 AM	**Source:**	Indian Head, CTO-43		
Sample Age:	4h	**Station:**	LAB CONTROL - 000		
Sample No:	01-9758-3788	**Material:**	Soil	**Client:**	CH2M Hill
Sample Date:	23 May-05 02:45 PM	**Code:**	13341-001	**Project:**	Ecologcal Risk Assessment
Receive Date:	25 May-05 10:00 AM	**Source:**	Indian Head, CTO-43		
Sample Age:	9d 23h	**Station:**	ISLBTX01 - 001		
Sample No:	06-0256-9786	**Material:**	Soil	**Client:**	CH2M Hill
Sample Date:	23 May-05 03:54 PM	**Code:**	13341-002	**Project:**	Ecologcal Risk Assessment
Receive Date:	25 May-05 10:00 AM	**Source:**	Indian Head, CTO-43		
Sample Age:	9d 22h	**Station:**	ISLBTX03 - 002		
Sample No:	05-3130-1206	**Material:**	Soil	**Client:**	CH2M Hill
Sample Date:	23 May-05 03:00 PM	**Code:**	13341-003	**Project:**	Ecologcal Risk Assessment
Receive Date:	25 May-05 10:00 AM	**Source:**	Indian Head, CTO-43		
Sample Age:	9d 23h	**Station:**	ISLCTX04 - 003		
Sample No:	08-5250-3187	**Material:**	Soil	**Client:**	CH2M Hill
Sample Date:	23 May-05 03:15 PM	**Code:**	13341-004	**Project:**	Ecologcal Risk Assessment
Receive Date:	25 May-05 10:00 AM	**Source:**	Indian Head, CTO-43		
Sample Age:	9d 22h	**Station:**	ISLCTX07 - 004		
Sample No:	06-8647-2034	**Material:**	Soil	**Client:**	CH2M Hill
Sample Date:	23 May-05 03:30 PM	**Code:**	13341-005	**Project:**	Ecologcal Risk Assessment
Receive Date:	25 May-05 10:00 AM	**Source:**	Indian Head, CTO-43		
Sample Age:	9d 22h	**Station:**	ISLCTX10 - 005		
Sample No:	11-9356-3884	**Material:**	Soil	**Client:**	CH2M Hill
Sample Date:	24 May-05 09:45 AM	**Code:**	13341-006	**Project:**	Ecologcal Risk Assessment
Receive Date:	25 May-05 10:00 AM	**Source:**	Indian Head, CTO-43		
Sample Age:	9d 4h	**Station:**	ISLCTX05 - 006		
Sample No:	06-8070-7540	**Material:**	Soil	**Client:**	CH2M Hill
Sample Date:	24 May-05 10:15 AM	**Code:**	13341-007	**Project:**	Ecologcal Risk Assessment
Receive Date:	25 May-05 10:00 AM	**Source:**	Indian Head, CTO-43		
Sample Age:	9d 3h	**Station:**	ISLCTX08 - 007		
Sample No:	11-6046-3923	**Material:**	Soil	**Client:**	CH2M Hill
Sample Date:	24 May-05 10:45 AM	**Code:**	13341-008	**Project:**	Ecologcal Risk Assessment
Receive Date:	25 May-05 10:00 AM	**Source:**	Indian Head, CTO-43		
Sample Age:	9d 3h	**Station:**	ISLCTX06 - 008		
Sample No:	14-9612-7906	**Material:**	Soil	**Client:**	CH2M Hill
Sample Date:	24 May-05 11:00 AM	**Code:**	13341-009	**Project:**	Ecologcal Risk Assessment
Receive Date:	25 May-05 10:00 AM	**Source:**	Indian Head, CTO-43		
Sample Age:	9d 3h	**Station:**	ISLCTX02 - 009		
Sample No:	03-8621-6496	**Material:**	Soil	**Client:**	CH2M Hill
Sample Date:	24 May-05 10:30 AM	**Code:**	13341-010	**Project:**	Ecologcal Risk Assessment
Receive Date:	25 May-05 10:00 AM	**Source:**	Indian Head, CTO-43		
Sample Age:	9d 3h	**Station:**	ISLCTX11 - 010		

CETIS Test Summary

Report Date: 11 Jul-05 10:01 AM
Link: 17-7775-6836

Sample No:	13-7719-7724	**Material:**	Soil	**Client:**	CH2M Hill
Sample Date:	24 May-05 11:15 AM	**Code:**	13341-011	**Project:**	Ecologcal Risk Assessment
Receive Date:	25 May-05 10:00 AM	**Source:**	Indian Head, CTO-43		
Sample Age:	9d 2h	**Station:**	ISLCTX09 - 011		

Sample No:	04-7729-9498	**Material:**	Soil	**Client:**	CH2M Hill
Sample Date:	24 May-05 01:00 PM	**Code:**	13341-012	**Project:**	Ecologcal Risk Assessment
Receive Date:	25 May-05 10:00 AM	**Source:**	Indian Head, CTO-43		
Sample Age:	9d 1h	**Station:**	ISLCTXREF1 - 012		

Reproduction Summary

Sample Code	Reps	Mean	Minimum	Maximum	SE	SD	CV
13341-000	4	23.75	18	27	1.9738	3.9476	16.62%
13341-012	4	8.25	3	13	2.0565	4.113	49.85%
13341-001	4	0.75	0	2	0.4787	0.9574	127.66
13341-002	4	2.75	0	4	0.9465	1.893	68.84%
13341-003	4	9.5	7	14	1.5546	3.1091	32.73%
13341-004	4	2	0	4	0.9129	1.8257	91.29%
13341-005	4	7.75	6	11	1.1087	2.2174	28.61%
13341-006	4	2.25	0	4	1.0308	2.0616	91.62%
13341-007	4	22.5	18	30	2.8723	5.7446	25.53%
13341-008	4	12	11	13	0.4082	0.8165	6.80%
13341-009	4	20	16	22	1.3540	2.7080	13.54%
13341-010	4	16	14	18	0.8165	1.633	10.21%
13341-011	4	9	3	15	2.7386	5.4772	60.86%

Reproduction Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4
13341-000	25	27	18	25
13341-012	13	9	8	3
13341-001	1	0	2	0
13341-002	4	3	0	4
13341-003	8	9	7	14
13341-004	1	3	4	0
13341-005	7	7	11	6
13341-006	0	1	4	4
13341-007	18	24	30	18
13341-008	12	13	11	12
13341-009	22	21	21	16
13341-010	16	14	16	18
13341-011	3	6	15	12

CETIS Analysis Detail

Eisenia 28-d Survival and Growth Soil Test — EnviroSystems, Inc.

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Reproduction	Comparison	17-7775-6836	17-7775-6836	11 Jul-05 9:57 AM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	18.45455	47.46723	0.03895	Equal Variances
Distribution	Shapiro-Wilk W	0.90917	0.74935	0.32718	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	112.5	112.5	1	12.62	0.01204	Significant Effect
Error	53.5	8.916667	6			
Total	166	121.41667	7			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13341-012		13341-001	3.55202	1.94318	0.0060	4.10298	Significant Effect

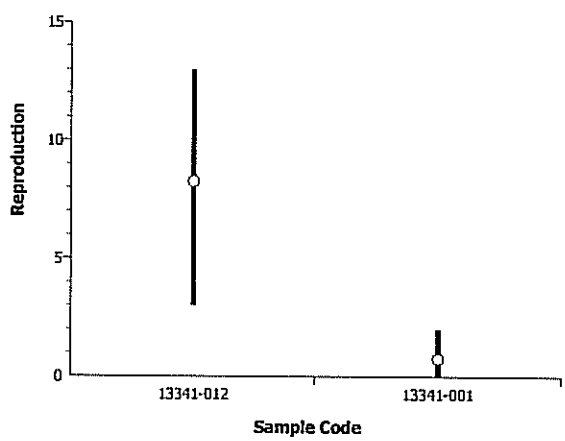
Data Summary

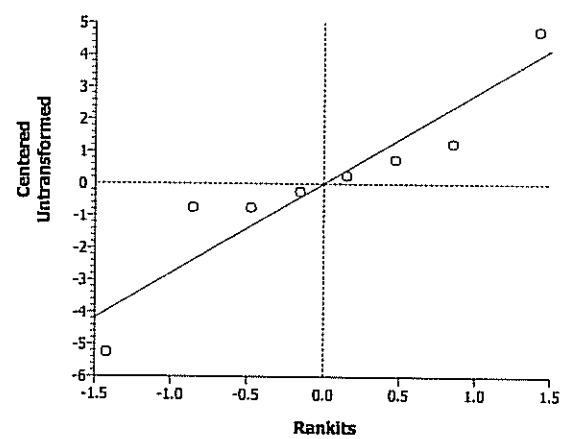
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13341-012	4	8.25	3	13	4.113				
13341-001	4	0.75	0	2	0.9574				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13341-012	13	9	8	3						
13341-001	1	0	2	0						

Graphics





CETIS Analysis Detail

Eisenia 28-d Survival and Growth Soil Test — **EnviroSystems, Inc.**

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Reproduction	Comparison	17-7775-6836	17-7775-6836	11 Jul-05 9:57 AM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	4.72093	47.46723	0.23468	Equal Variances
Distribution	Shapiro-Wilk W	0.94094	0.74935	0.58305	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	60.5	60.5	1	5.90	0.05120	Non-Significant Effect
Error	61.5	10.25	6			
Total	122	70.75	7			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13341-012		13341-002	2.42949	1.94318	0.0256	4.39906	Significant Effect

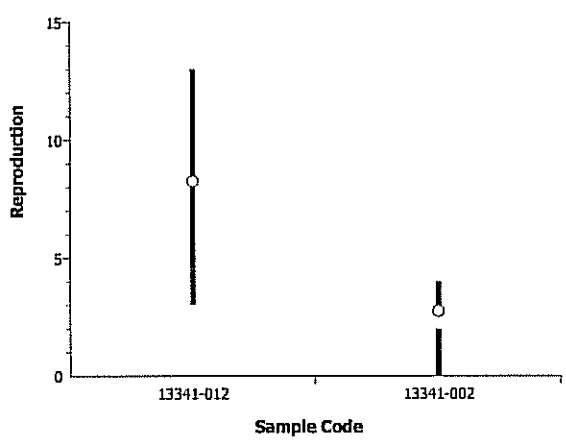
Data Summary

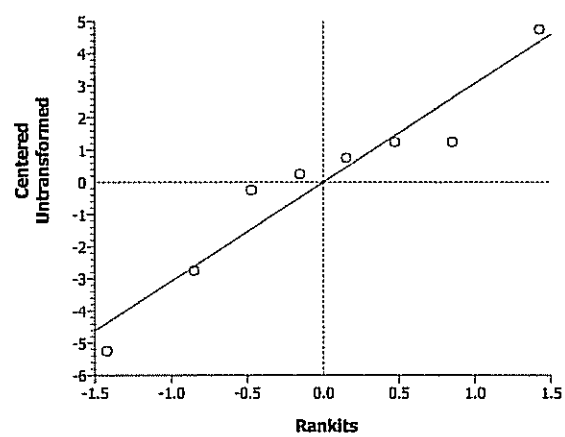
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13341-012	4	8.25	3	13	4.113				
13341-002	4	2.75	0	4	1.893				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13341-012	13	9	8	3						
13341-002	4	3	0	4						

Graphics





CETIS Analysis Detail

Eisenia 28-d Survival and Growth Soil Test — **EnviroSystems, Inc.**

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Reproduction	Comparison	17-7775-6836	17-7775-6836	11 Jul-05 9:57 AM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	1.75000	47.46723	0.65711	Equal Variances
Distribution	Shapiro-Wilk W	0.94321	0.74935	0.60551	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	3.125	3.125	1	0.24	0.64495	Non-Significant Effect
Error	79.75	13.29167	6			
Total	82.875	16.416667	7			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13341-012		13341-003	-0.4849	1.94318	0.6775	5.00942	Non-Significant Effect

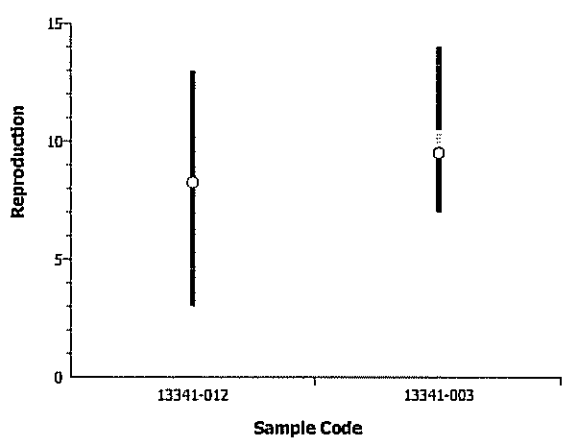
Data Summary

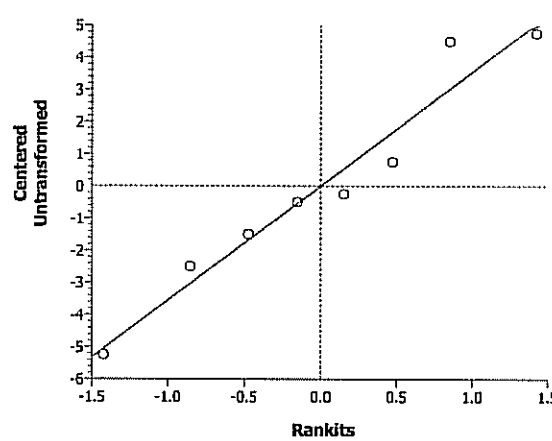
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13341-012	4	8.25	3	13	4.113				
13341-003	4	9.5	7	14	3.1091				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13341-012	13	9	8	3						
13341-003	8	9	7	14						

Graphics





CETIS Analysis Detail

Eisenia 28-d Survival and Growth Soil Test — EnviroSystems, Inc.

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Reproduction	Comparison	17-7775-6836	17-7775-6836	11 Jul-05 9:57 AM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	5.07500	47.46723	0.21521	Equal Variances
Distribution	Shapiro-Wilk W	0.98163	0.74935	0.96899	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	78.125	78.125	1	7.72	0.03209	Significant Effect
Error	60.75	10.125	6			
Total	138.875	88.25	7			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13341-012		13341-004	2.77778	1.94318	0.0160	4.37216	Significant Effect

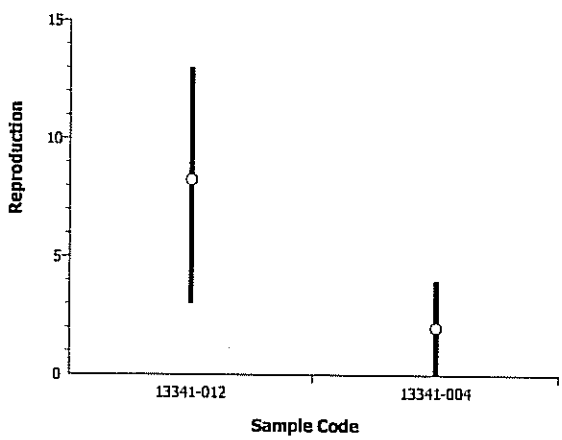
Data Summary

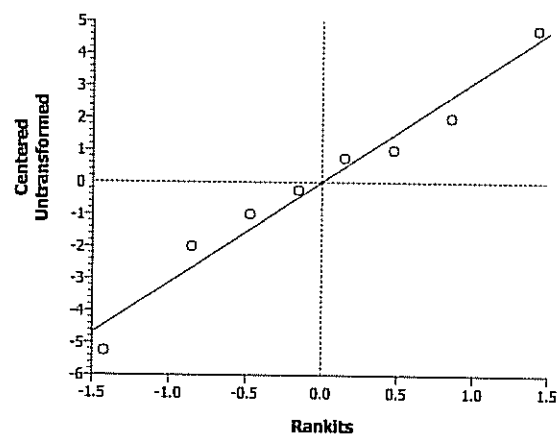
Sample Code	Count	Original Data Mean	Minimum	Maximum	SD	Transformed Data Mean	Minimum	Maximum	SD
13341-012	4	8.25	3	13	4.113				
13341-004	4	2	0	4	1.8257				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13341-012	13	9	8	3						
13341-004	1	3	4	0						

Graphics





CETIS Analysis Detail

Eisenia 28-d Survival and Growth Soil Test — **EnviroSystems, Inc.**

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Reproduction	Comparison	17-7775-6836	17-7775-6836	11 Jul-05 9:57 AM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	3.44068	47.46723	0.33724	Equal Variances
Distribution	Shapiro-Wilk W	0.95850	0.74935	0.76550	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.5	0.5	1	0.05	0.83762	Non-Significant Effect
Error	65.5	10.91667	6			
Total	66	11.416667	7			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13341-012		13341-005	0.21401	1.94318	0.4188	4.53987	Non-Significant Effect

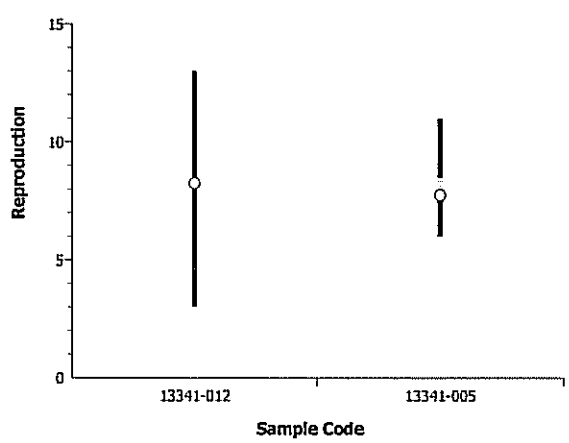
Data Summary

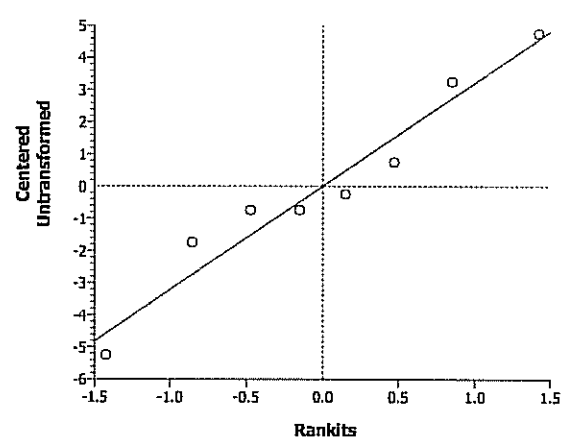
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13341-012	4	8.25	3	13	4.113				
13341-005	4	7.75	6	11	2.2174				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13341-012	13	9	8	3						
13341-005	7	7	11	6						

Graphics





CETIS Analysis Detail

Eisenia 28-d Survival and Growth Soil Test — EnviroSystems, Inc.

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Reproduction	Comparison	17-7775-6836	17-7775-6836	11 Jul-05 9:58 AM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	3.98039	47.46723	0.28636	Equal Variances
Distribution	Shapiro-Wilk W	0.98199	0.74935	0.97085	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	72	72	1	6.80	0.04021	Significant Effect
Error	63.5	10.58333	6			
Total	135.5	82.583333	7			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13341-012		13341-006	2.60829	1.94318	0.0201	4.47002	Significant Effect

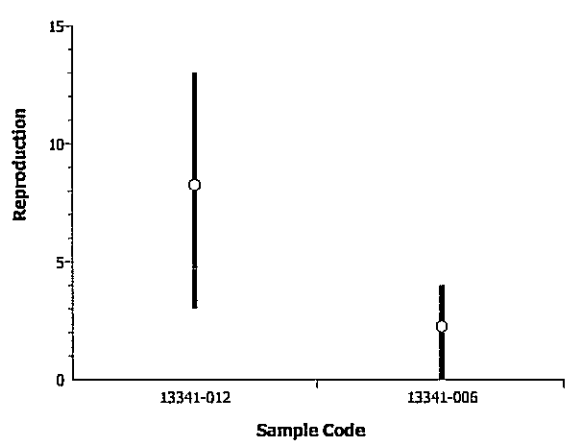
Data Summary

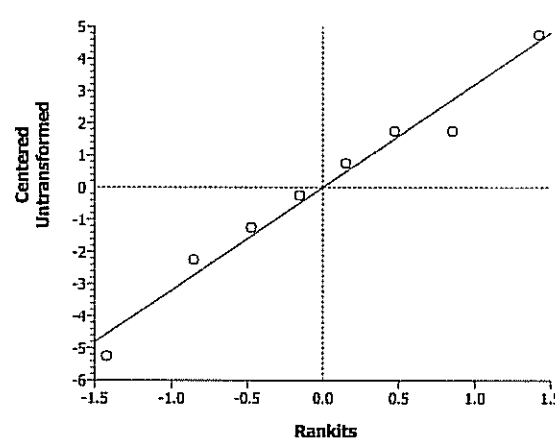
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13341-012	4	8.25	3	13	4.113				
13341-006	4	2.25	0	4	2.0616				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13341-012	13	9	8	3						
13341-006	0	1	4	4						

Graphics





CETIS Analysis Detail

Eisenia 28-d Survival and Growth Soil Test — EnviroSystems, Inc.

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Reproduction	Comparison	17-7775-6836	17-7775-6836	11 Jul-05 9:58 AM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	1.95074	47.46723	0.59697	Equal Variances
Distribution	Shapiro-Wilk W	0.92115	0.74935	0.41020	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	406.125	406.125	1	16.27	0.00685	Significant Effect
Error	149.75	24.95833	6			
Total	555.875	431.08333	7			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13341-012		13341-007	-4.0339	1.94318	0.9966	6.86445	Non-Significant Effect

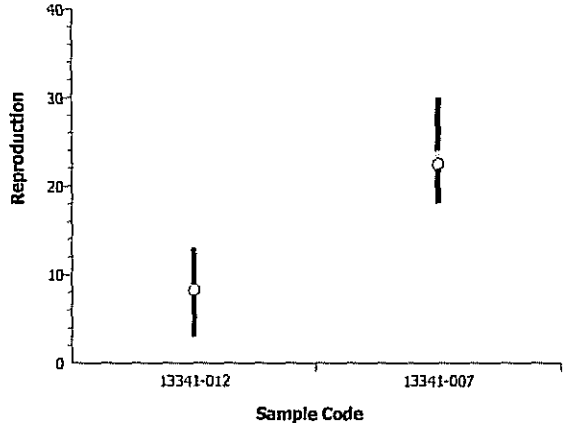
Data Summary

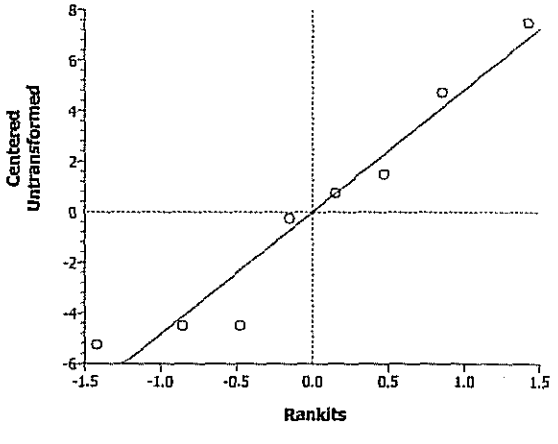
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13341-012	4	8.25	3	13	4.113				
13341-007	4	22.5	18	30	5.7446				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13341-012	13	9	8	3						
13341-007	18	24	30	18						

Graphics





CETIS Analysis Detail

Eisenia 28-d Survival and Growth Soil Test — EnviroSystems, Inc.

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Reproduction	Comparison	17-7775-6836	17-7775-6836	11 Jul-05 9:58 AM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	25.37500	47.46723	0.02478	Equal Variances
Distribution	Shapiro-Wilk W	0.89189	0.74935	0.23339	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	28.125	28.125	1	3.20	0.12389	Non-Significant Effect
Error	52.75	8.791667	6			
Total	80.875	36.916667	7			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13341-012		13341-008	-1.7886	1.94318	0.9381	4.07412	Non-Significant Effect

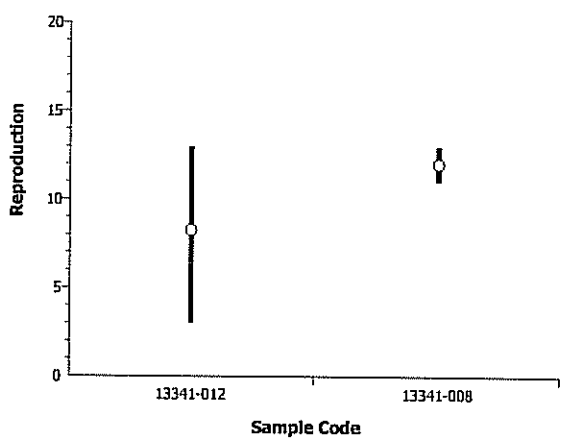
Data Summary

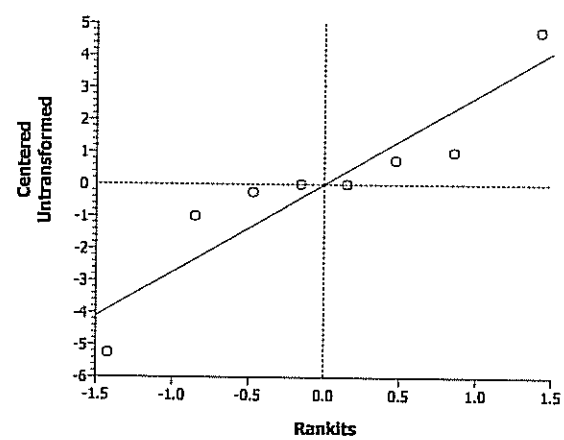
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13341-012	4	8.25	3	13	4.113				
13341-008	4	12	11	13	0.8165				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13341-012	13	9	8	3						
13341-008	12	13	11	12						

Graphics





CETIS Analysis Detail

Eisenia 28-d Survival and Growth Soil Test — EnviroSystems, Inc.

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Reproduction	Comparison	17-7775-6836	17-7775-6836	11 Jul-05 9:58 AM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	2.30682	47.46723	0.51025	Equal Variances
Distribution	Shapiro-Wilk W	0.92028	0.74935	0.40357	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	276.125	276.125	1	22.77	0.00309	Significant Effect
Error	72.75	12.125	6			
Total	348.875	288.25	7			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13341-012		13341-009	-4.7721	1.94318	0.9985	4.78453	Non-Significant Effect

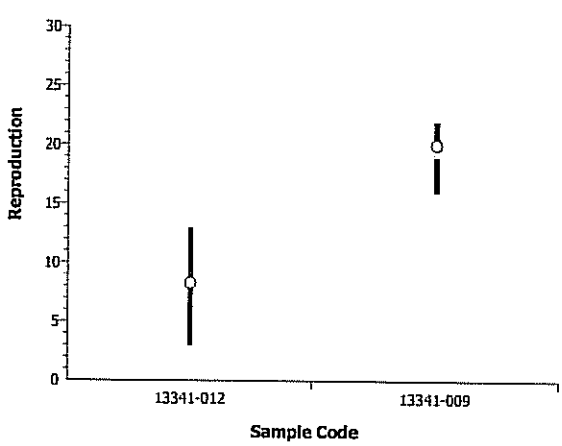
Data Summary

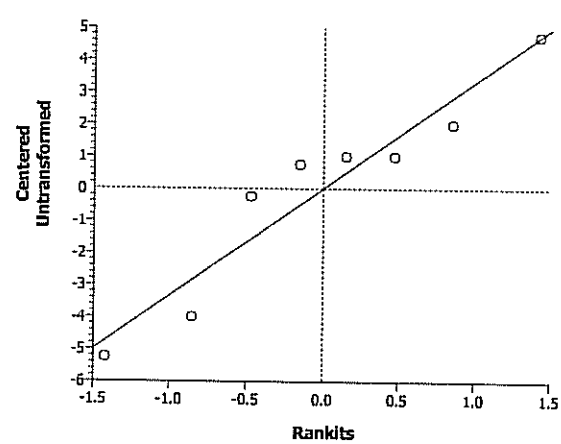
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13341-012	4	8.25	3	13	4.113				
13341-009	4	20	16	22	2.7080				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13341-012	13	9	8	3						
13341-009	22	21	21	16						

Graphics





CETIS Analysis Detail

Eisenia 28-d Survival and Growth Soil Test — EnviroSystems, Inc.

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Reproduction	Comparison	17-7775-6836	17-7775-6836	11 Jul-05 9:58 AM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	6.34375	47.46723	0.16346	Equal Variances
Distribution	Shapiro-Wilk W	0.95538	0.74935	0.73227	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	120.125	120.125	1	12.27	0.01279	Significant Effect
Error	58.75	9.791667	6			
Total	178.875	129.91667	7			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13341-012		13341-010	-3.5026	1.94318	0.9936	4.29958	Non-Significant Effect

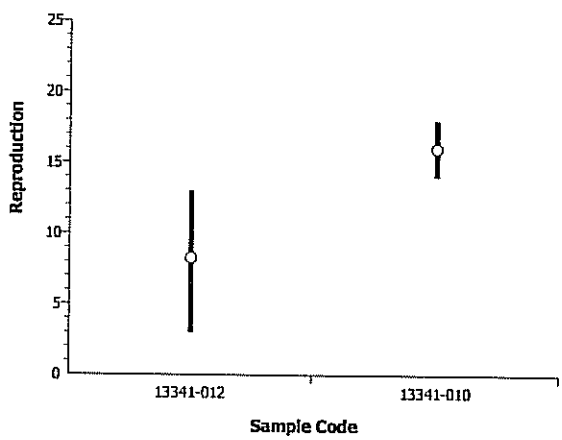
Data Summary

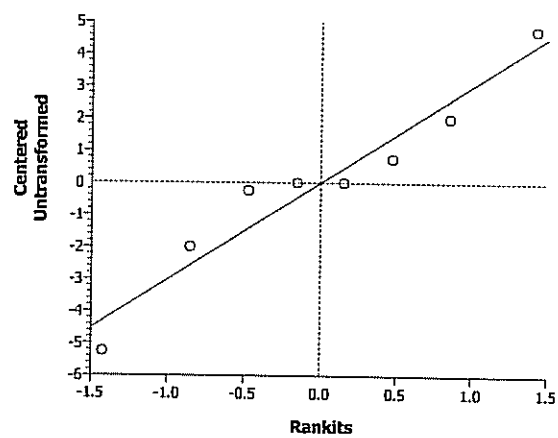
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13341-012	4	8.25	3	13	4.113				
13341-010	4	16	14	18	1.633				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13341-012	13	9	8	3						
13341-010	16	14	16	18						

Graphics





CETIS Analysis Detail

Eisenia 28-d Survival and Growth Soil Test — EnviroSystems, Inc.

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Reproduction	Comparison	17-7775-6836	17-7775-6836	11 Jul-05 9:58 AM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	1.77340	47.46723	0.64960	Equal Variances
Distribution	Shapiro-Wilk W	0.94424	0.74935	0.61587	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	1.125	1.125	1	0.05	0.83392	Non-Significant Effect
Error	140.75	23.45833	6			
Total	141.875	24.583334	7			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13341-012		13341-011	-0.219	1.94318	0.5830	6.65498	Non-Significant Effect

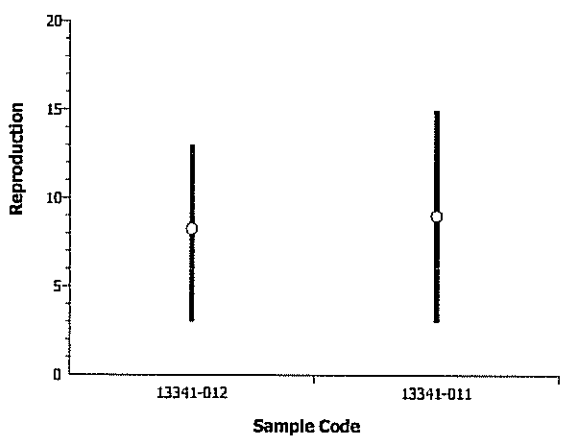
Data Summary

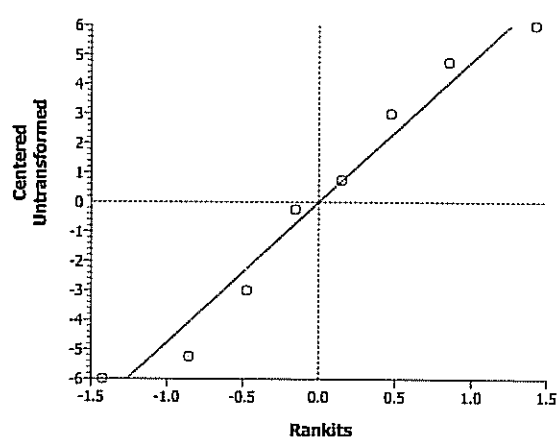
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13341-012	4	8.25	3	13	4.113				
13341-011	4	9	3	15	5.4772				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13341-012	13	9	8	3						
13341-011	3	6	15	12						

Graphics





SOIL pH

STUDY NUMBER: 13341 **CLIENT:** CH2M Hill

	As Received pH	Adjusted pH
Sample ID	pH (SU)	pH (SU)
Control		N/A
-001	6.02	
-002	5.71	
-003	6.39	
-004	6.36	
-005	6.41	
-006	7.29	
-007	6.92	
-008	6.31	
-009	6.79	
-010	6.89	
-011	6.20	
-012	4.94	
RECORDED BY:	BB	
DATE:	5/31/05	

NOTES: pH meter used:

PERCENT MOISTURE & LOSS ON IGNITION DATA

CLIENT: CH2M Hill

ESI STUDY NUMBER: 13341

ESI Sample ID	Beaker ID	Beaker Weight (g)	Weight Beaker + Wet Soil (g)	Weight Beaker + Dry Soil (g)		Crucible ID	Crucible Wt. (g)	Crucible + Pre Ignition Wt. (g)	Crucible + Post Ignition Wt. (g)
Blank	2	30.1665	40.5569	40.5573		41G	27.8452	38.2329	38.2327
Control	48	29.4307	37.5729	35.1389		80 8	29.4873	35.1728	34.6870
-001	440	28.3655	37.9572	~~37~~ 36.0817		86	27.7926	35.5204	35.2441
-002	7	29.2145	39.7414	38.0769		8F	27.8137	36.5905	36.3290
-003	501	30.8901	41.5546	39.7094		2C	29.8772	38.7042	38.3347
-004	500	29.5709	38.9351	37.0259		CC	32.8111	40.2732	39.7073
-005	49	29.5784	40.7861	~~40~~ 37.9337		7	27.6627	36.~~4364~~ 0284	35.5963
-006	42	29.6363	39.2622	37.3821		8	28.8731	36.5911	36.4011
-007	5E	29.0243	40.7274	38.4544		2D	26.7992	36.2428	35.7682
-008	1D	28.8989	38.6679	36.5869		9F	30.4852	38.1781	37.8403
-009	50	29.4852	39.7101	37.8104		8E	29.1762	37.5128	37.0459
-010	15	28.5203	40.0604	37.6871		CA	27.1424	36.3222	35.7831
-011	E	28.8654	38.5507	36.8395		8A	28.1702	36.1541	35.8187
-012	3D	28.9863	41.5531	37.9684		8C	29.0181	37.9999	37.4652
-012dup	11	28.3151	40.2593	36.7835		9G	29.9408	38.4140	37.8819
Blank	22	29.5997	41.0440	41.0450		9D	29.9224	41.3528	41.3511
—	~~106~~	~~28.7056~~	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
Date & Initials	5/26/05 BB	5/26/05 BB	5/26/05 BB	5/31/05 BB		5/31/05 BB	5/31/05 BB	5/31/05 BB	6/2/05 BB

COMMENTS: _____

ESI#: 13341
Client: CH2M Hill
Date: 05/31/05

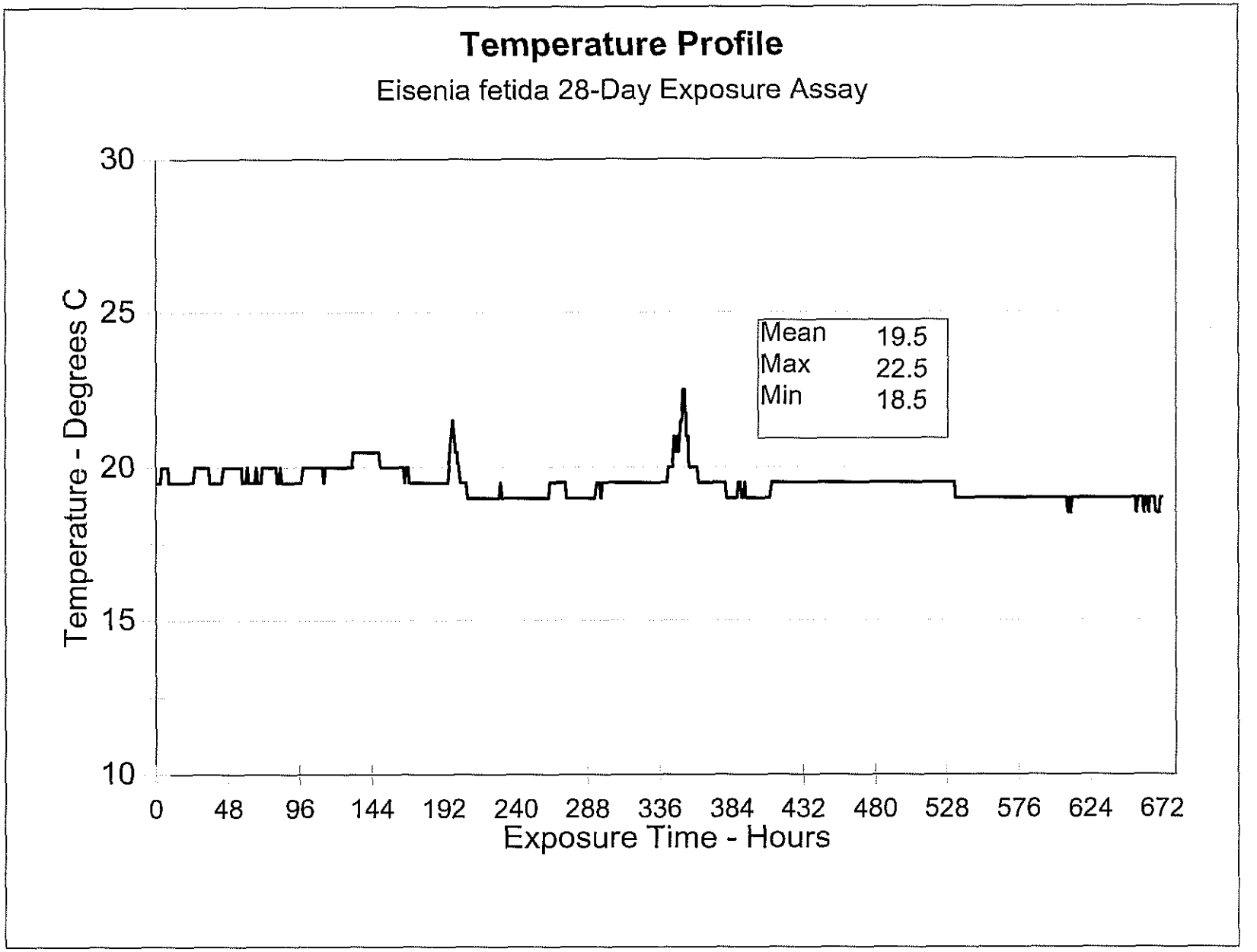
Sample ID	Crucible ID	Crucible Wt(g)	Crucible + Pre Ignition Wt (g)	Crucible + Post Ignition Wt (g)	Total LOI %
Blank	41G	27.8452	38.2329	38.2327	0.0
Control	808	29.4873	35.1728	34.6870	8.5
001	86	27.7926	35.5204	35.2441	3.6
002	8F	27.8137	36.5905	36.3290	3.0
003	2c	29.8772	38.7042	38.3347	4.2
004	cc	32.8111	40.2732	39.7073	7.6
005	7	27.6627	36.0108	35.5963	5.0
006	8	28.8731	36.5911	36.4011	2.5
007	2d	26.7992	36.2428	35.7682	5.0
008	9f	30.4852	38.1781	37.8403	4.4
009	8e	29.1762	37.5128	37.0459	5.6
010	ca	27.1424	36.3222	35.7831	5.9
011	8a	28.1702	36.1541	35.8187	4.2
012	8c	29.0181	37.9999	37.4652	6.0
012dup	9g	29.9408	38.4140	37.8819	6.3
Blank	9d	29.9224	41.3528	41.3511	0.0

PERCENT MOISTURE DETERMINATIONS

CLIENT: CH2M Hill **ESI STUDY NUMBER:** 13341

DATE: 05/26/05

ESI Sample ID	Beaker ID	Beaker Weight (g)	Weight Beaker + Wet Soil	(A) Soil Wet Weight (g)	Dry Wt. #1 (g)	Dry Wt. #2 (g)	Mean Dry Weight w/Beaker	(B) Soil Dry Weight (g)	% Moisture
Blank	2	30.1665	40.5569	10.3904	40.5573		40.5573	10.3908	-0.0%
Control	48	29.4307	37.5729	8.1422	35.1389		35.1389	5.7082	29.9%
001	440	28.3655	37.9572	9.5917	36.0817		36.0817	7.7162	19.6%
002	7	29.2145	39.7414	10.5269	38.0769		38.0769	8.8624	15.8%
003	501	30.8901	41.5546	10.6645	39.7094		39.7094	8.8193	17.3%
004	500	29.5709	38.9351	9.3642	37.0259		37.0259	7.4550	20.4%
005	49	29.5784	40.7861	11.2077	37.9337		37.9337	8.3553	25.5%
006	42	29.6363	39.2622	9.6259	37.3821		37.3821	7.7458	19.5%
007	5E	29.0243	40.7274	11.7031	38.4544		38.4544	9.4301	19.4%
008	1D	28.8989	38.6679	9.7690	36.5869		36.5869	7.6880	21.3%
009	50	29.4852	39.7101	10.2249	37.8104		37.8104	8.3252	18.6%
010	15	28.5203	40.0604	11.5401	37.6871		37.6871	9.1668	20.6%
011	E	28.8654	38.5507	9.6853	36.8395		36.8395	7.9741	17.7%
012	3D	28.9863	41.5531	12.5668	37.9684		37.9684	8.9821	28.5%
012 dup	11	28.3151	40.2593	11.9442	36.7835		36.7835	8.4684	29.1%
Blank	22	29.5997	41.0440	11.4443	41.0450		41.045	11.4453	-0.0%


Temperature Profile
Eisenia fetida 28-Day Exposure Assay
Temperature - Degrees C
30
25
20
15
10
Mean 19.5
Max 22.5
Min 18.5
0
48
96
144
192
240
288
336
384
432
480
528
576
624
672
Exposure Time - Hours

EnviroSystems, Incorporated
Organism Culture Record

Client and ESI Study Number: CH2M Hill # 13341

Assay: 28-day Exposure

I. Organism History

Species Eisenia fetida

Source Lab Reared X Hatchery Reared – Field Collected –

Hatch Date NA Receipt Date NA Age NA

Lot Number EFB1032205 Strain –

Brood Origin Happy D Ranch

II. Culture Conditions

System Static

Diet Flake Food ____ Phytoplankton ____ Trout Chow ____

Brine Shrimp ____ Rotiers ____ Corn Meal X

Milk Solids X Other ____ Other ____

Prophylactic Treatments ____

Comments ____

III. Water Quality

Temperature 21°C °C Salinity NA ppt DO_2 NA mg/L

pH ____ SU Hardness NA mg/L Alkalinity NA mg/L

Other ____

IV. Comments

Mature organisms, all with well developed clitellum.

Culture media: Peat moss, orchid compost, fine sand. Moisture content ≈ 75%.

Biologist [signature] Date 06/02/05

LABORATORY SAMPLE RECEIVING LOG

ESI Project Number: 13341 Date/Time Received: 5/25/05

Client Name and Address: CH2M Hill Antoine Barthobmew
13921 Park Center Road Herndon VA 20171 (703)471-1441

Method of Shipment/ Pick Up: From: Client

Via: Fed Ex

Description of Shipping / Packing Containers(s) 3 coolers
(Number, Type, Size)

Sample ID	ESI #	# Containers/Vol/Wt	Other	Sampled
ISLBTX01	-001	1x1g	E.f. 28Dy	5/23/05
ISLBTX03	-002			
ISLBTX04	-003			
ISLBTX07	-004			
ISLBTX10	-005			
ISLBTX05	-006			5/24/05
ISLBTX08	-007			
ISLBTX06	-008			
ISLBTX02	-009			
ISLBTX11	-010			
ISLBTX09	-011			
ISLBTXREF1	-012			

Sample Storage Location and Required Storage Conditions Refrigerator "F" Locked, 4°C & Dark

Signature: [signature] Date: 5/25/05

Notes: Samples Rec'd on ice 4°C

Date and Description of Final Sample Removal / Disposal:

№ 009478

Page 1 of 2

~~CompuChem~~ ESI #13341
a division of Liberty Analytical Corp.

CHAIN OF CUSTODY

501 Madison Ave.
Cary, NC 27513
Phone: 919-379-4100 Fax 919-379-4040

Courier FedEx
Airbill No.
Sampling Complete? Y or N

Client/Reporting Information	Project Information
Company Name: CH2M HILL	Project Name: Indian Head CTO-43
Address: 13921 Park Center Rd	Sampling Location: Indian Head, MD
City: Herndon State: VA Zip: 20171	Turnaround time: 28-day
Project Contact: ~~Lindsey Carr~~ Antoine Bartholomew	Batch QC or Project Specific? If Specific, which Sample ID?
Phone #: 703-471-6405	Are aqueous samples field filtered for metals? Y or N
Sampler's Name: Lindsey Carr	Are high concentrations expected? Y or N? If yes, which ID(s)?

Requested Analysis (include method and bottle type): BIOCRSAM (28-day)

Matrices: GW - Ground water; WW - Waste water; SW - Surface water; SO - Soil/Sediment; TB - Trip Blank; RI - Rinsate; WP - Wipe; O - Other

CompuChem No (Lab Use)	Field ID	Collection Date	Collection Time	Matrix	# of bottles	HCl	NaOH	HNO3	H2SO4	MEOH	Other	BIOCRSAM (28-day)	pH / Sample Info (Lab Use)
-001	ISLBTX01	5-23-05	1445	soil	1							✓	
-002	ISLBTX03	5-23-05	1545	soil	1							✓	
-003	ISLBTX04	5-23-05	1500	soil	1							✓	
-004	ISLBTX07	5-23-05	1515	soil	1							✓	
-005	ISLBTX10	5-23-05	1530	soil	1							✓	
-006	ISLBTX05	5/24/05	0945	soil	1							✓	
-007	ISLBTX08	5/24/05	1015	soil	1							✓	
-008	ISLBTX06	5/24/05	1045	soil	1							✓	
-009	ISLBTX02	5/24/05	1100	soil	1							✓	
-010	ISLBTX11	5/24/05	1030	soil	1							✓	

Lab Use Only

Sample Unpacked By:
Sample Order Entry By:
Samples Received in Good Condition? Y or N
If no, explain:

Cyanide samples checked for sulfide & chlorine? Y or NA
625 & Phenol samples checked for chlorine? Y or NA
608 samples checked for pH between 5.0-9.0? Y or NA

Comments

Sample Custody

Relinquished by: Lindsey Carr	Date/Time: 5/24/05 1800	Received by:	Date/Time: 5/25/05 1000
Relinquished by:	Date/Time:	Received by:	Date/Time:

Subcontact? Y or N If yes, where?
Custody Seal(s) intact? Y or N
On Ice? Y or N
Cooler Temp: 4 °C

Samples stored 60 days after date report mailed at no extra charge.

White & Yellow copy to lab • Pink copy for customer

№ 009480

Page 2 of 2

~~CompuChem~~ ESI #13341

a division of Liberty Analytical Corp.

CHAIN OF CUSTODY

~~501 Madison Ave.~~
~~Cary, NC 27513~~
~~Phone: 919-379-4100 Fax 919-379-4040~~

Courier: Fed Ex
Airbill No.
Sampling Complete? (Y) or N

Client/Reporting Information

Company Name: CH2M Hill
Address: 13921 Park Center Rd
City: Herndon State: VA Zip: 20171
Project Contact: Antoine Bartholomew
Phone #: (703) 471-1441
Sampler's Name: Lindsey Carr

Project Information

Project Name: Indian Head CTO-43
Sampling Location: Indian Head, MD
Turnaround time: 28-day
Batch QC or Project Specific? If Specific, which Sample ID?
Are aqueous samples field filtered for metals? Y or N
Are high concentrations expected? Y or N? If yes, which ID(s)?

Requested Analysis (include method and bottle type): Bioassay (28 day E. fetida)

Matrices: GW - Ground water; WW - Waste water; SW - Surface water; SO - Soil/Sediment; TB - Trip Blank; RI - Rinsate; WP - Wipe; O - Other

CompuChem No (Lab Use)	Field ID	Collection Date	Collection Time	Matrix	# of bottles	HCl	NaOH	HNO3	H2SO4	MEOH	Other	Bioassay (28 day E. fetida)	pH / Sample Info (Lab Use)
-011	ISLBTX09	5/24/05	1115	Soil	1							✓	
-012	ISLBTXREF1	5/24/05	1300	Soil	1							✓	

Lab Use Only

Sample Unpacked By:
Sample Order Entry By:
Samples Received in Good Condition? Y or N
If no, explain:
Cyanide samples checked for sulfide & chlorine? Y or NA
625 & Phenol samples checked for chlorine? Y or NA
608 samples checked for pH between 5.0-9.0? Y or NA

Comments

Sample Custody

Relinquished by: Lindsey Carr — Date/Time: 5/24/05 1800 — Received by: [signature] — Date/Time: 5/25/05 1000
Relinquished by: — Date/Time: — Received by: — Date/Time:
Subcontact? Y or N If yes, where? — Custody Seal(s) intact? (Y) or N — On Ice? (Y) or N — Cooler Temp: 4 °C

Samples stored 60 days after date report mailed at no extra charge.

White & Yellow copy to lab • Pink copy for customer

Appendix D
Food Web Exposure Model and Ingestion Screening Value

Food Web Exposure Model

American robin and white-footed mouse exposures (via the food web) to lead, mercury, and zinc were determined using uptake and food web models with measured earthworm tissue concentrations and estimated concentrations in terrestrial plants. Incidental ingestion of soil was not included when calculating the total level of exposure because the earthworms were not depurated prior to tissue analyses, and thus the soil in the earthworm gut was assumed to represent the bulk of soil ingested. Ingestion of drinking water was also not included because this was not a complete exposure pathway evaluated in the BERA.

Earthworm tissue concentrations were reported in wet weight and were converted to the dry weight for the food web exposure model using a moisture content of 84% for earthworm tissue (USEPA 1993). Because earthworms were not depurated prior to tissue analysis, the conversion to dry weight also included a moisture content of 13% for soil in the gut (average of 10 samples plus duplicate) and an assumption that 1/3 of the wet weight of an earthworm is comprised of soil in the gut (USEPA 1993). Tissue concentrations of methyl mercury were used in the food web models rather than total mercury.

Tissue concentrations in the above-ground vegetative portion of terrestrial plants were estimated by multiplying the average measured surface soil concentration for each metal by soil-to-plant BCFs obtained from Bechtel Jacobs (1998). The BCF values were based on root uptake from soil and were the geometric mean values of the ratio between dry-weight soil and dry-weight plant tissue. Tissue concentrations of mercury were based on total mercury concentrations in soil rather than methyl mercury consistent with the derivation of the BCF in the Bechtel Jacobs (1998) study. Terrestrial plant BCFs are listed in Table D-1.

Table D-1
Soil Bioconcentration Factors for Terrestrial Plants - Step 3

Chemical	Soil-Plant BCF (dry weight)	
	Value	Reference
Lead	0.038	Bechtel Jacobs 1998
Mercury	0.344	Bechtel Jacobs 1998
Zinc	0.358	Bechtel Jacobs 1998

Dietary intakes for each receptor species were calculated using the following formula (modified from USEPA [1993]):

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

where: DI_x = Dietary intake for chemical x (mg chemical/kg body weight/day)

FIR = Food ingestion rate (kg/day, dry weight)

FC_{xi} = Concentration of chemical x in food item i (mg/kg, dry weight)

PDF_i = Proportion of diet composed of food item i (dry weight basis)

BW = Body weight (kg, wet weight)

The exposure assumptions used in the food web model were consistent with BERA approach to provide a more realistic exposure evaluation, and included the following:

- All of the dietary items consumed by the receptor are assumed to be obtained from the site (i.e., an Area Use Factor of 1 is assumed).
- Chemicals are 100 percent bioavailable.
- Average ingestion rates are used.
- Average body weights are used. For the American robin, the average hatchling body weight from USEPA (1993) was used.

The exposure parameters used in the food web model for the American robin and white-footed mouse are shown in Table D-2.

Table D-2
Exposure Parameters for the American Robin and White-footed Mouse - Step 3

Receptor	Body Weight (kg)		Food Ingestion Rate (kg/day - dry)		Dietary Composition (percent)		
	Value	Reference	Value	Reference	Terr. Plants	Soil Invert.	Reference
American robin	0.045	USEPA 1993	0.0022	Levey and Karasov 1989	0	100	Martin et al. 1951
White-footed mouse	0.021	Silva and Downing 1995	0.0005	Sample and Suter 1994	51.0	49.0	Martin et al. 1951; Sample and Suter 1994

Ingestion Screening Values

Ingestion screening values for dietary exposures of lead, mercury, and zinc were derived for both receptors. Toxicological information from the literature for wildlife species most closely related to the receptor species was used, where available, but was also supplemented by laboratory studies of non-wildlife species (e.g., rats) where necessary. The ingestion screening values are expressed as milligrams of the chemical per kilogram body weight of the receptor per day (mg/kg-BW/day).

Sub-lethal endpoints were emphasized as assessment endpoints since they are the most relevant, ecologically, to maintaining viable populations and because they are generally the most studied chronic toxicological endpoints for ecological receptors. Sub-lethal endpoints are assumed to influence the probability of survival and/or the success of reproduction. If several chronic toxicity studies are available from the literature, the most appropriate study was selected for each receptor species based on study design, study methodology, study duration, study endpoint, and test species. Lowest Observed Adverse Effect Levels (LOAELs) based on growth and reproduction were utilized, where available, as the screening values. For lead and birds, a chronic Lowest Observed Adverse Effect Levels (LOAEL) was estimated from a NOAEL using an uncertainty factor of 5. Ingestion screening values for birds and mammals are shown in Table D-3.

Table D-3
Ingestion Screening Values for the American Robin and White-footed Mouse

Chemical	Test Organism	Body Weight (kg)	Duration	Exposure Route	Effect/Endpoint	LOAEL (mg/kg/d)	Reference
Lead	rat	0.35	3 generations	oral in diet	reproduction	80.0	Sample et al. 1996
	American kestrel	0.13	7 months	oral in diet	reproduction	19.3	Sample et al. 1996
Mercury	rat	0.35	3 generations	oral in diet	reproduction	0.16	Sample et al. 1996
	red-tailed hawk	1.10	12 weeks	oral in diet	survival/ neurological	1.20	USEPA 1995
Zinc	rat	0.35	GD 1-16	oral in diet	reproduction	320	Sample et al. 1996
	chicken	1.94	44 weeks	oral in diet	reproduction	131	Sample et al. 1996