APPENDICES

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Appendix A

Ecological Risk Assessment Work Plan

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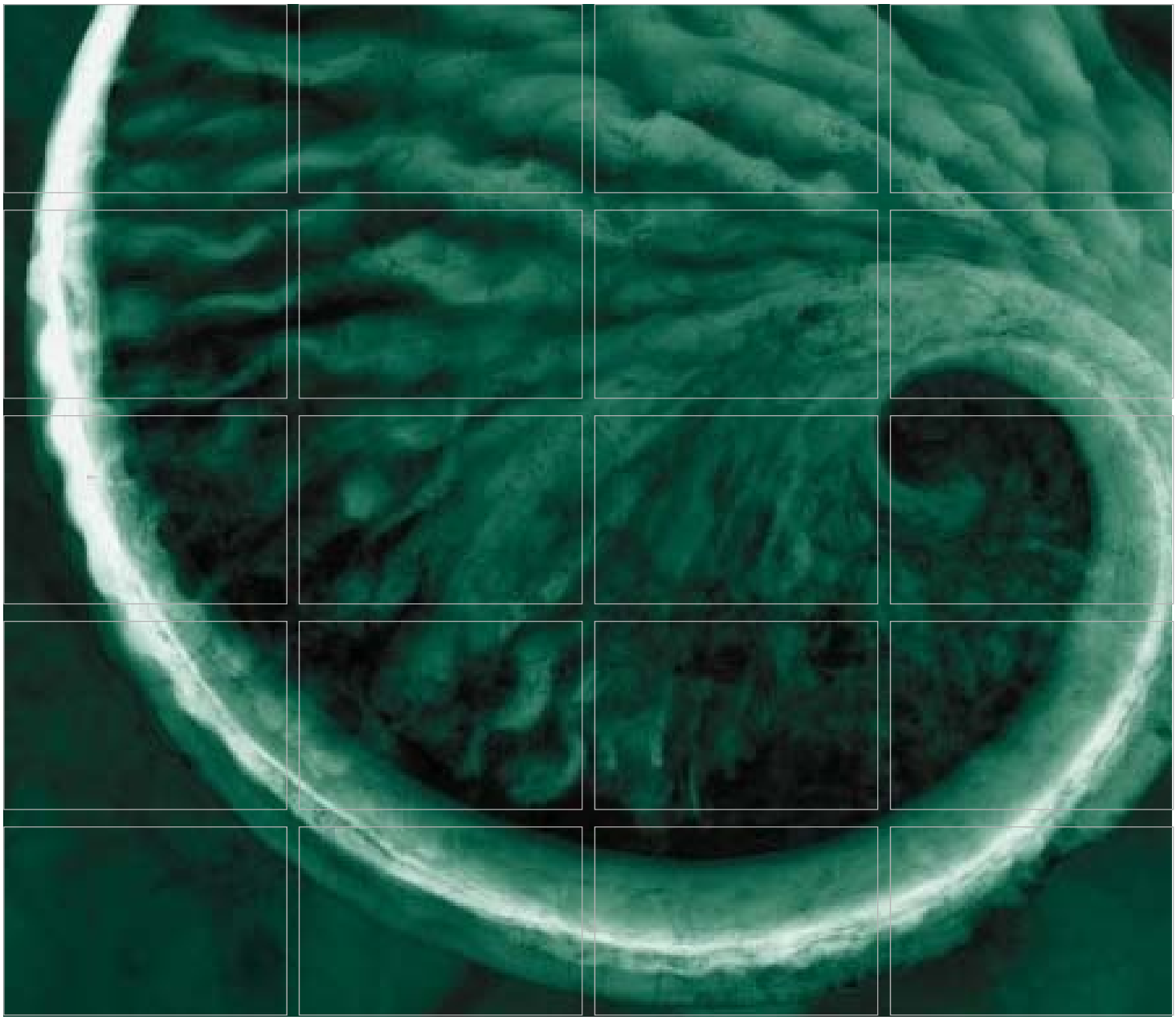

Draft Ecological Risk Assessment Work Plan

Lower Red Butte Creek
Salt Lake City, Utah

June 2012
www.erm.com

Prepared for:
Utah Department of Environmental Quality
Division of Water Quality

Department of Environmental Quality
Division of Water Quality

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June 2012

Project No. 0145323

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LIST OF ACRONYMS AND ABBREVIATIONS

95UCL	95 percent upper confidence limit
BERA	baseline ecological risk assessment
BROC	biological receptors of concern
BTEX	benzene, toluene, ethylbenzene, and xylenes
cfs	cubic feet per second
COPEC	constituent of potential ecological concern
DL/2	one half detection limit
dw	dry weight
EPC	exposure point concentration
ERA	ecological risk assessment
HHRA	human health risk assessment
HQ	hazard quotient
LC	laboratory control
LCD	laboratory control duplicate
KM	Kaplan Meier method
MS	matrix spike
MSD	matrix spike duplicate
ND	non detect
PAH	polycyclic aromatic hydrocarbons
PERA	probabilistic ecological risk assessment
QA	quality assurance
QC	quality control
ROS	regression order statistics
SAP	sampling and analysis plan
SLERA	scoping level ecological risk assessment
SMD	scientific management decision point
SOP	standard operating procedures

SVOC	semivolatile organic compounds
TOC	total organic carbon
TPH	total petroleum hydrocarbons
TRV	toxicity reference values
UCL	upper confidence limit
USEPA	United States Environmental Protection Agency
VOC	volatile organic compounds
WEF	wildlife exposure factors
WRS	Wilcoxon rank sum test

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1.0 INTRODUCTION

On 12 June 2010, approximately 800 barrels of a 33 API (= sp. gr. 0.825) crude oil was released (Incident) into Lower Red Butte Creek, Salt Lake City, Utah (CPL 2011), just downstream of the Red Butte Garden Arboretum. Immediately following the Incident (summer/fall 2010), Phase 1 of the creek cleanup was initiated. Approximately 400 barrels were recovered at the spill site on land and about 400 barrels entered Lower Red Butte Creek. As of 09 September 2010, a total of 778 of the 800 barrels are accounted for through recovery from water, soil removal, and evaporation (CPL 2011).

1.1 PURPOSE OF THE ECOLOGICAL RISK ASSESSMENT

On behalf of the Utah Department of Environmental Quality (UDEQ) Division of Water Quality, the oversight agency of the Incident, ERM has prepared this Ecological Risk Assessment work plan (ERA WP). The purpose of this ERA is to evaluate the potential for adverse ecological impacts that may occur as a result of potential exposures to residual concentrations of spill-related petroleum hydrocarbons following remediation efforts in Lower Red Butte Creek. Methods used to conduct the ERA will be consistent with State of Utah and USEPA guidance:

- Utah Administrative Code, Rule R315-101-5, Health Evaluation Criteria, Risk Assessment;[1]
- Framework for Ecological Risk Assessment (USEPA 1992a);
- Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments (USEPA 1997); and
- Guidelines for Ecological Risk Assessment (USEPA 1998).

[1] Utah Administrative Code, Rule R315-101-5, Health Evaluation Criteria, Risk Assessment specifically applies to Hazardous Waste sites. Nonetheless, where possible, this ERA will be consistent with this State rule.

Findings of this ERA[2] are intended to support evaluations/determinations of whether:

- The remediation response was sufficient to protect biota of concern;
- A more detailed ERA is warranted for this urban creek; and/or
- There is a need for and, if needed, what is the scope of additional risk management actions.

The purpose of this work plan is to describe the methods and, where relevant and available, provide exposure factors and toxicity benchmarks that will be used in the ERA.

1.2 KEY FEATURES OF THE ERA WORK PLAN

In preparing this work plan, the following features have been incorporated into the ERA:

- Where applicable, the ERA will be consistent in approach and methodology with the human health risk assessment (HHRA) that will be performed in parallel with this ERA.
- Constituents of potential ecological concern (COPECs) are petroleum hydrocarbons.
- Given the biotic receptors of concern, the ERA will evaluate the reach of Lower Red Butte Creek from the Former Lower Underflow Dam[3] to below 900 East as a single exposure area.
    - UDEQ (2005) *TPH Fractionation* guidance was used to evaluate total petroleum hydrocarbons (TPH). UDEQ's fractionation guidance builds on approaches previously described by the Total Petroleum Hydrocarbon Criteria Working Group (TPHCWG) and the Massachusetts Department of Environmental Protection (MaDEP). Where UDEQ TPH benchmarks were lacking, MaDEP benchmarks[4] were used to evaluate potential risks due to exposures to petroleum hydrocarbons—specifically, to aliphatic and aromatic carbon-chain fractions.

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[2] The findings of the Reference Creek (Ambient) Evaluation (McDaniel-Lambert 2012) were used to determine whether the source of the hydrocarbons detected in Lower Red Butte Creek were related to the Incident.

[3] Sampling location at the spill site

[4] MaDEP (2002, 2007)

- Reference creeks were identified to characterize ambient conditions of urban creeks not impacted by the Incident and were established to correctly identify concentrations and biological responses attributable to the Incident. Reference creeks identified in the *Red Butte Creek Crude Oil Spill Water, Sediment and Macroinvertebrate Sampling Plan,* v. 17 (CPL 2011) and used in this ERA are Emigration Creek, Parleys Creek, City Creek, and Mill Creek.[5]
- In-creek benthic community structure will be evaluated as an added line of evidence to characterize the ecological significance of any identified ecological risks.

[5] Like Red Butte Creek, these reference creeks have lengthy wild land reaches in the Wasatch front range, and then flow through residential/urban reaches before entering the Jordan River. Emigration Creek, Parleys Creek, City Creek, and Mill Creek were not affected by the Incident and are considered to be representative of urban creeks in the Salt Lake City area (CPL 2011).

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2.0 SITE DESCRIPTION

Descriptions of Lower Red Butte Creek were primarily obtained from:

- Salt Lake City Riparian Corridor Study: Final Red Butte Creek Management Plan (Bio-West 2010);
- Red Butte Creek Crude Oil Spill Water, Sediment and Macroinvertebrate Sampling Plan (CPL 2011); and
- Department of Wildlife Resources documents.[6]

This site description is provided to give a general sense of Lower Red Butte Creek. It is not intended to be a treatise on the abiotic/biotic features of Lower Red Butte Creek.

Red Butte Creek is a narrow rocky creek located between City Creek to the north and Emigration Creek to the south (CPL 2011; Bio-West 2010) (Figure 2-1). For the purposes of the ERA and consistent with the Red Butte Creek Management Plan (Bio-West 2010), Red Butte Creek has been divided into Upper Red Butte Creek (upstream of Red Butte Gardens) and Lower Red Butte Creek (downstream of Red Butte Gardens). Upper Red Butte Creek drains approximately 5,400 acres of mountainous land primarily owned and managed by the U.S. Forest Service (USFS). Red Butte Reservoir and the Red Butte Creek Research Natural Area are located in Upper Red Butte Creek.

Lower Red Butte Creek passes through an urban area where multiple point and nonpoint sources of chemicals likely input to the creek. The open channel portion of Lower Red Butte Creek terminates at approximately 900 East where the creek enters a series of culverts that discharge to Liberty Lake at Liberty Park. The 1300 South conduit then conveys the flows from Lower Red Butte Creek and Emigration Creek to the Jordan River via a 3.4 mile long pipe. One function of the impacted portion of Lower Red Butte Creek is as an urban stormwater conveyance system. There are campus parking lots and roadways immediately adjacent to the spill site. The impacted reach drops about 750 feet over a reach of 18,000 feet, averaging approximately a 4% drop (Figure 2-2).

[6] http://wildlife.utah.gov/dwr/

2.1 GEOLOGY

The surface geology of the Upper Red Butte Creek is composed of various members of the Triassic Ankareh formation as well as Jurassic/Triassic Nugget Sandstone (Bio-West 2010). Approximately 50 to 86 percent of the soils in the upper subwatershed have severe erosion potential. Lower Red Butte Creek flows through deposits ranging in size from finer-grained silt and clay to coarser sand and gravel deposits where 20 to 35 percent of the soil has severe to very severe erosion potential. Median streambed particle sizes range from 12 to 75 mm. Medium and large-sized gravel are the dominant substrate sizes in riffle areas of Red Butte Creek.

2.2 *IN-CREEK FLOWS*

Red Butte Creek has a perennial flow upstream of Red Butte Reservoir and is considered to have "perennial-reduced" flow below that point (Bio-West 2010). Although flow is regulated by the Red Butte Reservoir, the creek's hydrology is characterized by a distinct springtime peak in flow which is typical of snowmelt systems. Flows in Lower Red Butte Creek are "flashy" with rapid, brief rises in flow during storms, a typical pattern followed by urban creeks. Average annual high flows are 22 cfs, while typical base flows are 2 cfs. Episodic high flows are likely to affect the transport/spatial distribution of chemicals as well as physically affect biotic communities.

2.3 *FLORA AND FAUNA*

The most common trees along the streamside areas of Red Butte Creek are box elder (*Acer negundo*) and cottonwood (*Populus* sp.), with Gambel oak (*Quercus gambelii*) dominant in undeveloped upper slope areas. Siberian elm (*Ulmus pumila*), an introduced invasive tree species, is also fairly common. Russian olive (*Elaeagnus angustifolia*), an introduced invasive tree, is present but less prominent. Common shrub species include redosier dogwood (*Cornus sericea*), twinberry honeysuckle (*Lonicera involucrata*), and narrowleaf willow (*Salix exigua*), with Woods' rose (*Rosa woodsii*) common on upper portions of slopes. The understory vegetation layer includes native species such as Western poison ivy (*Toxicodendron rydbergii*) and Virginia creeper (*Parthenocissus quinquefolia*), and field horsetail (*Equisetum arvense*). Introduced species such as ornamental English ivy (*Hedra helix*), common periwinkle (*Vinca minor*), climbing nightshade (*Solanum dulcamara*), smooth brome (*Bromus inermis*), and lesser burdock (*Arctium minus*) are significant components of the understory cover in several reaches. In addition, the upper slope portions

of some reaches contain the invasive species whitetop (*Cardaria draba*) and houndstongue (*Cynoglossum officinale*). Canopy (tree) cover is generally high, though is markedly reduced in the lower urban reaches (Bio-West 2010).

Bio-West (2010) concludes that limited information is available about the fauna of the urban lower portion of Red Butte Creek. Deer, raccoon, and skunk have been observed in Lower Red Butte Creek. During the Audubon Society's 2005 Christmas bird count, over 30 different species of birds were observed within the University of Utah survey area, which includes portions of the Red Butte Creek riparian corridor (Bio-West 2010). Miller Bird Refuge and Bonneville Glen Park are generally recommended for recreational bird watching.

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3.0 DATA EVALUATION

Data collection activities in support of the ERA were designed to characterize (a) chemicals potentially present in surface water, sediments, and bank soils and (b) structure of benthic macroinvertebrate communities for Lower Red Butte Creek and for reference creeks: Emigration Creek, Parleys Creek, City Creek, and Mill Creek.[7]

All methods used to conduct the field collection and laboratory analyses are the same as those described in the *Red Butte Creek Crude Oil Spill Water, Sediment and Macroinvertebrate Sampling Plan* v. 15 [Incident Monitoring Sampling and Analysis Plan (SAP)] (CPL 2011). For the August 2011 Incident sampling effort, sampling stations were added to supplement sampling stations identified in the Incident Monitoring SAP to provide sufficient sample numbers in support of the ERA (Table 2-1).

Table 2-1. Incident Monitoring SAP and Supplemental Sampling Stations to Support the ERA

	Surface Water & Sediment Chemistry				**Macroinvertebrate**			
			Total N				**Total N**	
Site	**SAP**[a]	**ERA**[b]	Upstr[c]	Urban[d]	**SAP**[a]	**ERA**[b]	Upstr[c]	Urban[d]
Lower Red Butte Creek	7	6[e]	1	12	3	6	1	8
Reference Urban Creeks								
Emigration Creek	1	3	1	3	2	1	1	2
Parley's Creek	1	3	0	4	0	2	0	2
Mill Creek	1	3	1	3	2	1	1	2
City Creek	1	3	2	2	1	2	1	2
Total Lower Red Butte Creek Below Spill[d]				12				8
Total Ref Urban Creeks[d]				12				8

Notes:
a. sampling locations from Incident Monitoring SAP
b. sampling locations added to support the ERA
c. sampling locations in upstream (of spill) or natural reach of creeks
d. sampling locations in urbanized reach of creeks
e. assumes that the same sample can be used to support both the HHRA and ERA

[7] Emigration Creek, Parleys Creek, City Creek, and Mill Creek are considered representative of the background levels of hydrocarbons present in Red Butte Creek (CPL 2011).

Surface water, sediment, and bank soils were analyzed for:

- Total petroleum hydrocarbons (TPH),
- Volatile organic compounds (VOCs), including benzene, toluene, ethylbenzene, xylenes (BTEX); and
- Semivolatile organic compounds (SVOCs), including polycyclic aromatic hydrocarbons (PAHs); and
- Grain size and total organic carbon (TOC) [for soil and sediment only].

Surface water and sediment chemistry data are intended for comparison to water quality and sediment quality benchmarks that are protective of freshwater aquatic and benthic macroinvertebrate biota respectively.

To the extent possible, macroinvertebrate sampling locations were co-located with surface water and sediment sampling stations to facilitate correlation of chemistry and biology. Macroinvertebrate community structure data are intended to provide an additional line of evidence for characterizing/verifying ecological risks.

3.1 *DATA VALIDATION*

Data validation was conducted according to USEPA National Functional Guidelines (NFGs) (USEPA 1999a, 2004). Newer NFGs are available, but they are guidelines for USEPA's Contract Laboratory Program methods. The SW-846 methods are better represented by the earlier versions of NFGs.

All of the chemistry data were subject to a Level II review. A Level II review consists of a review of all sample-related quality control parameters, including holding times, blank contamination, laboratory control sample, matrix spike/matrix spike duplicate, and surrogates.

In addition, a Level IV data validation was conducted on 10 percent of the data. Level IV data validation consisted of a review of all parameters reviewed as part of the Level II review with additional review of instrument performance check (as applicable), initial and continuing calibrations, and internal standards (as applicable). In addition, Level IV includes review of the raw data, including chromatograms, log books, quantitation reports, and spectra.

Appropriate validation qualifiers were assigned to the data. All of the data, including qualified data, were considered usable and no data were rejected.

Findings of this data quality review will be used to determine whether (a) additional review is necessary or (b) data are acceptable for an evaluation of data usability.

ERM will receive analytical data in a format that provides adequate information for evaluation, including appropriate quality control measures and acceptance criteria. The laboratory report will describe the analytical method used, provide results on a sample by sample basis along with sample specific detection limits, and provide the results of appropriate quality control samples such as laboratory control spike samples, sample surrogates and internal standards (organic analyses only), and matrix spike samples.

3.2 *DATA USABILITY*

ERM will conduct a data evaluation/review following procedures in USEPA's (1992b) *Guidance for Data Usability in Risk Assessment – Part A* and USEPA's (1989) *Risk Assessment Guidance for Superfund* (RAGS). The usability evaluation aims to identify appropriate data for use in the risk assessment. According to USEPA (1992b), ERM will evaluate the following six criteria:

1. **Reports to risk assessors –** Confirm that sufficient information related to the site dataset is available for review. Required information includes:

    - Site description, including features of interest, and contaminant transport mechanisms;
    - Site map with sample locations;
    - Applicable SAP with sample design and procedures;
    - Analytical methods and reporting limits provided in lab reports;
    - Complete dataset in database format;
    - Lab reports include quality control sample results and narratives discussing quality assurance/quality control (QA/QC) issues; and
    - Lab qualifiers (appropriately defined).

2. **Documentation –** Confirm that the analytical results provided are associated with a specific sample location and collection procedure. Required information includes:

- Chain-of-custody forms;
- Sample location data (surveyed location coordinates or measurements relative to site features);
- Field notes, to confirm standard operating procedures (SOPs) were followed; and
- Lab reports, to confirm analytical SOPs followed and provide QC results and acceptance criteria.

3. **Data sources –** Determine whether the analytical techniques used are appropriate for risk assessment purposes. In particular, the review will seek answers to the following questions:

   - Have all the constituents of interest been identified and analyzed sufficiently?
   - Are sample depths appropriate for exposure routes of interest?
   - Do samples represent conditions to which current and future receptors will be exposed?
   - Were the data generated by certified labs? Were standard, approved, analyses used?

4. **Analytical methods and detection limits –** Evaluate whether the detection limits are low enough to allow adequate characterization of risks (compare to ecological screening levels). The evaluation should factor in reference conditions. The reference dataset should have reporting limits comparable to the site dataset to avoid complications in statistical dataset comparisons.

5. **Data review –** Assess the quality of the analytical data received from the laboratory (formal data validation in accordance with Functional Guidelines). This assessment will include evaluation of rejected data, and whether their elimination from the site dataset constitutes a significant data gap. Specific QA/QC issues reviewed in this step will include:

   - Holding time exceedances and/or sample condition issues;
   - Blank contamination and resultant censored data;
   - Sample duplicate differences outside acceptance range, including matrix spike/matrix spike duplicate (MS/MSD), laboratory

control/laboratory control duplicate (LC/LCSD), sample/field duplicate, sample/laboratory duplicate;

- Internal standards outside acceptance range;
- Surrogate percent recoveries outside acceptance range; and
- Calibrations outside laboratory control limits.

6. **Data quality indicators –** Verify that sampling and analytical systems used in support of project activities are in control and the quality of the data generated for this project is appropriate for making decisions affecting future activities with respect to precision, accuracy, representativeness, comparability, and completeness of the data:

   - Precision is evaluated using various lab QA/QC procedures.
   - Accuracy measures the level of bias that an analytical method or measurement exhibits, and is based largely on the results of the data review (Item 5). The potential impacts of biased data are evaluated in this step. Results with potential high bias could skew risk assessment to calculate a risk that is overestimated. Results with potential low bias could skew risk assessment to calculate a risk that is underestimated.
   - Representativeness is the degree to which data accurately and precisely represent a characteristic of the population at a sampling point or an environmental condition. If the SAP is properly prepared, with appropriate sample locations selected, the resultant data should be representative.
   - Completeness is expressed as a percentage of measurements that are valid and usable relative to the total number of measurements made (percent of results not rejected).
   - Comparability is a qualitative characteristic expressing the confidence with which one dataset can be compared with another. Generally, using the same, standard, analytical methods will result in comparable results.

3.3 *HANDLING NON-DETECTS*

Non-detects (NDs) or "left censored" data are inevitable in most environmental data sets. An organic compound was presumed not to exist in a particular environmental medium if it was never detected (100 percent non-detect) and detection limits met data quality objectives.

Consistent with guidance (USEPA 1989), constituents that were detected at detected at a frequency less than 5 percent were not quantitatively evaluated in this ERA.[8] When greater than 5 percent of the data were comprised of non-detected concentrations, NDs were handled in accordance with guidance (USEPA 2006, 2010) (see Appendix D).

3.3.1 Comparisons to Reference Urban Creeks

USEPA (2010) summarized the findings of studies examining the performances of the various parametric and nonparametric two-sample statistical analysis methods for data sets with NDs and multiple detection limits. USEPA (2010) and Helsel/USGS (2005) strongly discourage the use of one-half the detection limit (DL/2) substitution for non-detected concentrations when comparing two data sets. USEPA (2010) states that:

> "It is well known that the DL/2 method (with NDs replaced by DL/2) does not perform well, even when the percentage of NDs is only 5-10 percent."

USEPA's (2010) ProUCL v. 4.01.00 (hereafter referred to as USEPA ProUCL) supports several state-of-the-art nonparametric two-sample comparison methods (e.g., Wilcoxon Rank Sum [WRS], Gehan test), which can be applied to data sets containing non-detected concentrations. Nonparametric two-sample statistical methods are more robust and are preferred to the DL/2-based substitution method in the comparison of data to data for reference conditions (USEPA 2010; Helsel/USGS 2005). Non-detected results will be handled using non-parametric two-sample statistical methods recommended by Pro-UCL output (see Appendix D).

3.3.2 Calculation of 95 Percent Upper Confidence Limits

USEPA (2010) also summarized the findings of studies examining the performances of the various parametric and nonparametric upper confidence limit (UCL) computation methods for data sets with NDs and multiple detection limits. USEPA (2010) and Helsel/USGS (2005) strongly discourages the use of DL/2 substitution for non-detected concentrations when calculating 95UCLs.

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[8] Organic compounds that are 100 percent non-detects will be discussed in the uncertainty analysis.

USEPA ProUCL supports several nonparametric UCL computational methods, including regression order statistics (ROS) or Kaplan-Meier (KM) methods, which can be applied to data sets containing nondetected concentrations having multiple detection limits. These aforementioned statistical methods are preferred to DL/2-based substitutions and were used to obtain 95UCLs (USEPA 2010; Helsel/USGS 2005). 95UCLs recommended in the USEPA ProUCL output will be used in this ERA (see Appendix D).

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4.0 ECOLOGICAL RISK ASSESSMENT

The ERA process is used to systematically evaluate and organize data, assumptions, and uncertainties to help understand and predict the relationships between stressors and ecological effects in a way that is useful for environmental decision making (USEPA 1998). A tiered ERA approach will be employed as needed (Figure 4-1):

- Tier 1: Screening-Level ERA (SLERA);
- Tier 2: Baseline ERA (BERA); and
- Tier 3: Probabilistic ERA (PERA).

This tiered approach is intended to:

- Provide opportunities for regular input and direction by decision-makers;
- Provide a logical, stepwise approach for compiling and analyzing more site-specific information and incorporating more realistic assessments of exposure and effects;
- Provide opportunities to streamline and focus the ERA-related effort at each tier; and
- Provide opportunities to eliminate from further consideration areas, chemicals, and receptors for which an "acceptable" level of risk exists.

Accordingly, a scientific/management decision point (SMDP) exists at the conclusion of each tier, when it will be decided:

1. Whether or not the risk assessment, in its current state, is sufficient to support decision-making; and

2. If the assessment is determined to be insufficient, whether or not refinement of the current tier or progression to the next tier would provide a sufficient benefit to warrant the additional effort.

At this time, it is anticipated that a Tier 1 and perhaps a Tier 2 ERA will be required to support decision-making for Lower Red Butte Creek.

4.1 PROBLEM FORMULATION

Problem formulation establishes the scope of the ecological risk assessment, identifies the major factors to be considered, and ensures that ecological receptors likely to be exposed and exposure scenarios most likely to contribute to ecological risk are evaluated.

Problem formulation consists of the following subtasks:

- Identify biotic receptors of concern (BROC);
- Identify COPECs;
- Identify potentially complete exposure pathways; and
- Establish assessment endpoints and measures of effect.

4.1.1 *Identify Biotic Receptors of Concern*

Given the number of species and the complexity of biological communities, all species present in Lower Red Butte Creek cannot be individually assessed. BROCs were identified to (1) focus the ERA on those receptors of concern and (2) develop specific assessment endpoint statements.

Consistent with guidance (USEPA 1998), BROCs will be identified and will consider:

- Biota of regulatory interest – species and habitats that are protected by federal and state regulations;
- Biota of commercial/recreational interest – species that have an economic or recreational value (e.g. crops, livestock, fisheries, hunted game);
- Biota of resource management interest or habitats/species that may support functional attributes (e.g., flood control); and
- Biota of ecological interest – species that play an important role in mediating processes or interactions that affect the structure/function, or biodiversity of native habitats, communities, or ecosystems (e.g., keystone species).[9]

[9] Plants and animals that provide shelter and/or food for special status species were also considered when identifying receptors of ecological concern.

All trophic levels, including primary producers, were considered.

A review of the Utah Natural Heritage Program's Biodiversity Tracking and Conservation System (BIOTICS), Utah Division of Wildlife Resources (UDWR), and U.S. Fish and Wildlife Service (USFWS) found (a) no federal- or state-listed threatened and endangered species and (b) no designated critical habitat residing in the reach of interest for Lower Red Butte Creek. A refuge population of endangered June sucker (*Chasmistes liorus*) currently inhabits Red Butte Reservoir (Bio-West 2010). However, Red Butte Reservoir is located upstream of the spill site, and there are no known occurrences of the June sucker in Lower Red Butte Creek.

A managed population of native Bonneville cutthroat trout (*Oncorhynchus clarki utah*) exists in the creek above the Red Butte Reservoir (Bio-West 2010). Lower Red Butte Creek is not reported in agency publications as supporting a fishery (SLCO 2009), but trout have been observed in the creek, perhaps from private landowners stocking small numbers of trout for fishing (Bio-West 2010).

Members of the following guilds were considered to play a key role in maintaining the structure/function of in-creek and riparian habitats and these guilds were identified as BROCs:

In-Creek Biota

- Aquatic plants
- Aquatic invertebrates
- Benthic macroinvertebrates (sediment-dwelling)
- Fish
- Amphibians[10]

Riparian Biota

- Reptiles[10]
- Waterfowl/shorebirds
- Mammals

The ERA for Lower Red Butte Creek will focus largely on in-creek biota and riparian wildlife.

[10] Given the lack of relevant widely accepted toxicity benchmarks, no quantitative evaluation of amphibians or reptiles will be conducted. The lack of a quantitative evaluation for amphibians and reptiles will be qualitatively discussed in the uncertainty analysis of the ERA.

4.1.2 Identify Constituents of Potential Ecological Concern

COPECs are constituents that may adversely affect biota. COPECs do not necessarily signify a risk; rather, they are merely constituents that have been identified for further examination. COPECs were identified for the following media of concern:

Media of Concern	Evaluate Exposures To
• Surface water	• Aquatic biota
• Creek bed sediments	• Benthic macroinvertebrates
• Creek soil/sediment[11]	• Riparian birds and mammals

A constituent was identified as a COPEC in Lower Red Butte Creek unless either of the following lines of evidence was true:

- Detected in less than 5 percent of the samples; or
- Maximum concentration is less than the corresponding risk-based ecological screening level (ESL).

4.1.3 Identify Potentially Complete Exposure Pathways

Identification of complete exposure pathways focuses the ERA on those exposure scenarios that are most likely to put BROCs at risk. Potentially complete exposure pathways consist of:

- A source and mechanism of constituent release;
- A transport medium (e.g., soil, water, tissue);
- A point or area where receptors of concern may contact petroleum hydrocarbons (media concern); and
- An exposure route through which petroleum hydrocarbon uptake occurs (e.g., ingestion, inhalation, or dermal contact including immersion).

[11] While riparian wildlife may be exposed to both creek bank and creek bed substrate (combined bank soil and creek bed sediment), benthic macroinvertebrates were considered to be exposed only to creek bed (in-creek) sediments.

Exposure routes that will be considered include:

In-Creek Biota

- Direct contact (uptake) by aquatic biota for constituents in surface water;
- Direct contact (uptake) by benthic macroinvertebrate biota for constituents in sediment;

Riparian Biota

- Direct (dermal) contact by wildlife for constituents in surface water and sediment;
- Inhalation by wildlife for volatile constituents in surface water and sediment;
- Incidental ingestion by wildlife for constituents in sediment and bank soil;
- Ingestion (drinking) by wildlife for constituents in creek surface waters; and
- Ingestion by wildlife for constituents that have bioaccumulated into aquatic and benthic macroinvertebrate prey.

A conceptual site model (CSM) identifies and summarizes the sources, mechanisms of transport, media of concern, exposure routes, and receptor groups. A preliminary CSM for the Lower Red Butte Creek ERA is shown in Figure 4-1.

Bank soils are considered to be alluvial deposition of upcreek sediments as a result of past high flow events. Although available to riparian wildlife, these sediments are not typically available to and will not be quantitatively assessed for in-creek biota. For riparian wildlife, bank soil and sediment will be evaluated as part of the incidental ingestion exposure pathway.

Inhalation of VOCs and Dermal Contact. VOC vapors are rapidly dispersed in aboveground air following volatilization from soil or surface water. This dispersion, caused by wind and advection, results in very low exposure point concentrations of VOCs in aboveground air (USEPA 1998). Based on available information and previous experience, VOCs in outdoor air seldom "drive" risk (USEPA 2005). While potentially complete, inhalation exposure to VOCs is considered an insignificant exposure pathway for surface-dwelling wildlife (USEPA 2005).

Feathers of birds, fur on mammals, and scales on reptiles are believed to reduce dermal exposure by limiting the contact of the skin surface with the contaminated media (USEPA 2005). Accordingly, although potentially complete, dermal contact is considered an insignificant exposure pathway for wildlife (Peterle 1991; USEPA 2005).

Lack of a quantitative evaluation for these pathways will be discussed in the uncertainty analysis.

4.1.4 Assessment Endpoints

Assessment endpoints are "explicit expressions of the actual environmental value that is to be protected" (USEPA 1992a, 1998). Assessment endpoints link the risk assessment to management concerns. Assessment endpoints are comprised of two elements: (1) the entity of concern and (2) a characteristic of the entity that is important to protect and is potentially at risk (USEPA 1992a, 1998).

Assessment endpoints were established to protect in-creek aquatic biota and riparian wildlife BROCs (Table 4-2). Community-level assessment endpoints were established for aquatic and benthic macroinvertebrate communities. Population-level assessment endpoints were established for riparian wildlife (USEPA 1989).

Table 4-1. Assessment Endpoints for Lower (urban) Red Butte Creek

Receptor	Level	Assessment Endpoint[a]
In-Creek Aquatic Biota		
Aquatic Plant	Community	Continued structural integrity of aquatic plant community
Aquatic Invertebrate	Community	Continued structural integrity of aquatic invertebrate community
Benthic Macroinvertebrate	Community	Continued structural integrity of benthic macroinvertebrate community
Fish	Population	Continued persistence of fish populations
Amphibian	Population	Continued persistence of amphibian populations
Riparian Wildlife		
Reptiles	Population	Continued persistence of reptile populations
Waterfowl/Shorebirds	Population	Continued persistence of

Receptor	Level	Assessment Endpoint[a]
		waterfowl/shorebird populations
Mammals	Population	Continued persistence of riparian mammal populations
Note:: Consistent with reference urbanized reaches of creeks in Salt Lake City .		

4.2 *EXPOSURE ASSESSMENT*

Exposure assessment establishes the information necessary to determine or predict ecological exposures to COPECs under exposure conditions of interest. Given the community coverage and/or home ranges of identified BROCs, the ERA will evaluate the reach of Lower Red Butte Creek affected by the Incident[12] as a single exposure area.

4.2.1 *Exposure Point Concentrations*

An exposure point concentration (EPC) is the concentration of a constituent in an environmental medium that a receptor of concern is likely to contact. In accordance with regulatory guidance, the lesser value of (1) the upper 95th confidence limit on the mean (95UCL) or (2) the maximum measured concentration in accessible media will be used to estimate exposure (USEPA 1989). All calculations of EPCs will be performed using USEPA's ProUCL v. 4.01.00.

It is noted that TPH in surface water and sediments were analyzed using USEPA method 8015 (CPL 2011). This method does not report TPH in terms of carbon-chain fractions as needed when applying the MaDEP TPH approach. Accordingly, it is anticipated that the results of the USEPA 8015 analyses may be allocated to specific aliphatic/aromatic carbon-chain fractions using default (assumed) proportions provided by MaDEP (2002). Application of MaDEP methods will be performed in coordination with methods used in the HHRA.

Exposures for in-creek aquatic and benthic macroinvertebrate biota will be reported in terms of concentrations in surface water and sediment, respectively.[13]

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[12] From the Former Lower Underflow Dam (sampling location at the spill site) to Below 900 East (furthest downcreek sampling location).

[13] Toxicity benchmarks for aquatic and benthic macroinvertebrate biota are in units of concentration for surface water and sediment, respectively (see Section 4.3).

4.2.2 Riparian Wildlife

In addition to environmental point concentrations, the essential inputs needed to estimate exposure to terrestrial wildlife are:

- Indicator Species;
- Exposure equations;
- Wildlife exposure factors; and
- Biological uptake factors.

4.2.2.1 Indicator Species

Indicator species are identified to focus the ERA and evaluate risk for a representative set of species. Risks to indicator species are subsequently used to infer the potential for adverse impacts to taxonomically and functionally related BROCs. An indicator wildlife species is selected for each guild to represent member species based on:

- Taxonomic relatedness to receptors of concern;
- Similar function/role in the ecosystem;
- Known or presumed similarities in physiology and life history;
- Availability of wildlife exposure factor data (e.g., ingestion rates);
- Biological characteristics that would tend to maximize estimates of exposure (e.g., small body size, small home or foraging ranges, forages on ground surface);
- Minimizing extrapolation of existing toxicity data (to the degree possible); and
- Presence in a variety of on-site habitats to streamline the assessment effort.

Wherever possible, indicator species were selected to maximize estimates of exposure to ensure a conservative assessment of risk. Indicator wildlife species for Lower Red Butte Creek ERA include:

- Mallard – herbivore (waterfowl);
- Spotted sandpiper – invertivore (shorebird);
- Musk rat – herbivore; and

- Raccoon – invertivore.

To bound risk among herbivores and invertivores (invertebrate-consuming animals), indicator species were assumed to have a diet proportion of 100 percent (P = 1.0) for their particular food type (i.e., omnivores were considered to have an exposure intermediate to representative surrogate wildlife species.). Moreover, a spotted sandpiper and raccoon consuming only aquatic biota or only benthic macroinvertebrate biota will be assessed to bound risks to riparian wildlife with varying diet proportions for these prey types.

4.2.2.2 *Exposure Equations*

Exposures (or doses) are calculated using pathway-specific exposure equations for VOCs, SVOCs, and TPH. To facilitate comparisons with available toxicity data, estimates of exposure for BETX, TPH, and PAHs will be reported in the units of dose, $mg_{COPEC}/kg_{body\ wt}$-day, using the following general equation (USEPA 1993):[14]

$$Dose = EPC \bullet CR \bullet FC \bullet AF \bullet BW^{-1} \quad \ldots Eq.\ 4\text{-}1$$

where:

EPC = exposure point concentration for the medium of concern
CR = contact rate (e.g., ingestion rate)
FC = fraction of media contacted (e.g., diet proportions, proportion of time spent in Lower Red Butte Creek)
AF = assimilation factor
BW = body weight

For riparian wildlife, exposure is equal to the total environmental dose as follows:

$$Dose_{total} = \Sigma\ Dose_{\ i} \quad \ldots Eq.\ 4\text{-}2$$

where:

i = water, sediment, food

Finally, the dose due to the ingestion of surface water, sediment, and food can be parameterized as follows:

[14] Estimates of exposure to in-creek aquatic and benthic macroinvertebrate biota are in units of concentration, and, therefore, do not require exposure equations.

$Dose_{water}$ = DIR • AUF • C_{water} • $RGAF_{water}$ … Eq. 4-3

$Dose_{food}$ = FIR • AUF • BAF • C_{water} • $RGAF_{aquatic\ biota}$ … Eq. 4-4

$Dose_{sediment}$ = SIR • AUF • $C_{sediment}$ • $RGAF_{sediment}$ … Eq. 4-5

$Dose_{food}$ = FIR • AUF • BAF • $C_{sediment}$ • $RGAF_{macroinvert}$ … Eq. 4-6

where:

DIR = drinking rate (L/kg_{bw}-day)

SIR = incidental sediment ingestion rate ($kg_{sediment}/kg_{bw}$-day, dw)

FIR = food ingestion rate (kg_{food}/kg_{bw}-day, dw)

AUF = area use factor is equal to the area of reach of interest/home range – used to estimate of the percent of time the receptor spends at Lower Red Butte Creek (unitless, ranging from 0 to 100%)

BAF = bioaccumulation factor

$C_{sediment}$ = constituent exposure point concentration in sediment

C_{water} = constituent exposure point concentration in surface water (µg/L)

RGAF = gut absorption factor is equal to the percent of concentration in surface water, sediment, or food that is absorbed across the gastrointestinal tract (unitless, assumed to be 100%)

4.2.2.3 *Riparian Wildlife Exposure Factors*

In addition to COPEC concentrations, wildlife exposure factors (WEFs) are needed to evaluate exposure equations. To estimate exposures due to ingestion, the following WEFs are required:

- Food ingestion and water (drinking) rates;
- Sediment and food diet proportions;
- Body weight; and
- Foraging area or home range.

In an effort to provide the most accurate assessment with the least amount of uncertainty, indicators species-specific data are used when available. When data for a selected indicator species are not available, data for a taxonomically related species having a similar feeding biology and size are used—if needed, metabolic adjustments are made. When no wildlife

species-specific data are available, allometric regression equations provided in USEPA's *Wildlife Exposure Factor's Handbook* (1993) are used.

Wildlife exposure factors for the mallard, spotted sandpiper, musk rat, and raccoon are provided in Table 4-3.

Table 4-2. Wildlife Exposure Factors

Factor	Value	Source
Mallard		
Ingestion rate[1]	0.056 kg/kg-day	USEPA 1993
Drinking rate	0.0565 L/kg-day	USEPA 1993
Sediment diet proportion	3.3%	Beyer *et al*. 1994
Body weight[2]	1.134 kg	USEPA 1993
Home range[3]	580 ha	USEPA 1993
Spotted Sandpiper		
Ingestion rate[1]	0.163 kg/kg-day	USEPA 1993
Drinking rate	0.165 L/kg-day	USEPA 1993
Sediment diet proportion	8.2%	Beyer *et al*. 1994
Body weight[4]	0.052 kg	USEPA 1993
Home range	0.25 ha	USEPA 1993
Muskrat		
Ingestion rate[5]	0.30 kg/kg-day	USEPA 1993
Drinking rate	0.975 L/kg-day	USEPA 1993
Sediment diet proportion	9.4%[a]	Beyer *et al*. 1994
Body weight[6]	0.837 kg	USEPA 1993
Home range[7]	0.17 ha	USEPA 1993
Raccoon		
Ingestion rate[1]	0.537 kg/kg-day	USEPA 1993
Drinking rate	0.825 L/kg-day	USEPA 1993
Sediment diet proportion	9.4%	Beyer *et al*. 1994
Body weight[8]	3.99 kg	USEPA 1993
Home range[9]	156 ha	USEPA 1993

Factor	Value	Source

Notes:
1. calculated from allometric equation (USEPA 1993)
2. average of means from Nelson & Martin 1953, as cited in USEPA 1993
3. average of means from Kirby et al. 1985, as cited in USEPA 1993
4. average of means from Maxson & Oring 1980, as cited in USEPA 1993
5. average of means from Svihla & Svihla 1931, as cited in USEPA 1993
6. average of Reeves & Williams 1956, as cited in USEPA 1993
7. Neal 1968, as cited in USEPA 1993
8. average of means from Johnson 1970, as cited in USEPA 1993
9. average of means from Stuewer 1943, as cited in USEPA 1993

4.2.2.4 *Biological Uptake Models*

For quantifying food chain exposures, simplified exposure models have been developed for terrestrial and aquatic food webs. COPEC concentrations transferred up the food chain will be calculated using available chemical-specific surface water-to-aquatic biota and sediment-to-benthic macroinvertebrate bioaccumulation factors (BAFs). BAFs used to calculate uptake into the prey of riparian wildlife are listed in Table 4-4.

Table 4-4. Bioaccumulation Factors

COPEC	BAFs		Source
	sed-to-plant[1]	sed-to-macroinvert[2]	
TPH-Diesel / TPH-Motor Oil			
Aromatics	1.2	1431	USEPA 2007
Aliphatics	0.54	17	USEPA 2007

Notes:
BAFs were calculated using equations in Attachment 4-1 of USEPA 2007 (see also Appendix E)
1 sediment-to-plant BAFs were calculated using: $\log BAF = -0.229 \log K_{ow} + 1.0237$
where:
K_{ow} = octanol-water partitioning coefficient
2 sediment-to-macroinvertebrate BAFs were calculated using: $BAF = K_{ww} / K_d$
where:
$\log K_{ww} = 0.87 * \log K_{ow} - 2.0$
K_d (L/kg soil) = $f_{oc} * K_{oc}$
K_{ww} = biota-to-soil water partitioning coefficient (L/kg worm)
K_d = soil-to-water partitioning coefficient (L/kg soil)
K_{oc} = organic carbon-to-water partitioning coefficient (L/kg oc)
f_{oc} = fraction organic carbon (kg oc/kg soil) =

4.3 EFFECTS ASSESSMENT

The effects assessment establishes toxicity reference values (TRVs) that are protective of aquatic biota, benthic macroinvertebrates, and wildlife. Ideally, the TRV is the highest dose or media concentration at which no chronic effects occur, and above which chronic adverse effects begin to occur.

ERM will obtain TRVs that are protective of freshwater aquatic biota and benthic macroinvertebrate communities from widely recognized sources (Table 4-4).

Table 4-4. Sources of Toxicity Reference Values

TRVs	Surface Water	Sediment	Wildlife
Preferred	UT WQS MaDEP WQS	TEC/PEC MaDEP SQG	USEPA 2007
Alternative 1	NAWQC	NOAA SQuiRT	Sample et al. 1998
Alternative 2	Tier II WQS	Jones et al. 1997	TPHCWG 1997
Alternative 3	USEPA EcoTox		

Notes:
EcoTox =- USEPA Ecotox database
NAWQC = National Ambient Water Quality Criteria
TEC/PEC = Threshold effect concentration/probable effect concentration
WQS =

4.3.1 Surface Water and Sediment TRVs

4.3.1.1 Surface Water

ERM will compare COPEC concentrations in the water of Lower Red Butte Creek with the following surface water benchmarks (in order of preference):

- State of Utah water quality standards / objectives;
- MaDEP TPH surface water guidelines (MaDEP 2002);
- National Recommended Water Quality Criteria (NRWQC) (USEPA 2009); and
- Tier II values (USEPA 1993, as cited in Suter & Tsao 1996).

Specific TRVs will be provided in the ERA report once COPECs have been identified. MaDEP surface water guidelines for the protection of

freshwater aquatic biota are provided as it is anticipated that TPH will be detected in surface waters of Lower Red Butte Creek and MaDEP benchmarks may be less-known (Table 4-5).

Table 4-5. MaDEP Surface Water Quality Guidelines (MaDEP 2002)

Fraction	Surface Water Guideline (µg/L)	Basis of Guideline
C5-C8 Aliphatics	250	Acute LC50/10 for hexane (as surrogate for this range)
C9-C12 Aliphatics	1800	Acute LC50/10 for decane (as surrogate for this range
C9-C10 Aromatics	540	Acute LC50/10 for trimethylbenzene (as a surrogate for this range)
C9-C18 Aliphatics	1800	Acute LC50/10 for decane (as surrogate for this range)
C19-C36 Aliphatics	2100	Acute EC 50/10 fir cyclododecane (as surrogate for this range)
C11-C22 Aromatics	N. A.	Effects may be seen at less than EPH reporting limit; other testing methods (e.g., GC/MS) may be needed on site-specific basis

4.3.1.2 Sediment

ERM will compare chemical concentrations in the sediments of Lower Red Butte Creek with the following sediment benchmarks (in order of preference):

- Threshold effect concentration/probable effect concentrations (TEC/PEC) (MacDonald et al. 2000);[15]
- MaDEP TPH sediment benchmarks (MaDEP 2007);
- Freshwater sediment values from NOAA SQuiRT table (NOAA 2008); or
- Freshwater sediment toxicity benchmarks (Jones et al. 1997).

[15] No DWR sediment quality guidelines could be found—however if available, DWR sediment quality guidelines will be used.

Specific TRVs will be provided in the ERA report once COPECs have been identified. MaDEP sediment benchmarks for the protection of sediment-dwelling biota are provided as it is anticipated that TPH will be detected in sediments of Lower Red Butte Creek and MaDEP benchmarks may be less-known (Table 4-6). MaDEP carbon-chain fractions presented in Table 4-6 are consistent with MaDEP carbon-chain fractions evaluated for human health.[16]

Table 4-6 MaDEP Sediment Benchmarks for Petroleum Hydrocarbon Fractions

Hydrocarbon Fraction	Geometric Mean Log K_{ow}	K_{OC}	Final Chronic value (µg/L)	Sediment Benchmark (mg/kg oc)	Sediment Benchmark (f_{OC} = 0.001) (mg/kg)
Aliphatic Hydrocarbons					
C_5 - C_8	4.12	7.24×10^3	218	1591	1.59
C_9 - C_{18}	7.32	7.41×10^6	0.4	3167	3.17
C_{19} – C_{36}	11.64	8.32×10^{-10}	0.0001[a]	9883	9.88
Aromatic Hydrocarbons					
C_9 – C_{10}	3.84	3.98×10^3	59.4	236	0.24
C_{11} – C_{22}	4.81	3.31×10^4	2.8	92	0.09

[a] The fraction is not likely toxic because mean LC_{50} exceeds mean aqueous solubility

Sediment benchmarks will be modified using site-specific fraction of organic carbon (f_{oc}) to derive site-specific TRVs. These TRVs will be provided in the ERA report once COPECs have been identified.

4.3.2 Wildlife TRVs

ERM will obtain TRVs that are protective of riparian wildlife from the following widely recognized sources:

- USEPA ecological soil screening levels (USEPA 2003-2007)
- ORNL toxicological benchmarks for wildlife (Sample et al. 1998)
- TPHCWG toxicity benchmarks
- USEPA EcoTox[17]

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[16] MaDEP has developed benchmarks for alternative carbon fractions (MaDEP 2002). These benchmarks will be used should they be necessary.

[17] http://cfpub.epa.gov/ecotox/

USEPA's ecological soil screening levels (USEPA 2003-2007) represent a recent comprehensive effort to examine the available toxicological data for a selected group of constituents.

4.3.3 In-Creek Benthic Macroinvertebrate Community Structure

Findings of the benthic macroinvertebrate survey provide an additional line of evidence to characterize potential risks to in-creek biota. Quantitatively assessing the in-creek benthic macroinvertebrate community provides a number of advantages because they (USEPA 1999):

- Indicate localized conditions given their limited migration patterns or sessile mode of life;
- Integrate effects of short-term environmental variations; and
- Constitute a broad range of trophic levels and pollution tolerances, thus providing strong information for interpreting cumulative effects.

The benthic macroinvertebrate community can be characterized in a number of ways including measuring its diversity, its community composition, and its tolerance to perturbation. A 'healthy' assemblage will be relatively consistent in its proportional representation of taxa, although individual abundances may vary in magnitude. Specific metrics that allow us to understand the integrity of the benthic macroinvertebrate community and will be used in the ERA are listed in Table 4-7.

Table 4-7 In-Creek Benthic Macroinvertebrate Community Metrics

Category	Metric	Definition	Purpose
Diversity measures	Richness	Total number of taxa	Measures the overall variety of the macroinvertebrate assemblage
	Evenness	Relative abundance with which each species is represented in an area	Index of how close in numbers the species in the community are
	Diversity (Simpson's or Shannon-Wiener indices)	An index for the combined richness and evenness of species in the community	Provides an measure for the number of species weighted by their abundance

Category	Metric	Definition	Purpose
Composition measures	% EPT	Percent of composite of mayfly, stonefly, and caddisfly larvae	Measures the composite abundance of sensitive taxa; generally decreases after perturbation
	% Chironomidae	Percent of midge larvae	Measures the abundance of a tolerant taxon; generally increases after perturbation
Tolerance measures	Hilsenhoff biotic index (HBI)	Uses tolerance values to weight abundance in an estimate of overall pollution.	Perturbation should increase this value

4.4 RISK CHARACTERIZATION

Risk characterization integrates the results of the analysis phase (i.e., exposure and effects assessments) to evaluate the likelihood of adverse ecological impacts associated with exposure to COPCs (USEPA 1992a). The risk characterization consists of the following subtasks:

- Calculation of risk estimates (hazard quotients);
- Analysis of the benthic macroinvertebrate community structure;
- Identification of the sources of uncertainty; and
- Characterization of potential ecological impacts.

4.4.1 Risk Estimates – Hazard Quotients

Hazard quotients (HQs) are used to estimate the potential for adverse ecological impacts when sufficient exposure and toxicity data exist. An HQ is simply the ratio of the estimated exposure to the TRV:

$$HQ = \frac{\text{Estimated Exposure}}{\text{TRV}}$$

An HQ less than 1 indicates a negligible potential for adverse ecological impacts due to exposure to a particular COPEC, whereas an HQ greater than or equal to 1 indicates a potential for adverse ecological impacts due to exposure to that COPEC.

The hazard index (HI) is the sum of HQs (HI = Σ HQs) and was calculated to evaluate potential cumulative risks for constituents with similar structure activity relationships. Similar to HQs, an HI less than one (HI < 1) indicates a negligible potential for adverse ecological impacts due to cumulative exposures to COPECs, whereas an HI greater than or equal to one (HI ≥ 1) indicates a potential for adverse ecological impacts due to cumulative exposures to COPECs.

To provide a point-of-reference, HQs for reference creeks will be calculated, presented, and compared to HQs for Red Butte Creek.

4.4.2 Benthic Macroinvertebrate Community Structure

Metrics characterizing benthic macroinvertebrate community structure provide additional lines of evidence and are intended to assist in characterizing the relationship, or lack thereof, between spill-related compounds and biological responses of in-creek biota.

4.4.2.1 Comparison to Reference Urban Creeks (Two-Sample Tests)

Measures of benthic macroinvertebrate community diversity, composition, and tolerance will be compared between Lower Red Butte Creek and reference urban creeks. If community metrics for Lower Red Butte Creek and the reference creeks are determined by the Shapiro Wilks test to be normally distributed, the means for these creeks will be compared using a t-test. For non-normally distributed data, medians will be compared using a Wilcoxon Rank Sum test (see Table 4-1).

If the comparisons show that (a) there is no significant difference between a biotic metric in Lower Red Butte Creek and reference urban creeks and (b) values in Lower Red Butte Creek are indicative of a diverse community with pollutant-sensitive species, it will be concluded that negligible risk currently exists to benthic macroinvertebrate communities, and no further analyses will be conducted. If however, biotic metrics suggest Lower Red Butte Creek macroinvertebrate communities are impaired (i.e., low diversity, low percentage of EPT, high percent of pollutant-tolerant species as compared to reference urban creeks), further analyses will be conducted to further elucidate the relationship between spill-related petroleum hydrocarbons and biotic responses.

4.4.2.2 Recovery Relative to Distance from Spill Site (Spatial Trend Analysis)

Impacts of the Incident are expected to be most evident close to the spill site as compared to further downcreek. To test this hypothesis and to test if data sufficient data exist, values of each biotic metric will be plotted as a function of distance from the spill site for the most recent (August 2011) sampling event. These simple, linear regressions will be analyzed to determine if there is a statistically significant change in the biotic metric with distance from the spill site. The lack of a spatial trend (i.e., regression with a p-value > 0.05) and values in Lower Red Butte Creek that are indicative of a diverse community that includes pollutant-sensitive species would provide an additional line of evidence that the effects of the Incident are no longer evident in Lower Red Butte Creek and that recovery has occurred or is occurring.

If however, biotic metrics suggest Lower Red Butte Creek macroinvertebrate communities are impaired near the spill site as compared to downstream stations, further analyses and/or risk management action may be considered. If biotic metrics suggest Red Butte Creek macroinvertebrate communities are impaired at downcreek locations, it may be concluded that (a) petroleum-related compounds have been transported and persist in downcreek locations and/or (b) non-spill-related chemicals or other stressors may be present at downcreek locations. Additional analyses may be necessary to identify the factors that explain spatial trends (see Section 4.4.2.4).

4.4.2.3 Relationship to Spill-Related Petroleum Compounds (if needed)

Two-sample tests and trend analyses are intended to characterize benthic macroinverterbrate community structure relative to reference urban creeks and over space/time, respectively. However, these analyses do not identify the underlying factors/mechanisms explaining the trends in community metrics. If needed, and if sufficient data exist, these analyses are intended to quantify the relationships between spill-related petroleum compounds in surface water/sediments and the response of the benthic macroinvertebrate community—i.e., to discriminate between effects due to exposure to spill-related petroleum compounds and effects due to other (urban) stressors. If needed, it is anticipated that analyses may be conducted to characterize the degree to which spill-related compounds[18]

[18] Pyrogenic PAHs are frequently detected in urban runoff—a common source includes vehicular and other exhaust emissions (Douben 2003; Oren *et al.*2005)

explain the patterns in observed in biotic metrics (i.e., benthic macroinvertebrate community structure).

Data analyses needed to support these characterizations are likely to include one or more multivariate statistical analyses such as:

- Stepwise multiple regression analysis;
- Ordination analyses (i.e., canonical correlation);
- Cluster analyses; and/or
- Factor analysis (i.e., principal components analysis).

The specific objectives/scope and how to effectively communicate the methods/findings of these statistical analyses will be discussed with DWQ prior to commencing with the analyses.

4.4.3 Uncertainty Analysis

Consistent with US EPA (1989) guidance, a qualitative discussion of the uncertainties associated with the estimation of risks for Red Butte Creek will be presented in the ERA report. The uncertainty analysis will discuss uncertainties associated with each step of the risk assessment, including site characterization data, data usability, selection of COPECs, representative exposure concentrations, exposure assessment, effects assessment, and risk characterization. The likely consequence of identified uncertainties on the conclusions of ecological risk will be discussed and recommendations for reducing known uncertainties will be presented.

4.4.4 Characterization of Potential Ecological Impacts

A key feature of this ERA will be the use of multiple lines of evidence (where available) to support characterizations of risk. The use of multiple lines of evidence is especially critical where toxicity data are limited or lacking and are intended to further safeguard against underestimates of ecological risk.

At this time, it is anticipated that lines of evidence will include, but are not limited to:

- Observations made during the August 2011 sampling effort
- Benthic macroinvertebrate community structure
  - comparison to reference urban creeks

- spatial trends in the community structure
- relationship to spill-related compounds

Consistent with guidance (USEPA 1997, 1998), potential ecological risks due to exposures to residual concentrations of petroleum hydrocarbons in Red Butte Creek will be evaluated based on the preponderance of evidence.

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FIGURES

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Figure 2-1. Map of Red Butte, Emigration, City, and Parleys Creeks (from Bio-West 2010)

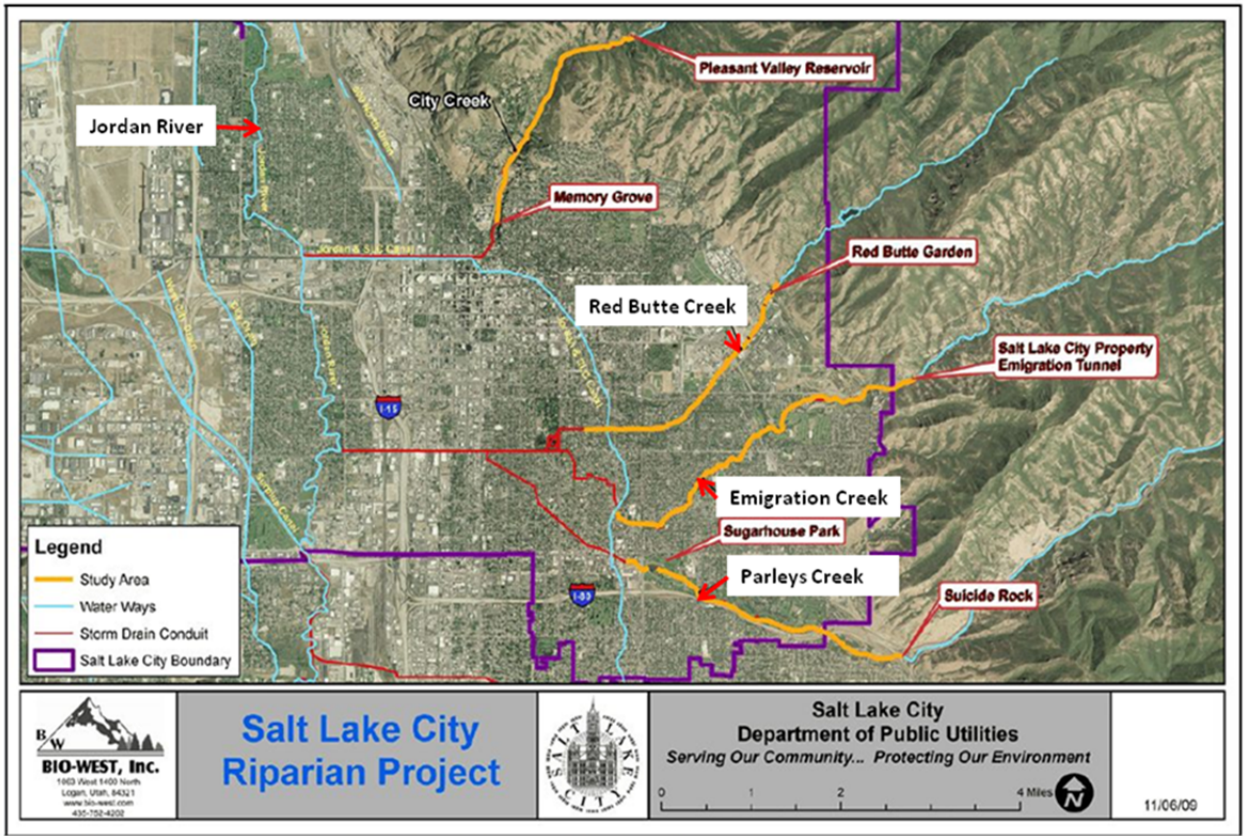


Figure 2-2. Longitudinal profile plot of Red Butte Creek streambed (from Bio-West 2010)

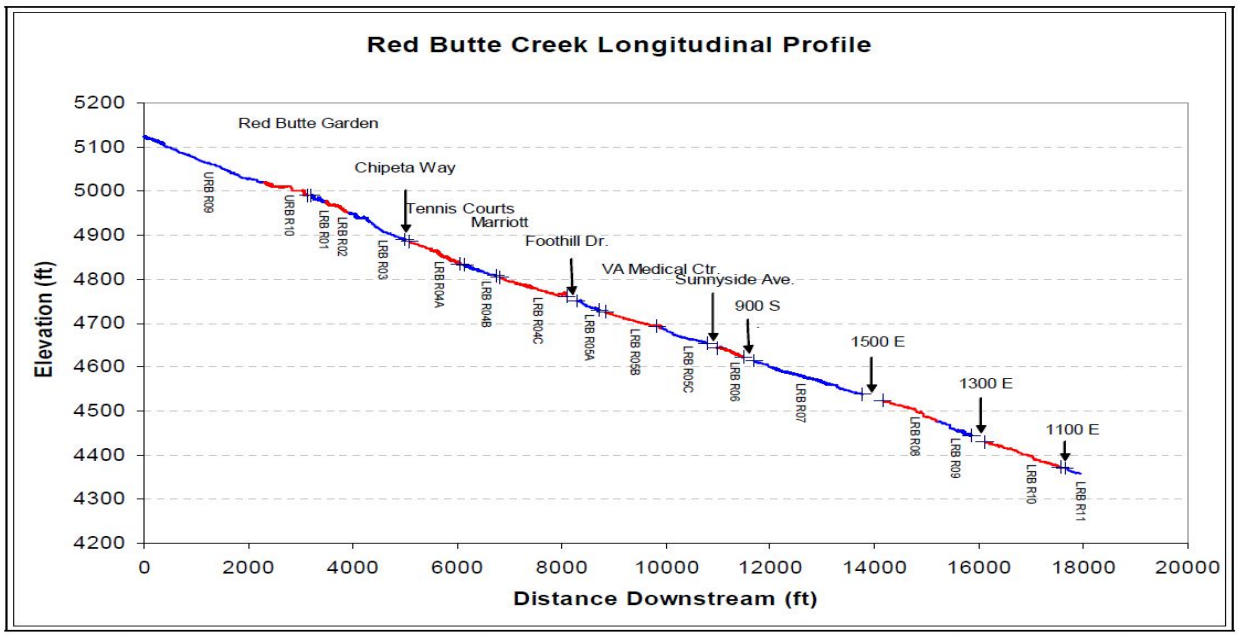
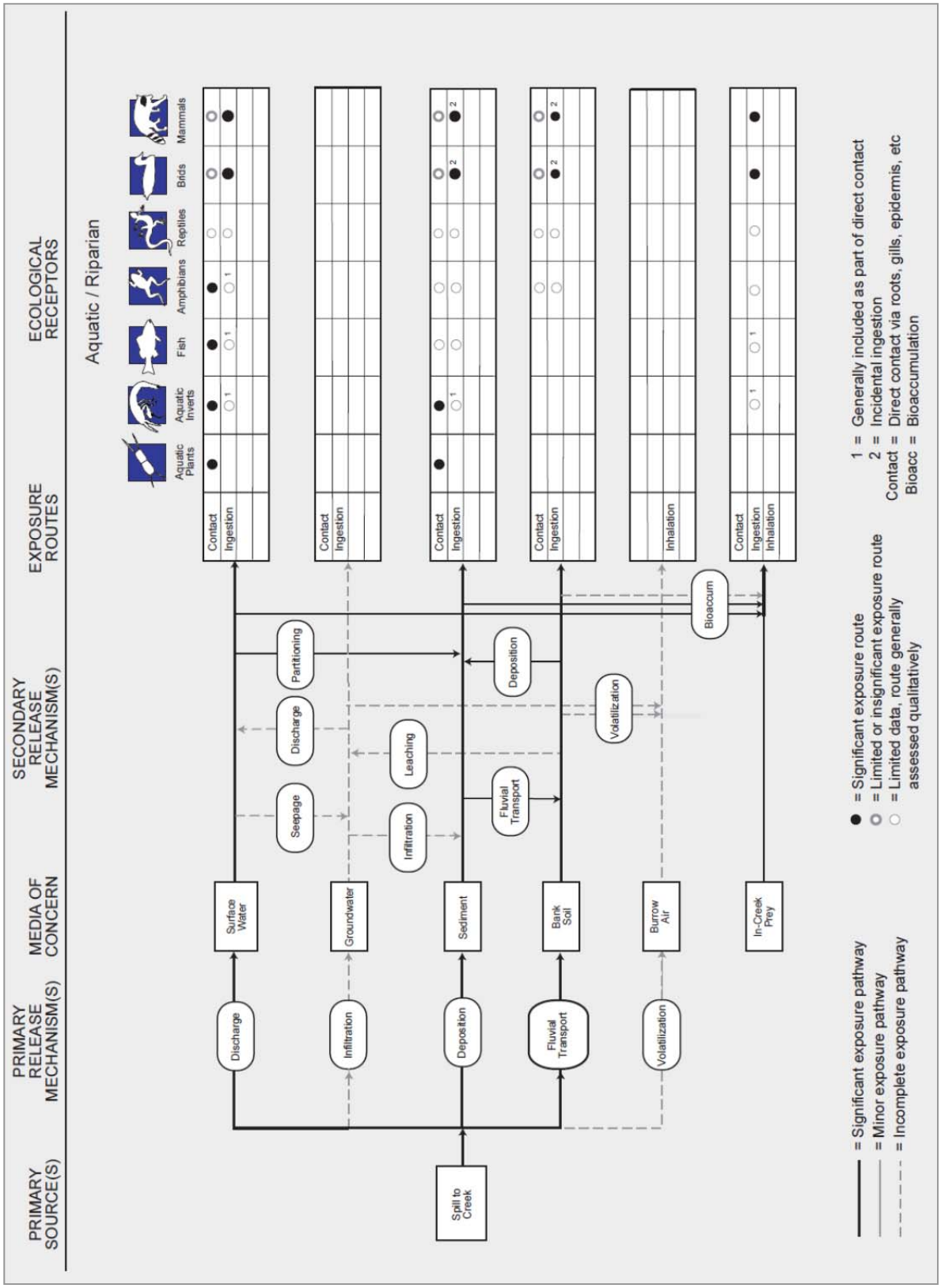


Figure 4-1. Preliminary Conceptual Site Model



Appendix B

Photographs of Sampling Locations

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APPENDIX B

PHOTOGRAPHS OF SAMPLING LOCATIONS AT RED BUTTE CREEK AND REFERENCE CREEKS

List of photographs

Photo 20: Mill creek below 2300 E, aerial view

Photo 21: Mill Creek below Highland Dr

Photo 22: Mill Creek below 700 E

Photo 23: Emigration Creek above 2100 E, looking upstream from 2100 E culvert

Photo 24: Emigration Creek above 2100 E, looking upstream

Photo 25: Emigration Creek above 1900 E, looking upstream from 1900 culvert

Photo 26: Emigration Creek at Donner Hill marker, looking downstream

Photo 27: Emigration Creek at Donner Hill marker, looking upstream

Photo 28: Emigration Creek above 1300 E, looking upstream

Photo 29: Parleys Creek above 2000 E, looking upstream

Photo 30: Parleys Creek below 1700 E, looking upstream at 1700 E culvert

Photo 31: Parleys Creek below 1700 E, looking downstream along south channel

Photo 32: Parleys Creek below 1700 E

Photo 1: Red Butte Creek below 900 E, looking upstream.

Photo 2: Red Butte Creek below 1100 E, looking upstream.

Photo 3: Red Butte Creek below 1300 E.

Photo 4: Red Butte Creek above 1500 E

Photo 5: Red Butte Creek above Sunnyside, looking downstream.

Photo 6: Red Butte Creek above Sunnyside, looking upstream.

Photo 7: Red Butte Creek at Mt. Olivet Diversion, looking upstream.

Photo 8: Red Butte Creek at Mt. Olivet Diversion, looking downstream.

Photo 9: Red Butte Creek above Foothill, looking upstream.

Photo 10: Red Butte Creek above Foothill, looking downstream.

Photo 11: Red Butte Creek at University Park Marriott, looking upstream.

Photo 12: Red Butte Creek at University Park Marriott, looking downstream.

Photo 13: Red Butte Creek below Chipeta Way, looking upstream.

Photo 14: Red Butte Creek below Chipeta Way, looking downstream.

Photo 15: Red Butte Creek at Lower Underflow Dam, looking upstream. Creek channel here was re-constructed using all new bed material.

Photo 16: City Creek below Loop Road.

Photo 17: City Creek below Loop Road, outfall of culvert crossing Loop Road. Only potential macro monitoring location is for approximately 20 feet below outfall. Discharge area shown at lower left.

Photo 18: City Creek at end of natural channel.

Photo 19: Mill Creek below 2300 E.

Photo 20: Mill Creek below 2300 E.

Photo 21: Mill Creek below Highland Dr.

Photo 22: Mill Creek below 700 E.

Photo 23: Emigration Creek above 2100 E, looking upstream from 2100 E culvert.

Photo 24: Emigration Creek above 2100 E, looking upstream

Photo 25: Emigration Creek above 1900 E, looking upstream from 1900 E culvert.

Photo 26: Emigration Creek at Donner Hill marker, looking downstream, riffle.

Photo 27: Emigration Creek at Donner Hill marker, looking upstream, pools with woody debris.

Photo 28: Emigration Creek above 1300 E, looking upstream.

Photo 29: Parleys Creek above 2000 E, looking upstream, wide straight channel adjacent to golf course.

Photo 30: Parleys Creek below 1700 E, looking upstream at 1700 E culvert.

Photo 31: Parleys Creek below 1700 E, looking downstream along south (primary) channel.

Photo 32: Parleys Creek below 1700 E, large outfall along north (secondary) channel, approximately 100-150 ft. downstream of 1700 E culvert outlet.

Appendix C

Quality Assurance/Quality Control (QA/QC) Memorandums

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Memorandum

Environmental Resources Management

2875 Michelle Drive
Suite 200
Irvine, CA 92606
(949) 623-4700
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To: Brent Robinson

From: Irene Lavigne
Shira DeGrood

Date: 21 February 2012, revised 04 April 2012

Subject: Data Review of Red Butte Creek Investigation
Samples Collected August – October 2011

Project Number: 0145323

Data Packages: American West Analytical Laboratories Data Packages 1108452, 1108453, 1108454, 1108455, 1108489, 1108511, 1109118, and 1110562
ALS Environmental Data Packages 1108369, 1108370, 1108371, 1108372, 1108373, 1108415, and 1109099
Lancaster Laboratories Data Package 1263977

The quality of the data was assessed and any necessary qualifiers were applied following the *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review,* October 1999 and *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review,* October 2004.

HOLDING TIME AND PRESERVATION EVALUATION

The sample shipments were received at the laboratory within the method-prescribed temperature preservation requirements. No sample data were qualified on the basis of the preservation evaluation.

The samples were prepared and analyzed within the method-prescribed time period from the date of collection with a number of exceptions. Samples analyzed for total organic carbons were analyzed 13 to 22 days outside of the 28-day holding time for this method. Detected results for 62 samples were qualified as estimated and biased low (J-) based on these holding time exceedances, as shown in Table 1.

BLANK EVALUATION

The method blank, equipment blank, field blank, and trip blank sample results were nondetected for each of the target analytes with one exception. A detection of the common laboratory contaminant, methylene chloride, in one field blank did not require qualification of sample data. All associated field samples were nondetected for this compound. The blank detection is shown in Table 2.

BLANK SPIKE EVALUATION

The laboratory control sample (LCS) recoveries were within the laboratory's limits of acceptance with two exceptions. No sample data were qualified on the basis of LCS outliers because the recoveries were biased high and the associated sample results were nondetected. The outlying LCS recoveries are listed in Table 3.

MATRIX SPIKE EVALUATION

The matrix spike (MS) and matrix spike duplicate (MSD) recoveries were within the laboratory's limits of acceptance with a number of exceptions. No sample data were qualified on the basis of the MS outliers. Sample data were not qualified if only one recovery in a MS/MSD pair exceeded control limits, if only the relative percent difference (RPD) exceeded control limits, if the spike sample was prepared using a non-client sample, if the sample data could be verified using an associated, in-control LCS recovery, or if the recovery was biased high and the associated sample results were nondetected. Additionally, if the concentration of the unspiked sample was greater than four times the spiked amount, the associated sample data were not qualified. The outlying MS recoveries are presented in Table 3.

SURROGATE EVALUATION

The surrogate recoveries were within acceptable limits. No qualifications to the data were made. The surrogate recoveries indicate minimal matrix interference in the samples.

FIELD DUPLICATE EVALUATION

Five samples were collected and submitted in duplicate. The primary samples associated with the duplicates in lab report 1109118 were not identified. ERM calculated the RPD between identified primary/duplicate pairs with detected results. The USEPA has not established control criteria for field duplicate samples; therefore, sample data are not qualified on the basis of field duplicate imprecision. The field duplicate results and calculated RPDs are presented in Table 4.

ANALYTICAL DUPLICATE EVALUATION

The laboratory prepared and analyzed a number of samples as analytical duplicates. ERM calculated the RPD between detected results. The RPDs were less than 20 percent, indicating acceptable precision. The duplicate results and RPDs are listed in Table 5.

CALIBRATION RANGE EVALUATION

The laboratory noted eight instances where the results of an undiluted sample exceeded the calibration range of the equipment. All instances of calibration range exceedences occurred in for PAHs where PAHs were analyzed using both 8270SIM and 8270. The recommended using the 8270 data in these instances. The sample results which exceeded the calibration range were qualified as estimated (J), and are shown in Table 6.

OVERALL ASSESSMENT

No data were determined to be unusable. All of the data, including qualified data, can be used for decision-making purposes; however, the limitations indicated by the applied qualifiers should be considered when using the data. The quality of the data generated during this investigation is acceptable for the preparation of technically-defensible documents.

Table 1
Samples with Exceeded Holding Times
Red Butte Creek Investigation
Samples Collected August to November 2011
Salt Lake City, Utah

Lab Package	Sample ID	Method	Holding Time (days)	# of Days Exceeded	ERM Qualifier
1108369	Mill Cr. Below 700 E. - Bed	TOC	28	13	J-
1108369	Mill Cr. Below 700 E. - Bank	TOC	28	13	J-
1108369	BD-1- Bed	TOC	28	13	J-
1108369	BD-1- Bank	TOC	28	13	J-
1108369	Mill Cr. Below Highland Drive - Bed	TOC	28	13	J-
1108369	Mill Cr. Below Highland Drive - Bank	TOC	28	13	J-
1108369	City Cr. Below N. Cyn. Loop - Bed	TOC	28	13	J-
1108369	City Cr. Below N. Cyn. Loop - Bank	TOC	28	13	J-
1108369	City Cr. Near Cyn. Entrance Gate - Bed	TOC	28	13	J-
1108369	City Cr. Near Cyn. Entrance Gate - Bank	TOC	28	13	J-
1108369	BD-2 - Bed	TOC	28	14	J-
1108369	BD-2 - Bank	TOC	28	14	J-
1108369	Mill Cr. Below 2300 E. - Bed	TOC	28	14	J-
1108369	Mill Cr. Below 2300 E. - Bank	TOC	28	14	J-
1108369	Mill Cr. Above Country Gage - Bed	TOC	28	14	J-
1108369	Mill Cr. Above Country Gage - Bank	TOC	28	14	J-
1108369	City Cr. @ Lower Natural Channel - Bed	TOC	28	14	J-
1108369	City Cr. @ Lower Natural Channel - Bank	TOC	28	14	J-
1108369	City Cr. @ N. Cyn. Footbridge - Bed	TOC	28	14	J-
1108369	City Cr. @ N. Cyn. Footbridge - Bank	TOC	28	14	J-
1108370	Gaging Station - Bed	TOC	28	17	J-
1108370	Gaging Station - Bank	TOC	28	17	J-
1108370	1731 E. 900 S. - Bed	TOC	28	17	J-
1108370	1731 E. 900 S. - Bank	TOC	28	17	J-
1108370	Avove Sunnyside - Bed	TOC	28	17	J-
1108370	Avove Sunnyside - Bank	TOC	28	17	J-
1108370	Mt. Olivet Div. - Bed	TOC	28	17	J-
1108370	Mt. Olivet Div. - Bank	TOC	28	17	J-
1108371	Below 900 E. - Bed	TOC	28	17	J-
1108371	Below 900 E. - Bank	TOC	28	17	J-
1108371	Below 1100 E. - Bed	TOC	28	22	J-
1108371	Below 1100 E. - Bank	TOC	28	22	J-
1108371	Below 1300 E. - Bed	TOC	28	22	J-
1108371	Below 1300 E. - Bank	TOC	28	22	J-
1108371	Above 1500 E. - Bed	TOC	28	22	J-
1108371	Above 1500 E. - Bank	TOC	28	22	J-
1108372	Above Foothill - Bed	TOC	28	17	J-
1108372	Above Foothill - Bank	TOC	28	17	J-
1108372	Univ.Marriott - Bed	TOC	28	17	J-

Table 1
Samples with Exceeded Holding Times
Red Butte Creek Investigation
Samples Collected August to November 2011
Salt Lake City, Utah

Lab Package	Sample ID	Method	Holding Time (days)	# of Days Exceeded	ERM Qualifier
1108372	Univ.Marriott - Bank	TOC	28	17	J-
1108372	Below Chipeta - Bed	TOC	28	17	J-
1108372	Below Chipeta - Bank	TOC	28	17	J-
1108372	Above Amphitheater - Bed	TOC	28	17	J-
1108372	Above Amphitheater - Bank	TOC	28	17	J-
1108373	Underflow Dam - Bed	TOC	28	17	J-
1108373	Underflow Dam - Bank	TOC	28	17	J-
1108415	Parleys Cr. Blow 1300 E. - Bed	TOC	28	20	J-
1108415	Parleys Cr. Blow 1300 E. - Bank	TOC	28	20	J-
1108415	Parleys Cr. Below 1700 E. - Bed	TOC	28	20	J-
1108415	Parleys Cr. Below 1700 E. - Bank	TOC	28	20	J-
1108415	Parleys Cr. Above 2000 E. - Bed	TOC	28	20	J-
1108415	Parleys Cr. Above 2000 E. - Bank	TOC	28	20	J-
1108415	Parleys Cr. Above I-215 - Bed	TOC	28	20	J-
1108415	Parleys Cr. Above I-215 - Bank	TOC	28	20	J-
1108415	Emigration Cr. Above 1300 E. - Bed	TOC	28	20	J-
1108415	Emigration Cr. Above 1300 E. - Bank	TOC	28	20	J-
1108415	Emigration Cr. Above 1900 E. - Bed	TOC	28	20	J-
1108415	Emigration Cr. Above 1900 E. - Bank	TOC	28	20	J-
1108415	Emigration Cr. Above 2100 E. - Bed	TOC	28	20	J-
1108415	Emigration Cr. Above 2100 E. - Bank	TOC	28	20	J-
1108415	Emigration Cr. @ Donner Hill Marker - Bed	TOC	28	22	J-
1108415	Emigration Cr. @ Donner Hill Marker - Bank	TOC	28	22	J-

Data packages reviewed: AWAL 1108452, 1108453, 1108454, 1108455, 1108489, 1108511, 1109118, 1110562; ALS 1108369, 1108370, 1108371, 1108372, 1108373, 1108415, 1109099; Lancaster 1263977

Key:
TOC = Total organic carbon; Walkley-Black Method, ASA-9 90-3
J- = Detected sample result qualified as estimated and biased low

Table 2
Blank and Associated Suspect Sample Detections
Red Butte Creek Investigation
Samples Collected August to November 2011
Salt Lake City, Utah

Lab Package	Blank ID	Associated Samples	Detected Compound	Reported Concentration	Report Limit	Units	ERM Qualifier
1109118	FB-1	NA	Methylene chloride	2.12	2.00	µg/L	--

Data packages reviewed: AWAL 1108452, 1108453, 1108454, 1108455, 1108489, 1108511, 1109118, 1110562; ALS 1108369, 1108370, 1108371, 1108372, 1108373, 1108415, 1109099; Lancaster 1263977

Key:
FB = Field blank
NA = Not applicable; associated samples not qualified
µg/L = Micrograms per liter

Table 3
Spike Recoveries Outside of Acceptable Limits
Red Butte Creek Investigation
Samples Collected August to November 2011
Salt Lake City, Utah

Lab Package	Spike Sample ID	Associated Sample	Compound	Recovery (%)	Limit (%)	RPD	RPD Limit	Sample Result	ERM Qualifier
LCS									
1110562	LCS-15267	NA	3,3'-Dimethylbenzidine	218	27-184	--	--	--	--
1110562	LCS-15281	NA	Pentachlorophenol	122	10-112	--	--	--	--
MS/MSD									
1108452	Batch MS/MSD	NA	Phenol	73.6/65.9	10-71	11	35.0	--	--
1108452	Red Butte Cr. @ Gaging Station MS/MSD	NA	Pentachlorophenol	44.1/59.0	10-131	28.9	25	--	--
1108452	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	1,1,1-Trichloroethane	117/74.3	20-144	44.5	35	--	--
1108452	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	1,1-Dichloroethene	98/65.5	24-174	39.8	35	--	--
1108452	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	1,2-Dichlorobenzene	88.9/39.2	10-148	77.6	35	--	--
1108452	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	1,2-Dichloropropane	91.6/62.6	28-140	37.7	35	--	--
1108452	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	Benzene	100/67.1	17-138	39.3	35	--	--
1108452	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	Chlorobenzene	93.3/51.8	13-150	57.3	35	--	--
1108452	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	Ethylbenzene	96.2/53.0	10-164	57.9	35	--	--
1108452	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	Isopropylbenzene	92.3/47.9	26-146	63.4	35	--	--

Table 3
Spike Recoveries Outside of Acceptable Limits
Red Butte Creek Investigation
Samples Collected August to November 2011
Salt Lake City, Utah

Lab Package	Spike Sample ID	Associated Sample	Compound	Recovery (%)	Limit (%)	RPD	RPD Limit	Sample Result	ERM Qualifier
1108452	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	Naphthalene	45.0/21.9	13-156	69	35	--	--
1108452	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	Toluene	84.3/39.9	23-168	47.8	35	--	--
1108452	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	Trichloroethene	100/62.0	14-161	47.3	35	--	--
1108452	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	Xylenes, total	92.5/46.2	10-160	59.5	35	--	--
1108453	Batch MS/MSD	NA	Phenol	73.6/65.9	10-71	11	35.0	--	--
1108453	Red Butte Creek Below 1300 E. -Bank MS/MSD	NA	Phenol	79.7/68.5	10-71	15.2	35	--	--
1108453	Red Butte Cr. @ Gaging Station MS/MSD	NA	Pentachlorophenol	44.1/59.0	10-131	28.9	25	--	--
1108453	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	1,1,1-Trichloroethane	117/74.3	20-144	44.5	35	--	--
1108453	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	1,1-Dichloroethene	98/65.5	24-174	39.8	35	--	--
1108453	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	1,2-Dichlorobenzene	88.9/39.2	10-148	77.6	35	--	--
1108453	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	1,2-Dichloropropane	91.6/62.6	28-140	37.7	35	--	--
1108453	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	Benzene	100/67.1	17-138	39.3	35	--	--
1108453	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	Chlorobenzene	93.3/51.8	13-150	57.3	35	--	--

Table 3
Spike Recoveries Outside of Acceptable Limits
Red Butte Creek Investigation
Samples Collected August to November 2011
Salt Lake City, Utah

Lab Package	Spike Sample ID	Associated Sample	Compound	Recovery (%)	Limit (%)	RPD	RPD Limit	Sample Result	ERM Qualifier
1108453	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	Ethylbenzene	96.2/53.0	10-164	57.9	35	--	--
1108453	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	Isopropylbenzene	92.3/47.9	26-146	63.4	35	--	--
1108453	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	Naphthalene	45.0/21.9	13-156	69	35	--	--
1108453	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	Toluene	84.3/39.9	23-168	47.8	35	--	--
1108453	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	Trichloroethene	100/62.0	14-161	47.3	35	--	--
1108453	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	Xylenes, total	92.5/46.2	10-160	59.5	35	--	--
1108454	Batch MS/MSD	NA	DRO	523/1690	10-230	30	25	4X	--
1108454	Red Butte Cr. Below Chipeta - Bed MS/MSD	NA	ORO	77.3/-23.1	10-200	40.9	30	--	--
1108454	Red Butte Creek Below 1300 E. -Bank MS/MSD	NA	Phenol	79.7/68.5	10-71	15.2	35	--	--
1108454	Red Butte Cr. @ Gaging Station MS/MSD	NA	Pentachlorophenol	44.1/59.0	10-131	28.9	25	--	--
1108454	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	1,1,1-Trichloroethane	117/74.3	20-144	44.5	35	--	--
1108454	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	1,1-Dichloroethene	98/65.5	24-174	39.8	35	--	--
1108454	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	1,2-Dichlorobenzene	88.9/39.2	10-148	77.6	35	--	--

Table 3
Spike Recoveries Outside of Acceptable Limits
Red Butte Creek Investigation
Samples Collected August to November 2011
Salt Lake City, Utah

Lab Package	Spike Sample ID	Associated Sample	Compound	Recovery (%)	Limit (%)	RPD	RPD Limit	Sample Result	ERM Qualifier
1108454	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	1,2-Dichloropropane	91.6/62.6	28-140	37.7	35	--	--
1108454	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	Benzene	100/67.1	17-138	39.3	35	--	--
1108454	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	Chlorobenzene	93.3/51.8	13-150	57.3	35	--	--
1108454	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	Ethylbenzene	96.2/53.0	10-164	57.9	35	--	--
1108454	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	Isopropylbenzene	92.3/47.9	26-146	63.4	35	--	--
1108454	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	Naphthalene	45.0/21.9	13-156	69	35	--	--
1108454	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	Toluene	84.3/39.9	23-168	47.8	35	--	--
1108454	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	Trichloroethene	100/62.0	14-161	47.3	35	--	--
1108454	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	Xylenes, total	92.5/46.2	10-160	59.5	35	--	--
1108455	Batch MS/MSD	NA	DRO	523/1690	10-230	30	25	4X	--
1108455	Red Butte Cr. Below Chipeta - Bed MS/MSD	NA	ORO	77.3/-23.1	10-200	40.9	30	--	--
1108455	Red Butte Creek Below 1300 E. -Bank MS/MSD	NA	Phenol	79.7/68.5	10-71	15.2	35	--	--
1108455	Red Butte Cr. @ Gaging Station MS/MSD	NA	Pentachlorophenol	44.1/59.0	10-131	28.9	25	--	--

Table 3
Spike Recoveries Outside of Acceptable Limits
Red Butte Creek Investigation
Samples Collected August to November 2011
Salt Lake City, Utah

Lab Package	Spike Sample ID	Associated Sample	Compound	Recovery (%)	Limit (%)	RPD	RPD Limit	Sample Result	ERM Qualifier
1108455	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	1,1,1-Trichloroethane	117/74.3	20-144	44.5	35	--	--
1108455	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	1,1-Dichloroethene	98/65.5	24-174	39.8	35	--	--
1108455	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	1,2-Dichlorobenzene	88.9/39.2	10-148	77.6	35	--	--
1108455	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	1,2-Dichloropropane	91.6/62.6	28-140	37.7	35	--	--
1108455	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	Benzene	100/67.1	17-138	39.3	35	--	--
1108455	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	Chlorobenzene	93.3/51.8	13-150	57.3	35	--	--
1108455	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	Ethylbenzene	96.2/53.0	10-164	57.9	35	--	--
1108455	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	Isopropylbenzene	92.3/47.9	26-146	63.4	35	--	--
1108455	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	Naphthalene	45.0/21.9	13-156	69	35	--	--
1108455	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	Toluene	84.3/39.9	23-168	47.8	35	--	--
1108455	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	Trichloroethene	100/62.0	14-161	47.3	35	--	--
1108455	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	Xylenes, total	92.5/46.2	10-160	59.5	35	--	--
1108489	Red Butte Cr. Below Chipeta - Bed MS/MSD	NA	ORO	77.3/-23.1	10-200	40.9	30	--	--

Table 3
Spike Recoveries Outside of Acceptable Limits
Red Butte Creek Investigation
Samples Collected August to November 2011
Salt Lake City, Utah

Lab Package	Spike Sample ID	Associated Sample	Compound	Recovery (%)	Limit (%)	RPD	RPD Limit	Sample Result	ERM Qualifier
1108489	Red Butte Creek Below 1300 E. -Bank MS/MSD	NA	Phenol	79.7/68.5	10-71	15.2	35	--	--
1108489	City Cr. Below N. Cyn. Loop - Bank MS/MSD	NA	Phenol	93.4/90.9	10-71	2.78	35	--	--
1108489	Red Butte Cr. @ Gaging Station MS/MSD	NA	Pentachlorophenol	44.1/59.0	10-131	28.9	25	--	--
1108489	Batch MS/MSD	NA	Benzo(a)pyrene	115/61.0	15-169	61.4	25	--	--
1108489	Batch MS/MSD	NA	Pentachlorophenol	67.5/93.5	10-131	32.3	25	--	--
1108489	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	1,1,1-Trichloroethane	117/74.3	20-144	44.5	35	--	--
1108489	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	1,1-Dichloroethene	98.0/65.5	24-174	39.8	35	--	--
1108489	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	1,2-Dichlorobenzene	88.9/39.2	10-148	77.6	35	--	--
1108489	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	1,2-Dichloropropane	91.6/62.6	28-140	37.7	35	--	--
1108489	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	Benzene	100/67.1	17-138	39.3	35	--	--
1108489	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	Chlorobenzene	93.3/51.8	13-150	57.3	35	--	--
1108489	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	Ethylbenzene	96.2/53.0	10-164	57.9	35	--	--
1108489	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	Isopropylbenzene	92.3/47.9	26-146	63.4	35	--	--
1108489	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	Naphthalene	45.0/21.9	13-156	69	35	--	--

Table 3
Spike Recoveries Outside of Acceptable Limits
Red Butte Creek Investigation
Samples Collected August to November 2011
Salt Lake City, Utah

Lab Package	Spike Sample ID	Associated Sample	Compound	Recovery (%)	Limit (%)	RPD	RPD Limit	Sample Result	ERM Qualifier
1108489	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	Toluene	84.3/39.9	23-168	47.8	35	--	--
1108489	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	Trichloroethene	100/62.0	14-161	47.3	35	--	--
1108489	Red Butte Cr. @ Mt. Olivet Diversion - Bank MS/MSD	NA	Xylenes, total	92.5/46.2	10-160	59.5	35	--	--
1108489	Batch MS/MSD	NA	Tetrahydrofuran	71.5/101	43-146	33.9	25	--	--
1108511	City Cr. Below N. Cyn. Loop - Bank MS/MSD	NA	Phenol	93.4/90.9	10-71	2.78	35	--	--
1108511	Batch MS/MSD	NA	4-Nitorphenol	7.41/0	10-135	200	35	--	--
1108511	Batch MS/MSD	NA	Phenol	88.5/82.9	10-71	6.45	35	--	--
1108511	Batch MS/MSD	NA	Benzo(a)pyrnee	115/61.0	15-169	61.4	25	--	--
1108511	Batch MS/MSD	NA	Pentachlorophenol	67.5/93.5	10-131	32.3	25	--	--
1108511	Parleys Cr. Above 2000 E. - Bank MS/MSD	NA	Tetrahydrofuran	75.8/52.8	10-136	35.9	35	--	--
1108511	Batch MS/MSD	NA	Naphthalene	73.4/50.7	13-156	41.1	35	--	--
1109118	SL-15 MS/MSD	NA	Acenaphthene	129/112	31-113	14	35	--	--
1109118	SL-15 MS/MSD	NA	Pyrene	152/135	31-150	12	35	--	--
1109118	SL-15 MS/MSD	NA	Acenaphthene	136/119	31-113	12.9	35	--	--
1109118	BD-1 MS/MSD	NA	Tetrahydrofuran	54.8/76.6	43-146	33.2	25	--	--
1110562	Reidel Pond Inlet MS/MSD	NA	DRO	57.1/77.2	60-161	29.9	25	--	--
1110562	Reidel Pond Outlet MS/MSD	NA	1,4-Naphthoquinone	10.4/7.95	10-177	26.9	99	--	--
1110562	Reidel Pond Outlet MS/MSD	NA	3&4-Methylphenol	122/105	10-96	15.4	99	--	--
1110562	Reidel Pond Outlet MS/MSD	NA	3,3'-Dimethylbenzidine	175/179	10-152	2.07	99	--	--
1110562	Reidel Pond Outlet MS/MSD	NA	Hexachlorophene	199/199	10-168	0.207	25	--	--

Table 3
Spike Recoveries Outside of Acceptable Limits
Red Butte Creek Investigation
Samples Collected August to November 2011
Salt Lake City, Utah

Lab Package	Spike Sample ID	Associated Sample	Compound	Recovery (%)	Limit (%)	RPD	RPD Limit	Sample Result	ERM Qualifier
1110562	Reidel Pond Outlet MS/MSD	NA	Kepone	10.2/140	10-175	173	46	--	--
1110562	Reidel Pond Outlet MS/MSD	NA	n-Decane	9.91/6.68	10-53	39	32	--	--
1110562	Reidel Pond Outlet MS/MSD	NA	o-Toluidine	118/91.9	10-107	24.8	46	--	--
1110562	Reidel Pond Sediment MS/MSD	NA	4,6-Dinitro-2-methylphenol	29.5/47.0	10-250	45.9	35	--	--
1110562	Reidel Pond Sediment MS/MSD	NA	Phenol	88.2/90.0	10-71	1.99	35	--	--
1110562	Reidel Pond Sediment MS/MSD	NA	Pentachlorophenol	249/245	20-131	1.58	35	--	--
1110562	Reidel Pond Outlet MS/MSD	NA	2-Chloroethyl vinyl ether	0/0	32-163	0	25	--	--
1110562	Reidel Pond Outlet MS/MSD	NA	Acrolein	0/97.5	10-325	200	25	--	--

Data packages reviewed: AWAL 1108452, 1108453, 1108454, 1108455, 1108489, 1108511, 1109118, 1110562; ALS 1108369, 1108370, 1108371, 1108372, 1108373, 1108415, 1109099; Lancaster 1263977

Key:
LCS = Laboratory control sample
MS/MSD = Matrix spike/matrix spike duplicate
RPD = Relative percent difference
Batch = Sample was prepared using a non-client sample
NA = Not applicable; associated samples not qualified
ORO = Oil range organics; 28 to 36 carbon chain range
DRO = Diesel range organics; 10 to 28 carbon chain range
4X = Concentration of unspiked sample was greater than 4 times the amount spiked; no qualification required

Table 4
Field Duplicate Results and Calculated Relative Percent Differences
Red Butte Creek Investigation
Samples Collected August to November 2011
Salt Lake City, Utah

Lab Package	Sample/Duplicate ID	Compound	Concentration		Report Limit	Units	RPD
			Sample	Duplicate			
1108369	Mill Cr. Below 700 E.-Bed/BD-1-Bed	TOC	4100	4900	620	mg/kg	18
1108369	Mill Cr. Below 700 E.-Bank/BD-1-Bank	TOC	22000	11000	3700/3200	mg/kg	67
1108369	City Cr. Near Cyn. Entrance Gate-Bed/BD-2-Bed	TOC	810	2200	310/300	mg/kg	92
1108369	City Cr. Near Cyn. Entrance Gate-Bank/BD-2-Bank	TOC	10000	11000	1400/1700	mg/kg	10
1108489	Mill Cr. Below 700 E.-Bed/BD-1-Bed	Moisture	22.1	22.6	0.0100	%	2.2
1108489	Mill Cr. Below 700 E.-Bed/BD-1-Bed	Total Solids	77.9	77.4	0.0100	%	0.6
1108489	Mill Cr. Below 700 E.-Bank/BD-1-Bank	Moisture	31.8	31.8	0.0100	%	0
1108489	Mill Cr. Below 700 E.-Bank/BD-1-Bank	Total Solids	68.2	68.2	0.0100	%	0
1108489	City Cr. Near Cyn. Entrance Gate-Bed/BD-2-Bed	Moisture	20.8	19.0	0.0100	%	9.0
1108489	City Cr. Near Cyn. Entrance Gate-Bed/BD-2-Bed	Total Solids	79.2	81.0	0.0100	%	2.2
1108489	City Cr. Near Cyn. Entrance Gate-Bank/BD-2-Bank	Moisture	25.1	24.5	0.0100	%	2.4
1108489	City Cr. Near Cyn. Entrance Gate-Bank/BD-2-Bank	Total Solids	74.9	75.5	0.0100	%	0.8
1108489	Mill Cr. Below 700 E.-Bed/BD-1-Bed	DRO	113	186	25.7/51.7	mg/kg	49
1108489	Mill Cr. Below 700 E.-Bank/BD-1-Bank	DRO	255	258	58.7/58.6	mg/kg	1.2
1108489	City Cr. Near Cyn. Entrance Gate-Bank/BD-2-Bank	DRO	36.7	42.8	26.7/26.5	mg/kg	15
1108489	Mill Cr. Below 700 E.-Bed/BD-1-Bed	ORO	64.2	161	25.7/25.8	mg/kg	86
1108489	Mill Cr. Below 700 E.-Bank/BD-1-Bank	ORO	214	180	29.3	mg/kg	17
1108489	Mill Cr. Below 700 E.-Bed/BD-1-Bed	Fluoranthene	232	35.3	12.8/12.9	µg/kg	147
1108489	Mill Cr. Below 700 E.-Bed/BD-1-Bed	Pyrene	200	40.5	12.8/12.9	µg/kg	133
1108489	Mill Cr. Below 700 E.-Bank/BD-1-Bank	Benz(a)anthracene	42.1	39.1	14.7	µg/kg	7.4
1108489	Mill Cr. Below 700 E.-Bank/BD-1-Bank	Benzo(b)fluoranthene	43.0	46.9	14.7	µg/kg	8.7
1108489	Mill Cr. Below 700 E.-Bank/BD-1-Bank	Chrysene	58.7	58.6	14.7	µg/kg	0.2
1108489	Mill Cr. Below 700 E.-Bank/BD-1-Bank	Fluoranthene	104	75.2	14.7	µg/kg	32
1108489	Mill Cr. Below 700 E.-Bank/BD-1-Bank	Phenanthrene	62.6	34.2	14.7	µg/kg	59
1108489	Mill Cr. Below 700 E.-Bank/BD-1-Bank	Pyrene	111	87.0	14.7	µg/kg	24

Table 4
Field Duplicate Results and Calculated Relative Percent Differences
Red Butte Creek Investigation
Samples Collected August to November 2011
Salt Lake City, Utah

Lab Package	Sample/Duplicate ID	Compound	Concentration		Report Limit	Units	RPD
			Sample	Duplicate			
1108489	Mill Cr. Below 700 E.-Bed/BD-1-Bed	Bis(2-ethylhexyl)adipate	1370	1470	860/866	µg/kg	7.0

Data packages reviewed: AWAL 1108452, 1108453, 1108454, 1108455, 1108489, 1108511, 1109118, 1110562; ALS 1108369, 1108370, 1108371, 1108372, 1108373, 1108415, 1109099; Lancaster 1263977

Key:
RPD = Relative percent difference
TOC = Total organic carbon; Walkley-Black Method, ASA-9 90-3
mg/kg = Milligrams per kilogram
µg/kg = Micrograms per kilogram

Table 5
Analytical Duplicate Results and Calculated Relative Percent Differences
Red Butte Creek Investigation
Samples Collected August to November 2011
Salt Lake City, Utah

Lab Package	Sample ID	Compound	Concentration		Report Limit	Units	RPD	ERM Qualifier
			Sample	Duplicate				
1108369	Mill Cr. Below 700 E. - Bed	TOC	4100	4320	607	mg/kg	5.2	--
1108454	Red Butte Cr. @ Univ. Marriott - Bank	Moisture	27.85	26.6	0.0100	%	4.6	--
1108454	Batch duplicate	Moisture	1.130	1.22	0.0100	%	7.7	--
1108454	Red Butte Cr. @ Univ. Marriott - Bank	Total Solids	72.15	73.4	0.0100	%	1.7	--
1108454	Batch duplicate	Total Solids	98.87	98.8	0.0100	%	0.1	--
1108455	Red Butte Cr. @ Univ. Marriott - Bank	Moisture	27.85	26.6	0.0100	%	4.6	--
1108455	Red Butte Cr. @ Univ. Marriott - Bank	Total Solids	72.15	73.4	0.0100	%	1.7	--
1108489	Batch duplicate	Moisture	1.120	1.00	0.0100	%	11	--
1108489	Mill Cr. Below HIghland Drive - Bank	Moisture	26.59	27.5	0.0100	%	3.4	--
1108489	Batch duplicate	Total Solids	99.09	99.0	0.0100	%	0.1	--
1108489	Mill Cr. Below HIghland Drive - Bank	Total Solids	73.41	72.5	0.0100	%	1.2	--
1108511	Batch duplicate	Moisture	10.72	11.3	0.0100	%	5.3	--
1108511	Parleys Cr. Above I-215 - Bank	Moisture	21.62	19.6	0.0100	%	9.8	--
1108511	Batch duplicate	Total Solids	89.28	88.7	0.0100	%	0.7	--
1108511	Parleys Cr. Above I-215 - Bank	Total Solids	78.38	80.4	0.0100	%	2.5	--
1109099	SD-16	TOC	650	642	287	mg/kg	1.2	--

Data packages reviewed: AWAL 1108452, 1108453, 1108454, 1108455, 1108489, 1108511, 1109118, 1110562; ALS 1108369, 1108370, 1108371, 1108372, 1108373, 1108415, 1109099; Lancaster 1263977

Key:
RPD = Relative percent difference
TOC = Total organic carbon; Walkley-Black Method, ASA-9 90-3
Batch = Sample prepared using non-client sample
mg/kg = Milligrams per kilogram

Table 6
Calibration Range Exceedances
Red Butte Creek Investigation
Samples Collected August to November 2011
Salt Lake City, Utah

Lab Package	Sample ID	Compound	Reported Concentration	Units	ERM Qualifier	Notes
1110019	Weber Sand Mix Crude	1-Methylnaphthalene	508 E	mg/kg	J	Concentration exceeds calibration range
1110019	Weber Sand Mix Crude	2-Methylnaphthalene	399 E	mg/kg	J	Concentration exceeds calibration range
1110019	Weber Sand Mix Crude	Naphthalene	282 E	mg/kg	J	Concentration exceeds calibration range
1110562	Hayes Asphalt	Benz(a)anthracene	821 E	µg/kg	J	Concentration exceeds calibration range
1110562	Hayes Asphalt	Benzo(a)pyrene	941 E	µg/kg	J	Concentration exceeds calibration range
1110562	Hayes Asphalt	Chrysene	1770 E	µg/kg	J	Concentration exceeds calibration range
1110562	Hayes Asphalt	Phenanthrene	1230 E	µg/kg	J	Concentration exceeds calibration range
1110562	Hayes Asphalt	Pyrene	4530 E	µg/kg	J	Concentration exceeds calibration range

Data packages reviewed: AWAL 1108452, 1108453, 1108454, 1108455, 1108489, 1108511, 1109118, 1110562; ALS 1108369, 1108370, 1108371, 1108372, 1108373, 1108415, 1109099; Lancaster 1263977

Key:
E = Sample concentration exceeded instrument calibration range
µg/kg = Micrograms per kilogram
J = Detected sample result qualified as estimated

Appendix D

Reference Creek (Ambient) Evaluation

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McDaniel Lambert

TO: **Mark Shibata**
ERM, Inc.
FROM: **Kathleen Souweine, MPH**
Katie Butler, MPH
McDaniel Lambert, Inc.
DATE: **April 27, 2012**

RE: **Red Butte – Statistical Comparisons**

MEMORANDUM

As requested, McDaniel Lambert, Inc. has prepared additional statistical comparisons between Red Butte Creek bed sediments versus reference ("background") creek bed sediments to aid ERM with the ecological risk characterization of Red Butte Creek. The analysis is for both polycyclic aromatic hydrocarbons (PAHs) and total petroleum hydrocarbons (TPH).

McDaniel Lambert has also provided updated results, tables, and graphs for the statistical comparisons between PAHs in Red Butte Creek bed and bank sediments versus background creek bed and bank sediments which differ slightly from those presented in the *Draft Human Health Risk Assessment (HHRA) for Red Butte Creek Salt Lake City, Utah* (McDaniel Lambert 2012). Conclusions following statistical comparisons have remained the same, and minor changes were made to summary statistics following ERM's data validation that recommended using 8270 data instead of 8270SIM for PAHs. Also, TPH comparisons were added to the bed and bank background evaluation.

1.0 Methods

In this background evaluation, PAH and TPH concentrations in Red Butte Creek sediment are compared to local background levels using exploratory analyses and statistical comparative methods based on USEPA guidance (USEPA 2002, USEPA 2010). For full details on the methods employed in this analysis, please refer to Section 2 of the Draft HHRA (McDaniel Lambert 2012).

2.0 Results for Bed and Bank Sediment Combined

The local background dataset consists of 32 sediment samples collected from various locations in surrounding unimpacted creeks (City Creek, Emigration Creek, Mill Creek and Parley's Creek). The Red Butte Creek dataset consists of 27 sediment samples collected during the August and October 2011 sampling events. Samples were collected from both the bottom of the creek bed (bed samples) as well as in exposed sediments in the surrounding banks (bank samples) in both Red Butte Creek and the background creeks. Statistical comparison tests determined that bed and bank data are not significantly different, demonstrating that the datasets (bed and bank) could be analyzed together for the background evaluation in the HHRA.

A background sample from an unimpacted and natural reach of Red Butte Creek, labeled as Above Amphitheater, was collected immediately upstream of the spill site. Because it was from Red Butte and not representative of the surrounding creeks, the Above Amphitheater sample was not included in the local background creeks dataset.

2.1 PAH Summary Statistics

Table 1 summarizes the analytical data for the 20 PAHs considered in the background evaluation. Per USEPA guidance, at least 4 to 6 detected observations were required to characterize the background population. Five PAHs, 1-methylnapthalene, 2-methylnapthalene, dibenz(a,h)anthracene, fluorene, and naphthalene, which were detected in Red Butte Creek, were not assessed in the background evaluation because there were insufficient detects. For the remaining PAHs with sufficient detections, exploratory data analysis was conducted prior to hypothesis testing. As indicated in the Q-Q plots (available in Attachment 1), most of the PAHs in Red Butte Creek and the background creeks have similar distributions; for benzo[k]fluoranthene, and indeno[1,2,3-cd]pyrene, the distribution of concentrations in Red Butte Creek appears to be higher than that of background. Concentrations for three samples taken at 1225 Harvard Ave (Oct 2011), Above 1500 E. (Aug 2011), and 1731 E. 900 S. (Aug 2011) are consistently present in the upper tail of the distributions and were determined to be potential outliers. This may indicate that samples taken at these locations may be representative of a different source or population than the rest of the Red Butte Creek dataset.

2.1.1 PAH Hypothesis Tests

Table 2 summarizes the results of the Shapiro-Wilks test for normality, comparison tests, and background analysis outcomes. Per USEPA guidance, at least 8 to 10 detected observations were required to perform statistical background comparison tests. Gehan's test for central tendency was conducted for seven PAHs; results indicated that concentrations of all seven PAHs – benzo(a)anthrancene, benzo(a)pyrene, benzo(b)flouranthene, chrysene, flouranthene, phenenthrene and pyrene – in sediment at Red Butte Creek are consistent with or below local background levels. While Gehan's tests indicate that there is no statistical difference between the distributions of PAH concentrations at Red Butte Creek and those in background, visual inspection of the Q-Q plots indicate that upper tails of the onsite data may differ from upper tails of the background data. Therefore, the upper tail (quantile) test was used to detect whether a shift to the right in the uppertails of the onsite and background distributions is present. The upper tail test was conducted for seven PAHs; results were consistent with the central tendency tests, concluding Red Butte Creek to be at or below background levels. Results of both the Gehan and upper tail tests show Red Butte Creek to be consistent with background; however, visual inspection of the Q-Q plots shows the presence of outliers above background concentration.

2.1.2 PAH Comparison to Background Level Threshold Values

Hypothesis testing is the preferred approach to compare site and background concentrations; however, individual site observations can be compared with background threshold values (BTVs) to identify potential hotspots. Table 3 shows a comparison of the maximum detections at each sampling locations and the calculated BTVs for each PAH with sufficient detects. Instances where creek detections exceeded the BTV occurred only in three distinct locations: 1731 East 900 South, Above 1500 East, and 1225 Harvard Ave; these locations are consistent

with the outliers identified in the previous analysis. The results indicate that PAH concentrations in sediment collected from three locations are representative of a different source or population than the rest of the Red Butte Creek dataset.

2.2 TPH Summary Statistics and Hypothesis Tests

Table 1 summarizes the analytical data for the TPH Diesel Range Organics (DRO) and TPH Oil Range Organics (ORO). Overall, the Q-Q plots for TPH DRO and TPH ORO (Attachment 1) show similar distributions of TPHs in Red Butte Creek and background creeks; however the distribution of TPH Diesel in background creeks appears to have elevated concentrations in the upper tail, potentially representing outliers in the background creek dataset. Table 2 summarizes the results of the Shapiro-Wilks test for normality, comparison tests, and background analysis outcomes. Because TPH Diesel was detected in 100% of both Red Butte and background samples and concentrations fit a normal or lognormal distribution, the two-sample t-test was chosen to compare the populations. The t-test concluded TPH DRO in Red Butte Creek to be at or below background levels. Gehan's test for central tendency was conducted for TPH ORO; results indicated that TPH ORO in Red Butte Creek is also consistent with or below local background levels. The upper tail (quantile) test was used to detect whether a shift to the right in the uppertails of the onsite and background distributions is present for TPH DRO and TPH ORO. Results were consistent with the central tendency tests, concluding Red Butte Creek to be at or below background levels.

3.0 Results for Bed Sediment

The local background bed sediment dataset is based on 16 samples collected from bed sediment in surrounding unimpacted creeks (City Creek, Emigration Creek, Mill Creek and Parley's Creek). The Red Butte Creek bed sediment dataset consists of 15 samples collected from bed sediment during the August and October 2011 sampling events. The bed sediment samples are a subset of the entire suite of samples (bed and bank) discussed in Section 2. As in the comparison conducted with both creek bed and bank sediment, the Above Amphitheater sample was not included in the background creeks dataset.

3.1 PAH Summary Statistics and Hypothesis Tests

Table 4 summarizes the analytical data for the 20 PAHs considered in the background evaluation. Per USEPA guidance, at least 4 to 6 detected observations were required to characterize the background population. Eleven PAHs, 1-methylnapthalene, 2-methylnapthalene, anthracene, benz(a)anthracene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, dibenz(a,h)anthracene, fluorene, indeno(1,2,3-cd)pyrene, and naphthalene, which were detected in Red Butte Creek bed sediment, were not assessed in the background evaluation because there were insufficient detects.

For the five PAHs with sufficient detections, exploratory data analysis was conducted prior to hypothesis testing. As indicated in the Q-Q plots (available in Attachment 2), the PAHs in Red Butte Creek and the background creeks have similar distributions; however, for fluoranthene, phenanthrene, and pyrene, the distribution of concentrations in Red Butte Creek bed sediment appears to be slightly lower than that of background bed sediment. Concentrations for the bed sample taken at 1225 Harvard Ave in Red Butte Creek (Oct 2011) are sometimes present in the upper tail of the distributions, and this sample was determined to be a potential outlier. This

indicates that 1225 Harvard Ave may be representative of a different source or population than the rest of the Red Butte Creek dataset.

Table 5 summarizes the results of the Shapiro-Wilks test for normality, comparison tests, and background analysis outcomes. Per USEPA guidance, at least 8 to 10 detected observations were required to perform statistical background comparison tests. Gehan's test for central tendency was conducted for three PAHs with sufficient detects; results indicated that concentrations of those three PAHs –chrysene, flouranthene, and pyrene – in bed sediment at Red Butte Creek are consistent with or below local background levels. The upper tail (quantile) test was used to detect whether a shift to the right in the uppertails of the onsite and background distributions is present. The upper tail test was conducted for three PAHs; results were consistent with the central tendency tests, concluding Red Butte Creek to be at or below background levels. Unlike the bed and bank data, the bed data did not show excessive evidence of potential hotspots with higher concentrations for the PAHs evaluated. Therefore, a BTV analysis was determined to be unnecessary. While the comparisons show that some Red Butte Creek PAHs in bed sediment are consistent with background sources, the results are inconclusive for most PAHs due to insufficient detects.

3.2 *TPH Summary Statistics and Hypothesis Tests*

Table 4 summarizes the analytical data for the TPH DRO and TPH ORO considered in the background evaluation. The Q-Q plots for TPH DRO and TPH ORO show the distributions of both TPHs appear slightly higher in Red Butte Creek than background creeks (see Attachment 2). Table 5 summarizes the results of the Shapiro-Wilks test for normality, comparison tests, and background analysis outcomes. Because TPH Diesel was detected in 100% of both Red Butte and background sediment bed samples and concentrations fit a normal or lognormal distribution, the two-sample t-test was chosen to compare the populations. The t-test concluded TPH DRO in Red Butte Creek to be at or below background levels. However, consideration of both the comparison test results and the appearance of the Q-Q plot provide insufficient evidence to conclude TPH DRO in Red Butte bed sediment is consistent with TPH DRO in background bed sediment. Gehan's test for central tendency was conducted for TPH ORO; the resulting p-value of 0.06 indicates that there is insufficient data to conclude Red Butte bed sediment is consistent with background bed sediment. In summary, there are too few samples to conclusively determine whether or not TPH DRO and TPH ORO are consistent with background in bed sediment.

Enclosure:

Table 1: PAH Summary Statistics for Red Butte Creek and Background
Table 2: Background Comparison Summary Table
Table 3: Background Threshold Values (BTV) Comparison
Table 4: PAH Summary Statistics for Red Butte Creek and Background, Bed Sediment
Table 5: Background Comparison Summary Table, Bed Sediment
Attachment 1: Q-Q Plots, Bed and Bank Sediment
Attachment 2: Q-Q Plots, Bed Sediment

References:

McDaniel Lambert, Inc. 2012. Draft Human Health Risk Assessment. Red Butte Creek, Salt Lake City, Utah. March.

U.S. Environmental Protection Agency (USEPA). 2002. Guidance for Comparing Background and Chemical Concentrations in Soils for CERCLA Sites. September. OSWER 9285.7-41.

U.S. Environmental Protection Agency (USEPA). 2010. ProUCL – Version 4.1. Environmental Sciences Division, National Exposure Research Laboratory. Available from worldwide web: http://www.epa.gov/esd/tsc/software.htm#ProUCL. User's Guide dated May 2010.

TABLES

Table 1. PAH Summary Statistics for Red Butte Creek and Background

			Non Detects		Detects				
	N	% Detect	Min	Max	Min	Max	Mean	Median	Std. Dev
1-Methylnaphthalene									
Red Butte Creek	27	11%	0.010	0.014	0.014	0.026	0.018	0.015	0.0063
Background	32	3%	0.011	0.015	0.053	0.053	0.053	0.053	-
2-Chloronaphthalene									
Red Butte Creek	24	0%	0.344	0.483	-	-	-	-	-
Background	32	0%	0.366	0.502	-	-	-	-	-
2-Methylnaphthalene									
Red Butte Creek	27	4%	0.010	0.015	0.024	0.024	0.024	0.024	-
Background	32	0%	0.011	0.015	-	-	-	-	-
Acenaphthene									
Red Butte Creek	27	0%	0.010	0.015	-	-	-	-	-
Background	32	3%	0.00067	0.015	0.0010	0.0010	0.0010	0.0010	-
Acenaphthylene									
Red Butte Creek	27	0%	0.010	0.015	-	-	-	-	-
Background	32	3%	0.00033	0.015	0.00039	0.00039	0.00039	0.00039	-
Anthracene									
Red Butte Creek	27	19%	0.010	0.014	0.014	0.090	0.052	0.058	0.031
Background	32	25%	0.011	0.015	0.00039	0.072	0.024	0.016	0.026
Benz(a)anthracene									
Red Butte Creek	27	37%	0.010	0.014	0.026	0.365	0.113	0.052	0.120
Background	32	56%	0.011	0.015	0.00083	0.234	0.062	0.045	0.053
Benzo(a)pyrene									
Red Butte Creek	27	33%	0.010	0.014	0.026	0.300	0.113	0.042	0.107
Background	32	41%	0.011	0.015	0.0017	0.125	0.049	0.042	0.035
Benzo(b)fluoranthene									
Red Butte Creek	27	33%	0.010	0.014	0.030	0.352	0.131	0.056	0.128
Background	32	1225	0.011	0.015	0.0016	0.205	0.064	0.053	0.049
Benzo(g,h,i)perylene									
Red Butte Creek	27	15%	0.010	0.014	0.019	0.269	0.097	0.050	0.117
Background	32	13%	0.011	0.015	0.0015	0.031	0.013	0.011	0.014
Benzo(k)fluoranthene									
Red Butte Creek	27	19%	0.010	0.014	0.016	0.145	0.088	0.105	0.060
Background	32	22%	0.011	0.015	0.0013	0.062	0.026	0.026	0.023
Chrysene									
Red Butte Creek	27	59%	0.011	0.014	0.014	0.373	0.081	0.038	0.100
Background	32	59%	0.011	0.015	0.0011	0.223	0.070	0.059	0.053
Dibenz(a,h)anthracene									
Red Butte Creek	27	11%	0.010	0.014	0.020	0.200	0.086	0.039	0.099
Background	32	3%	0.00066	0.015	0.0037	0.0037	0.0037	0.0037	-
Fluoranthene									
Red Butte Creek	27	59%	0.011	0.014	0.025	0.702	0.141	0.059	0.197
REIDEL Pond	32	69%	0.011	0.015	0.0016	0.487	0.114	0.095	0.112
Fluorene									
Red Butte Creek	27	4%	0.010	0.014	0.021	0.021	0.021	0.021	-
Background	32	3%	0.00066	0.015	0.029	0.029	0.029	0.029	-
Indeno(1,2,3-cd)pyrene									
Red Butte Creek	27	22%	0.010	0.014	0.035	0.344	0.130	0.110	0.111
Background	32	22%	0.00067	0.015	0.0015	0.059	0.035	0.033	0.024
Naphthalene									
Red Butte Creek	27	15%	0.0020	0.0028	0.014	0.029	0.022	0.022	0.0072
Background	32	3%	0.00066	0.0030	0.049	0.049	0.049	0.049	-
Phenanthrene									
Red Butte Creek	27	41%	0.010	0.014	0.017	0.347	0.106	0.050	0.110
Background	32	56%	0.011	0.015	0.0011	0.371	0.096	0.076	0.096
Pyrene									
Red Butte Creek	27	59%	0.011	0.014	0.030	0.602	0.135	0.064	0.173
Background	32	69%	0.011	0.015	0.0020	0.379	0.107	0.082	0.097
TPH Diesel Range Organics									
Red Butte Creek	24	100%	-	-	38.5	165	89.9	79.2	35.4
Background	32	100%	-	-	29.5	308	103.7	86.3	76.3
TPH Oil Range Organics									
Red Butte Creek	24	88%	22.3	24.9	30.5	199	86.5	77.7	45.8
Background	32	75%	23.5	27.6	26.2	214	83.8	77.8	48.6

Note: Concentrations in mg/kg.

Table 2. Background Comparison Summary Table

Analyte	Is Site> Bkgd?	Rationale	Background Comparison			
			Dataset[1]	Shapiro Wilk Test Conclusion	Central Tendency Test Conclusion H_0: site < bkgrd	Upper Tail Test (Quantile Test) Conclusion H_0: site < bkgrd
1-Methylnaphthalene	No	Insufficient data to conduct background tests or graphical analyses, test for proportions indicates frequency of detection not statistically different than background (p=0.268). Maximum detection less than only detection in background.				
2-Chloronaphthalene	No	Not detected in RBC				
2-Methylnaphthalene	No	Less than 5% detects in RBC				
Acenaphthene	No	Not detected in RBC				
Acenaphthylene	No	Not detected in RBC				
Anthracene	Inconclusive	Insufficient data to conduct statistical tests; RBC mean and median are higher than background				
Benz(a)anthracene	No	Statistical comparison tests conclude site levels at or below background	Red Butte Creek Background	Lognormal Not Normal	Gehan: p=0.82	Do Not Reject H_0
Benzo(a)pyrene	No	Statistical comparison tests conclude site levels at or below background	Red Butte Creek Background	Lognormal Normal	Gehan: p=0.49	Do Not Reject H_0
Benzo(b)fluoranthene	No	Statistical comparison tests conclude site levels at or below background	Red Butte Creek Background	Lognormal Not Normal	Gehan: p=0.85	Do Not Reject H_0
Benzo(g,h,i)perylene	Inconclusive	Insufficient data to conduct statistical tests; Visual inspection of QQ Plot inconclusive				
Benzo(k)fluoranthene	Inconclusive	Visual inspection of scatterplots indicates RBC distribution higher than background				
Chrysene	No	Statistical comparison tests conclude site levels at or below background	Red Butte Creek Background	Lognormal Not Normal	Gehan: p=0.58	Do Not Reject H_0
Dibenz(a,h)anthracene	Inconclusive	Insufficient data to conduct background tests or graphical analyses, test for proportions indicates frequency of detection not statistically different than background (p=0.268).Mean and median in RBC exceed only detection in background.				
Fluoranthene	No	Statistical comparison tests conclude site levels at or below background	Red Butte Creek Background	Not Normal Not Normal	Gehan: p=0.75	Do Not Reject H_0
Fluorene	No	Less than 5% detects in RBC; single detections in RBC and background are similar				
Indeno(1,2,3-cd)pyrene	Inconclusive	Insufficient data to conduct background tests; Visual inspection of scatterplots indicates RBC distribution higher than background				
Naphthalene	No	Insufficient data to conduct background tests or graphical analyses, test for proportions indicates frequency of detection not statistically different than background (p=0.147). Maximum detection less than only detection in background.				
Phenanthrene	No	Statistical comparison tests conclude site levels at or below background	Red Butte Creek Background	Lognormal Not Normal	Gehan: p=0.80	Do Not Reject H_0
Pyrene	No	Statistical comparison tests conclude site levels at or below background	Red Butte Creek Background	Not Normal Not Normal	Gehan: p=0.71	Do Not Reject H_0
TPH Diesel Range Organics	No	Statistical comparison tests conclude site levels at or below background	Red Butte Creek Background	Normal Lognormal	t-test: p=0.81	Do Not Reject H_0
TPH Oil Range Organics	No	Statistical comparison tests conclude site levels at or below background	Red Butte Creek Background	Normal Lognormal	Gehan: p=0.16	Do Not Reject H_0

[1]Red Butte Creek (RBC) dataset includes risk assessment data collected August and October 2011. Background data includes City, Emigration, Mill and Parleys Creeks. Bank and bed data were combined for RBC and background data because these datsets were not statistically different.

Table 3. Background Threshold Values (BTV) Comparison

Analyte	BTV[1] (mg/kg)	Location	Detects	Max. Detect (mg/kg)	Greater than BTV?
Anthracene	**0.035**	1731 E. 900 S.	2	0.071	yes
		Above 1500 E	1	0.058	yes
		1225 Harvard Ave	1	0.090	yes
		Univ. Marriott	1	0.028	no
Benz(a)anthracene	**0.120**	1731 E. 900 S.	3	0.365	yes
		Above 1500 E	1	0.267	yes
		Above Sunnyside	1	0.069	no
		Below 1100 E.	1	0.052	no
		Below 1300 E.	1	0.038	no
		Gaging Station	1	0.026	no
		1225 Harvard Ave	1	0.194	yes
		Univ. Marriott	1	0.039	no
Benzo(a)pyrene	**0.076**	1731 E. 900 S.	3	0.258	yes
		Above 1500 E	2	0.187	yes
		Above Sunnyside	1	0.040	no
		Below 1100 E.	1	0.042	no
		Below 1300 E.	1	0.040	no
		1225 Harvard Ave	1	0.300	yes
Benzo(b)fluoranthene	**0.118**	1731 E. 900 S.	3	0.352	yes
		Above 1500 E	1	0.288	yes
		Above Sunnyside	1	0.056	no
		Below 1300 E.	1	0.054	no
		Gaging Station	1	0.032	no
		1225 Harvard Ave	1	0.250	yes
		Univ. Marriott	1	0.030	no
Benzo(k)fluoranthene	**0.032**	1731 E. 900 S.	3	0.140	yes
		Above 1500 E	1	0.105	yes
		1225 Harvard Ave	1	0.145	yes
Chrysene	**0.132**	1731 E. 900 S.	4	0.373	yes
		Above 1500 E	2	0.257	yes
		Above Sunnyside	1	0.078	no
		Below 1100 E.	2	0.064	no
		Below 1300 E.	1	0.057	no
		Below 900 E.	2	0.025	no
		Gaging Station	1	0.042	no
		1225 Harvard Ave	1	0.162	yes
		Univ. Marriott	2	0.038	no

Table 3. Background Threshold Values (BTV) Comparison

Analyte	BTV[1] (mg/kg)	Location	Detects	Max. Detect (mg/kg)	Greater than BTV?
Fluoranthene	**0.259**	1731 E. 900 S.	4	0.702	yes
		Above 1500 E	3	0.533	yes
		Above Sunnyside	1	0.129	no
		Below 1100 E.	2	0.097	no
		Below 1300 E.	2	0.082	no
		Below 900 E.	2	0.028	no
		Gaging Station	1	0.045	no
		1225 Harvard Ave	1	0.257	no
		Univ. Marriott	2	0.097	no
Indeno(1,2,3-cd)pyrene	**0.039**	1731 E. 900 S.	3	0.127	yes
		Above 1500 E	1	0.096	yes
		Below 1300 E.	1	0.035	no
		1225 Harvard Ave	1	0.344	yes
Phenanthrene	**0.200**	1731 E. 900 S.	3	0.347	yes
		Above 1500 E	1	0.284	yes
		Above Sunnyside	1	0.078	no
		Below 1100 E.	2	0.050	no
		Below 1300 E.	2	0.033	no
		1225 Harvard Ave	1	0.131	no
		Univ. Marriott	1	0.111	no
Pyrene	**0.234**	1731 E. 900 S.	4	0.602	yes
		Above 1500 E	3	0.487	yes
		Above Sunnyside	1	0.121	no
		Below 1100 E.	2	0.094	no
		Below 1300 E.	2	0.074	no
		Below 900 E.	2	0.036	no
		Gaging Station	1	0.051	no
		1225 Harvard Ave	1	0.287	yes
		Univ. Marriott	2	0.098	no

[1]95% KM UPL (t)

Table 4. PAH Summary Statistics for Red Butte Creek and Background, Bed Sediment

			Non Detects		Detects				
	N	% Detect	Min	Max	Min	Max	Mean	Median	SD
1-Methylnaphthalene									
Red Butte Creek	15	20%	0.011	0.014	0.014	0.026	0.018	0.015	0.0063
Background	16	6%	0.011	0.015	0.053	0.053	0.053	0.053	-
2-Chloronaphthalene									
Red Butte Creek	12	0%	0.380	0.483	-	-	-	-	-
Background	16	0%	0.381	0.501	-	-	-	-	-
2-Methylnaphthalene									
Red Butte Creek	15	7%	0.011	0.015	0.024	0.024	0.024	0.024	-
Background	16	0%	0.011	0.015	-	-	-	-	-
Acenaphthene									
Red Butte Creek	15	0%	0.011	0.015	-	-	-	-	-
Background	16	0%	0.001	0.015	-	-	-	-	-
Acenaphthylene									
Red Butte Creek	15	0%	0.011	0.015	-	-	-	-	-
Background	16	0%	0.000	0.015	-	-	-	-	-
Anthracene									
Red Butte Creek	15	13%	0.011	0.014	0.014	0.090	0.052	0.052	0.054
Background	16	25%	0.012	0.015	0.00039	0.043	0.019	0.016	0.020
Benz(a)anthracene									
Red Butte Creek	15	20%	0.011	0.014	0.027	0.19	0.091	0.052	0.090
Background	16	56%	0.012	0.014	0.00083	0.099	0.055	0.052	0.031
Benzo(a)pyrene									
Red Butte Creek	15	27%	0.011	0.014	0.026	0.30	0.112	0.062	0.13
Background	16	50%	0.012	0.014	0.0017	0.061	0.039	0.042	0.018
Benzo(b)fluoranthene									
Red Butte Creek	15	20%	0.011	0.014	0.034	0.25	0.12	0.083	0.11
Background	16	56%	0.012	0.014	0.0016	0.095	0.052	0.048	0.029
Benzo(g,h,i)perylene									
Red Butte Creek	15	20%	0.011	0.014	0.019	0.27	0.12	0.072	0.13
Background	16	13%	0.011	0.015	0.0015	0.031	0.016	0.016	0.021
Benzo(k)fluoranthene									
Red Butte Creek	15	20%	0.011	0.014	0.016	0.15	0.064	0.032	0.070
Background	16	19%	0.011	0.015	0.0013	0.027	0.018	0.026	0.015
Chrysene									
Red Butte Creek	15	53%	0.011	0.014	0.014	0.16	0.045	0.031	0.048
Background	16	56%	0.012	0.014	0.0011	0.091	0.055	0.055	0.029
Dibenz(a,h)anthracene									
Red Butte Creek	15	20%	0.011	0.014	0.020	0.20	0.086	0.039	0.099
Background	16	0%	0.00067	0.015	-	-	-	-	-
Fluoranthene									
Red Butte Creek	15	53%	0.011	0.014	0.025	0.26	0.067	0.039	0.078
Background	16	75%	0.012	0.014	0.0016	0.24	0.10	0.095	0.079
Fluorene									
Red Butte Creek	15	7%	0.011	0.014	0.021	0.021	0.021	0.021	-
Background	16	0%	0.00067	0.015	-	-	-	-	-
Indeno(1,2,3-cd)pyrene									
Red Butte Creek	15	20%	0.011	0.014	0.057	0.34	0.18	0.13	0.15
Background	16	13%	0.00067	0.015	0.025	0.033	0.029	0.029	0.005
Naphthalene									
Red Butte Creek	15	20%	0.0023	0.0028	0.014	0.027	0.020	0.017	0.0069
Background	16	6%	0.00067	0.0030	0.049	0.049	0.049	0.049	-
Phenanthrene									
Red Butte Creek	15	33%	0.011	0.014	0.017	0.13	0.054	0.045	0.045
Background	16	63%	0.012	0.014	0.0011	0.23	0.080	0.070	0.067
Pyrene									
Red Butte Creek	15	53%	0.011	0.014	0.035	0.29	0.076	0.040	0.087
Background	16	75%	0.012	0.014	0.002	0.22	0.096	0.086	0.069
Diesel Range Organics									
Red Butte Creek	12	100%	-	-	38.5	124	82.9	79.9	30.1
Background	16	100%	-	-	29.5	186	74.1	66.6	41.5
Oil Range Organics									
Red Butte Creek	12	75%			31	199	93.4	108.0	54.5
Background	16	50%			29	113	70.0	72.3	25.2

Note: Concentrations in mg/kg

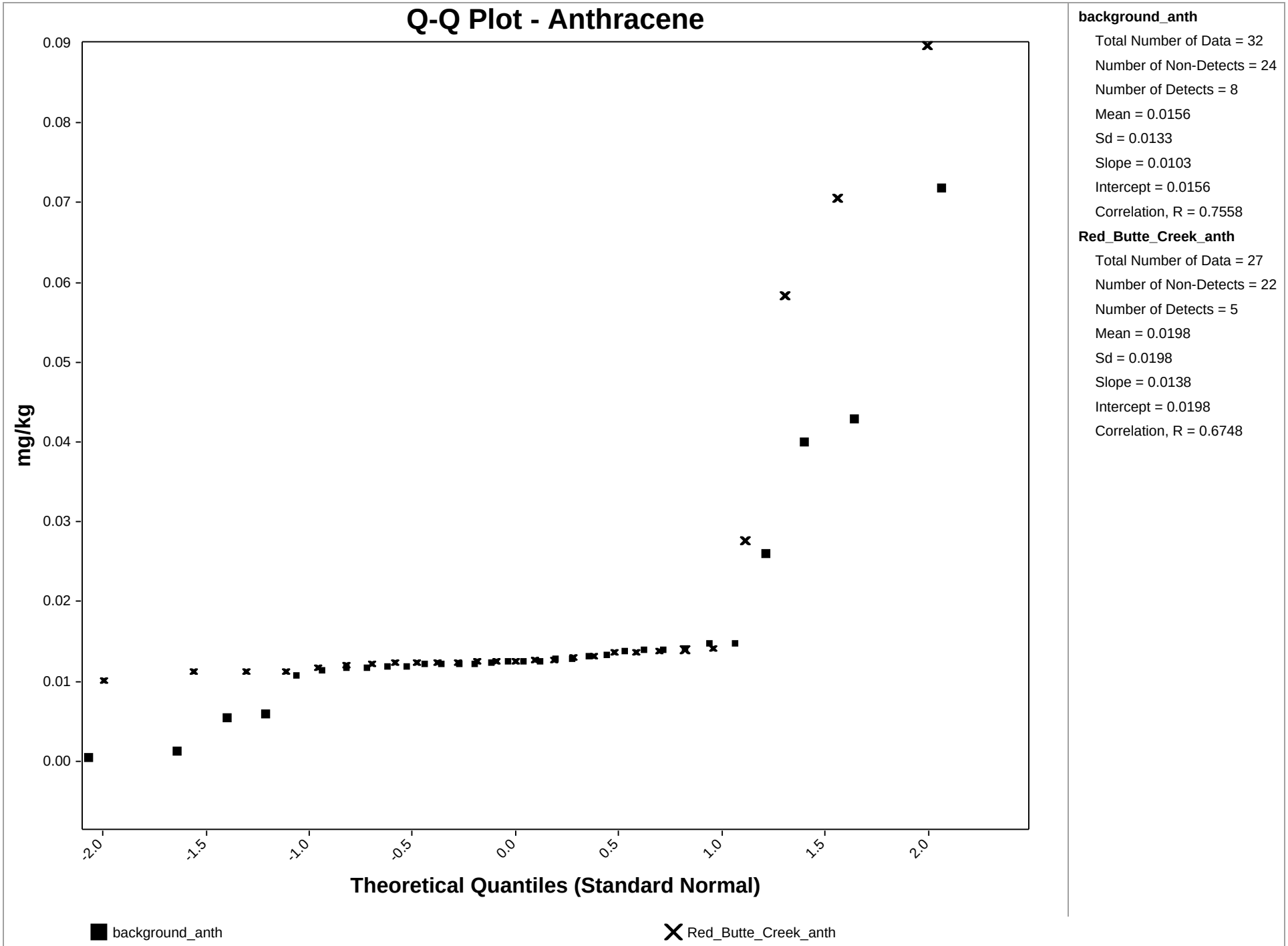
Table 5. Background Comparison Summary Table, Bed Sediment

Analyte	Is Site> Bkgd?	Rationale	Background Comparison			
			Dataset[1]	Shapiro Wilk Test Conclusion	Central Tendency Test Conclusion H_0: site < bkgrd	Upper Tail Test (Quantile Test) Conclusion H_0: site < bkgrd
1-Methylnaphthalene	No	Insufficient data to conduct background tests or graphical analyses, maximum detection less than only detection in background.				
2-Chloronaphthalene	No	Not detected in RBC bed sediment				
2-Methylnaphthalene	Inconclusive	Not detected in background bed sediment, and detected in 1 of 15 Red Butte Creek bed sediment samples				
Acenaphthene	No	Not detected in RBC bed sediment				
Acenaphthylene	No	Not detected in RBC bed sediment				
Anthracene	Inconclusive	Insufficient data to conduct statistical tests; RBC mean and median are higher than background				
Benz(a)anthracene	Inconclusive	Insufficient data to conduct statistical tests; RBC mean is higher than background				
Benzo(a)pyrene	Inconclusive	Visual inspection of QQplots indicates RBC distribution similar to background				
Benzo(b)fluoranthene	Inconclusive	Insufficient data to conduct statistical tests; RBC mean and median are higher than background				
Benzo(g,h,i)perylene	Inconclusive	Insufficient data to conduct statistical tests; RBC mean and median are higher than background				
Benzo(k)fluoranthene	Inconclusive	Insufficient data to conduct statistical tests; RBC mean and median are higher than background				
Chrysene	No	Statistical comparison tests conclude site levels at or below background	Red Butte Creek Background	Not normal Not Normal	Gehan: p=0.78	Do Not Reject H_o
Dibenz(a,h)anthracene	Inconclusive	Not detected in background bed sediment				
Fluoranthene	No	Statistical comparison tests conclude site levels at or below background	Red Butte Creek Background	Not normal Not normal	Gehan: p=0.92	Do Not Reject H_o
Fluorene	Inconclusive	Not detected in background bed sediment				
Indeno(1,2,3-cd)pyrene	Inconclusive	Insufficient data to conduct statistical tests; RBC mean and median are higher than background				
Naphthalene	Inconclusive	Insufficient data to conduct background tests or graphical analyses, maximum detection less than only detection in background.				
Phenanthrene	No	Insufficient data to conduct statistical tests; visual inspection of QQ plot indicates background distribution elevated compared to site distribution				
Pyrene	No	Statistical comparison tests conclude site levels at or below background	Red Butte Creek Background	Not normal Not normal	Gehan: p=0.91	Do Not Reject H_o
Diesel Range Organics	Inconclusive	Statistical comparison tests conclude site levels at or below background but visual inspection of QQ plot indicates site distribution may be elevated compared to site distribution	Red Butte Creek Background	Normal Lognormal	t-test: p=0.27	Do Not Reject H_o
Oil Range Organics	Inconclusive	P-value close to 0.05 indicates insufficient data and visual inspection of QQ plot shows site distribution may be elevated compared to site distribution	Red Butte Creek Background	Normal Normal	Gehan: p=0.06	Do Not Reject H_o

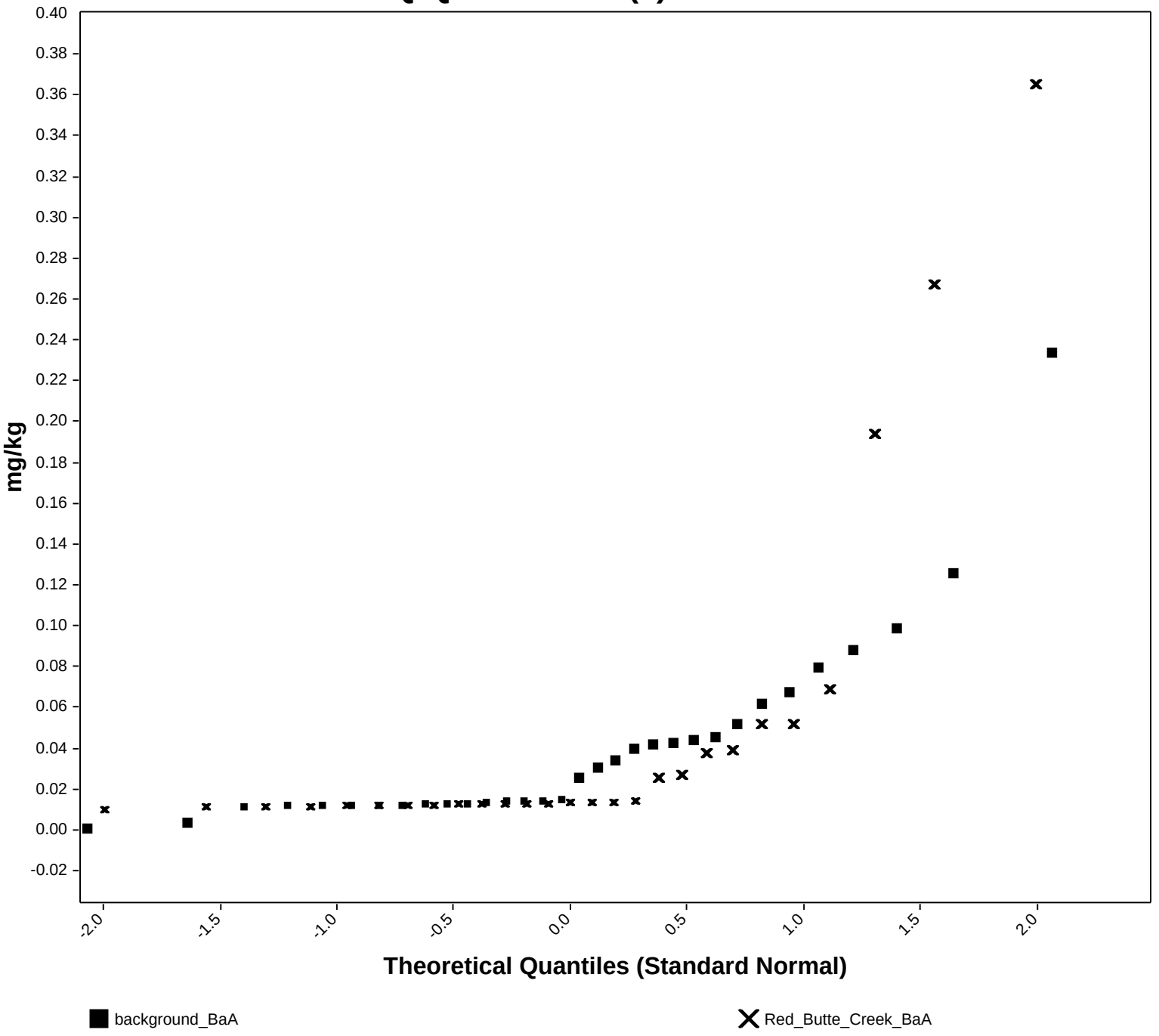
[1]Red Butte Creek (RBC) dataset includes risk assessment data collected August and October 2011. Background data includes City, Emigration, Mill and Parleys Creeks.

Attachment 1

Q-Q Plots, Bed and Bank Sediment


Q-Q Plot - Anthracene
mg/kg
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
Theoretical Quantiles (Standard Normal)
background_anth
Red_Butte_Creek_anth
background_anth
Total Number of Data = 32
Number of Non-Detects = 24
Number of Detects = 8
Mean = 0.0156
Sd = 0.0133
Slope = 0.0103
Intercept = 0.0156
Correlation, R = 0.7558
Red_Butte_Creek_anth
Total Number of Data = 27
Number of Non-Detects = 22
Number of Detects = 5
Mean = 0.0198
Sd = 0.0198
Slope = 0.0138
Intercept = 0.0198
Correlation, R = 0.6748

Q-Q Plot - Benz(a)anthracene



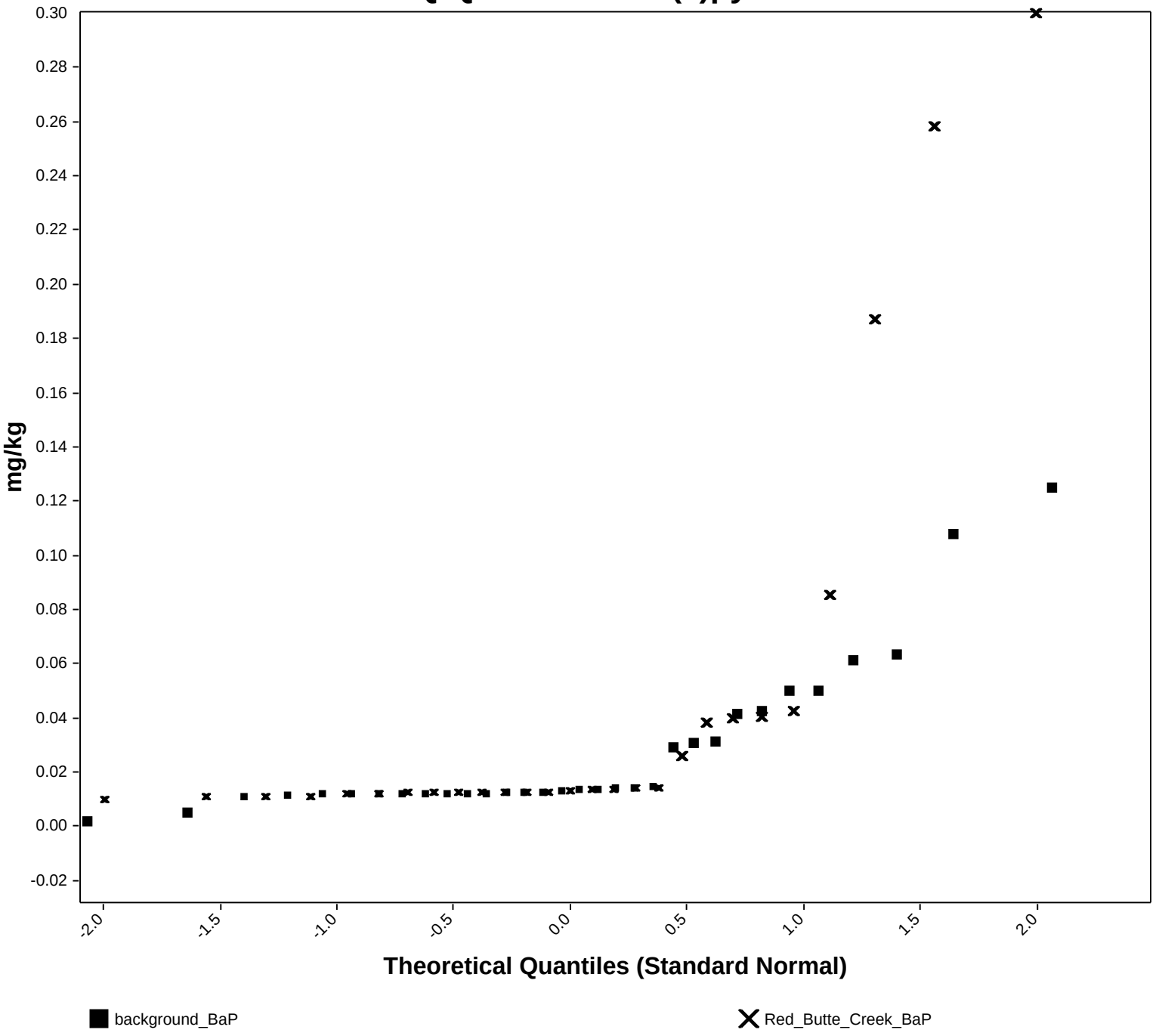
background_BaA

- Total Number of Data = 32
- Number of Non-Detects = 14
- Number of Detects = 18
- Mean = 0.0405
- Sd = 0.0466
- Slope = 0.0396
- Intercept = 0.0405
- Correlation, R = 0.8273

Red_Butte_Creek_BaA

- Total Number of Data = 27
- Number of Non-Detects = 17
- Number of Detects = 10
- Mean = 0.0496
- Sd = 0.0861
- Slope = 0.0623
- Intercept = 0.0496
- Correlation, R = 0.7019

Q-Q Plot - Benzo(a)pyrene



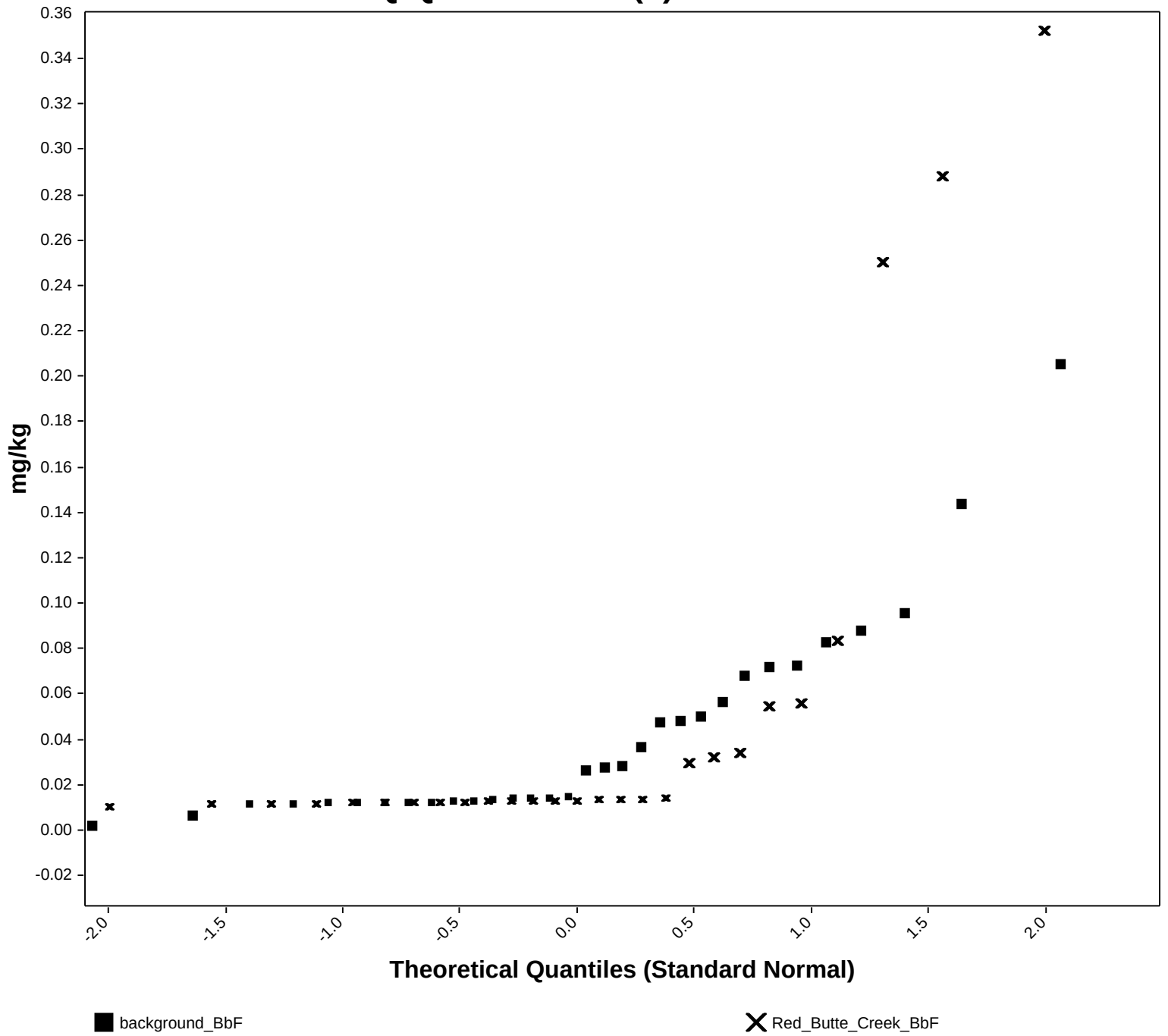
background_BaP

- Total Number of Data = 32
- Number of Non-Detects = 19
- Number of Detects = 13
- Mean = 0.0274
- Sd = 0.0286
- Slope = 0.0242
- Intercept = 0.0274
- Correlation, R = 0.8246

Red_Butte_Creek_BaP

- Total Number of Data = 27
- Number of Non-Detects = 18
- Number of Detects = 9
- Mean = 0.0459
- Sd = 0.0764
- Slope = 0.0559
- Intercept = 0.0459
- Correlation, R = 0.7099

Q-Q Plot - Benzo(b)fluoranthene



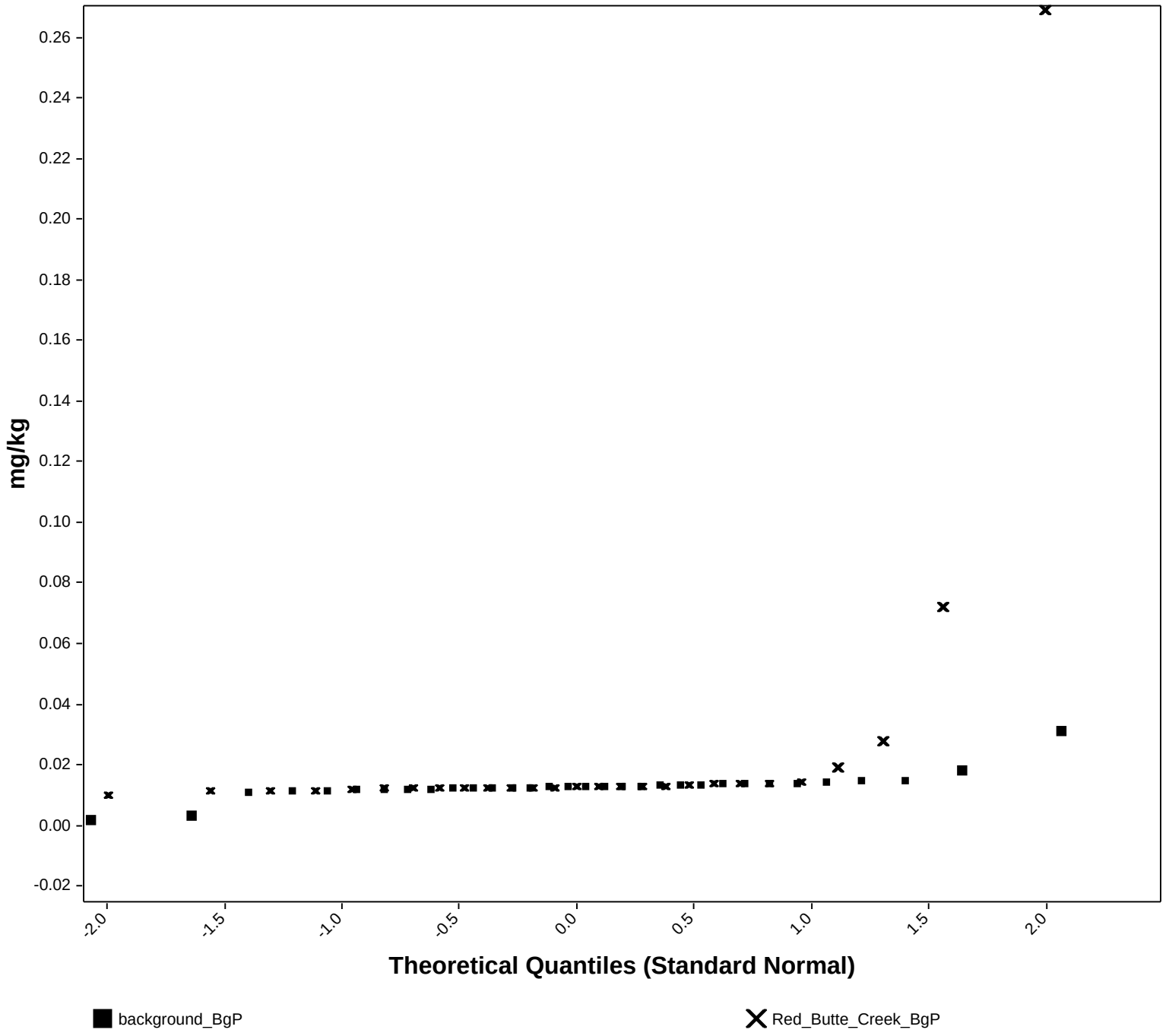
background_BbF

- Total Number of Data = 32
- Number of Non-Detects = 14
- Number of Detects = 18
- Mean = 0.0417
- Sd = 0.0447
- Slope = 0.0395
- Intercept = 0.0417
- Correlation, R = 0.8614

Red_Butte_Creek_BbF

- Total Number of Data = 27
- Number of Non-Detects = 18
- Number of Detects = 9
- Mean = 0.0520
- Sd = 0.0910
- Slope = 0.0660
- Intercept = 0.0520
- Correlation, R = 0.7044

Q-Q Plot - Benzo(g,h,i)perylene



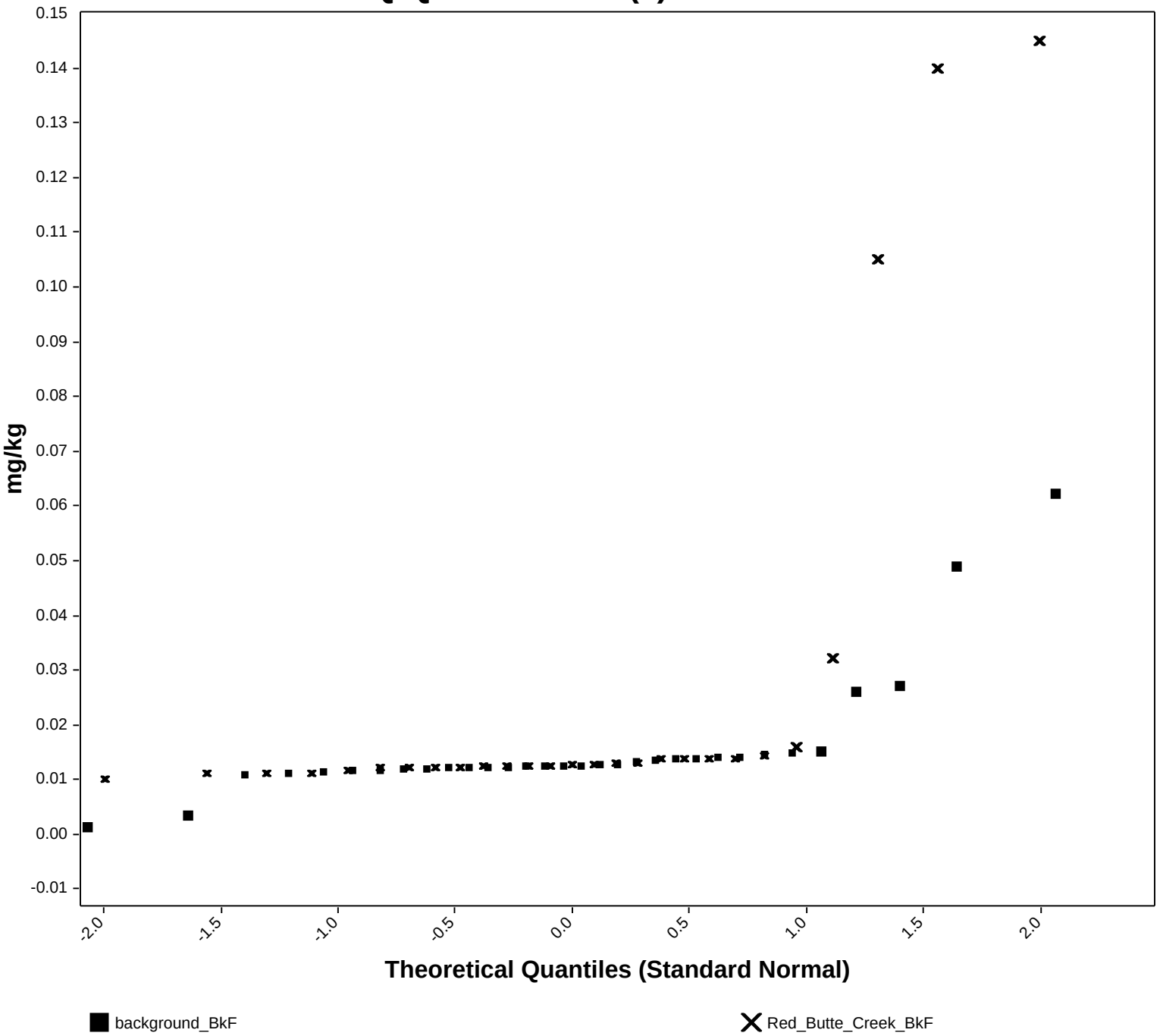
background_BgP

- Total Number of Data = 32
- Number of Non-Detects = 28
- Number of Detects = 4
- Mean = 0.0128
- Sd = 0.0044
- Slope = 0.0036
- Intercept = 0.0128
- Correlation, R = 0.7928

Red_Butte_Creek_BgP

- Total Number of Data = 27
- Number of Non-Detects = 23
- Number of Detects = 4
- Mean = 0.0250
- Sd = 0.0502
- Slope = 0.0265
- Intercept = 0.0250
- Correlation, R = 0.5123

Q-Q Plot - Benzo(k)fluoranthene



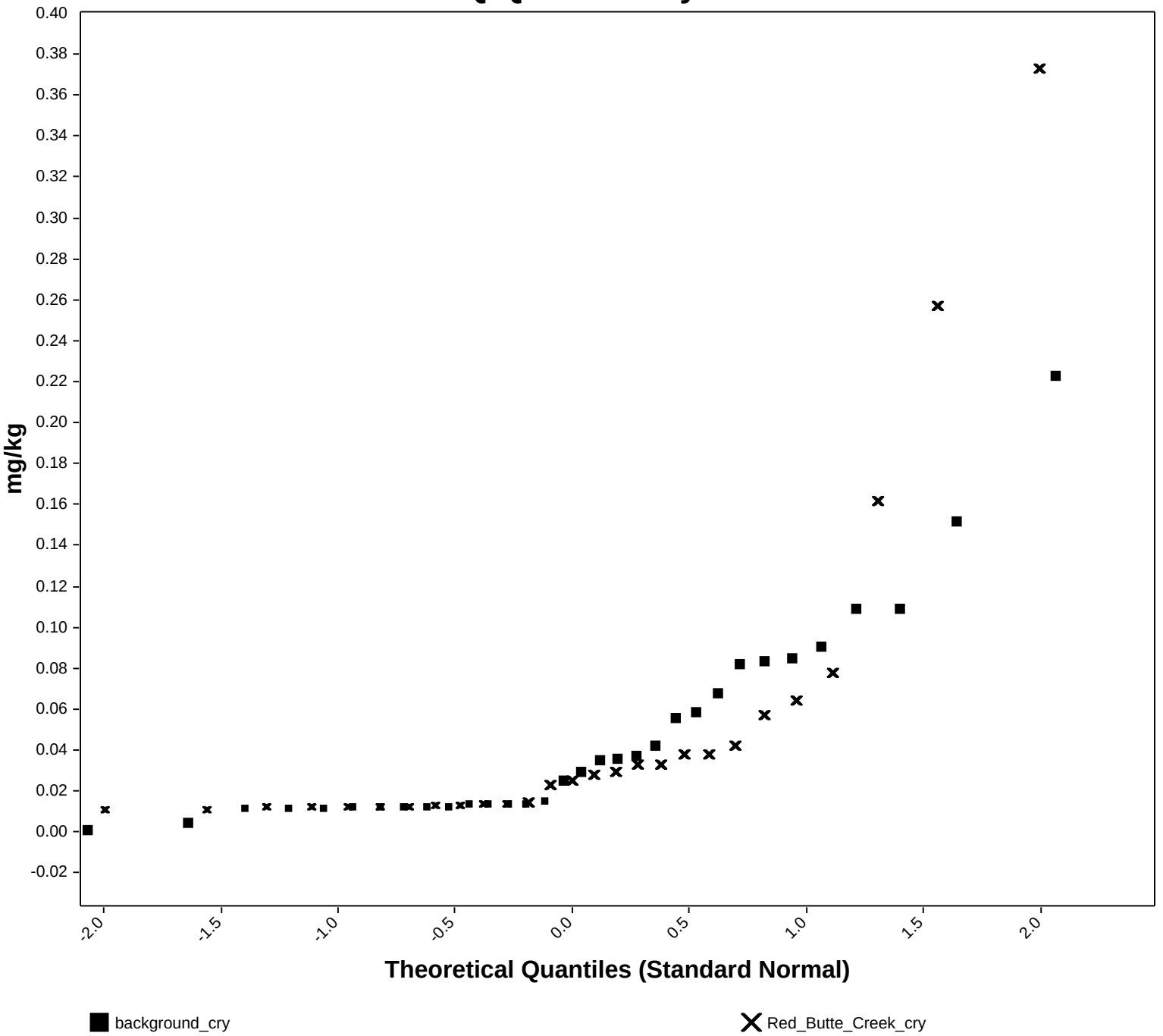
background_BkF

- Total Number of Data = 32
- Number of Non-Detects = 25
- Number of Detects = 7
- Mean = 0.0157
- Sd = 0.0115
- Slope = 0.0087
- Intercept = 0.0157
- Correlation, R = 0.7351

Red_Butte_Creek_BkF

- Total Number of Data = 27
- Number of Non-Detects = 22
- Number of Detects = 5
- Mean = 0.0264
- Sd = 0.0380
- Slope = 0.0255
- Intercept = 0.0264
- Correlation, R = 0.6514

Q-Q Plot - Chrysene



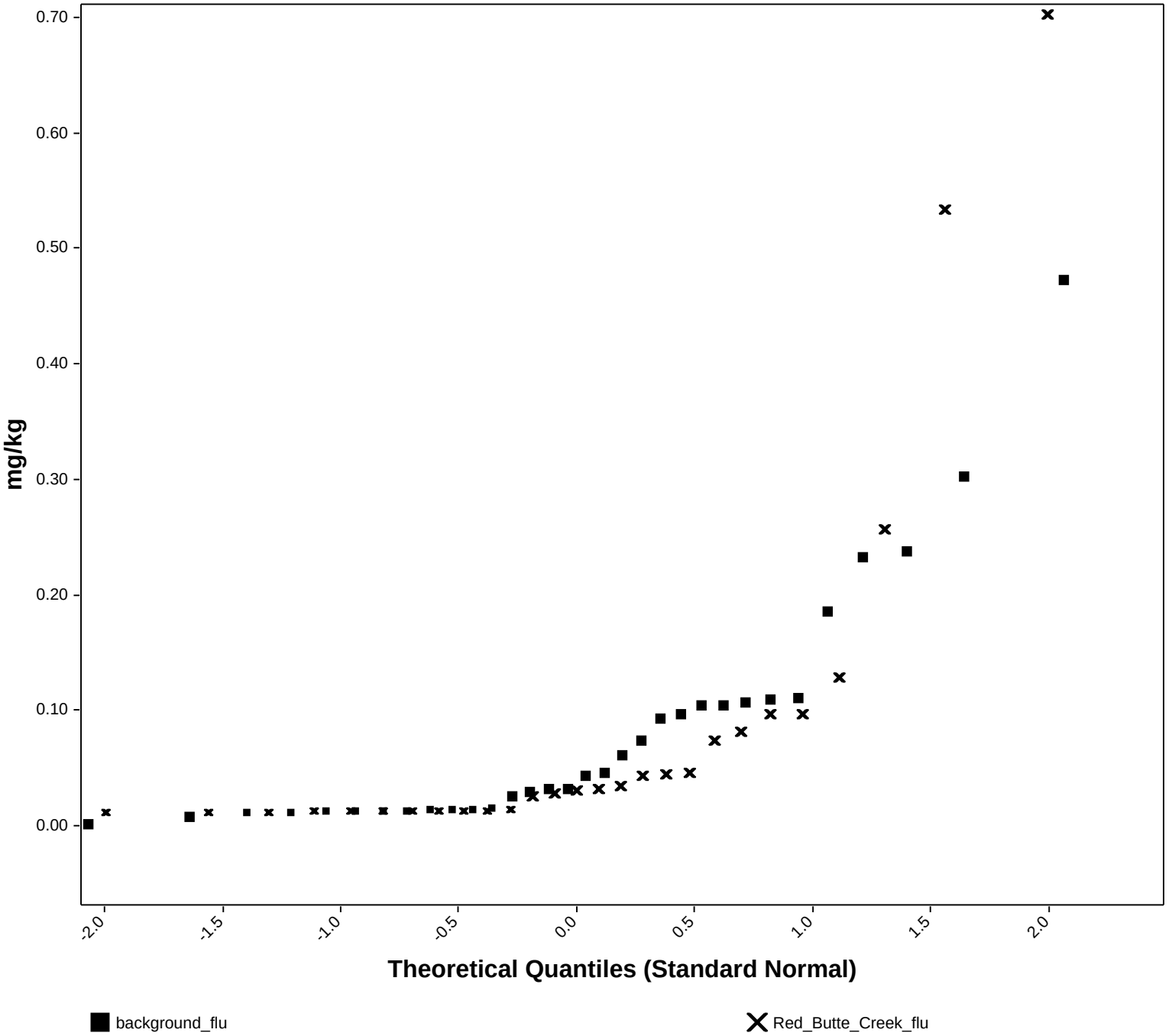
background_cry

- Total Number of Data = 32
- Number of Non-Detects = 13
- Number of Detects = 19
- Mean = 0.0467
- Sd = 0.0497
- Slope = 0.0447
- Intercept = 0.0467
- Correlation, R = 0.8774

Red_Butte_Creek_cry

- Total Number of Data = 27
- Number of Non-Detects = 11
- Number of Detects = 16
- Mean = 0.0530
- Sd = 0.0833
- Slope = 0.0622
- Intercept = 0.0530
- Correlation, R = 0.7242

Q-Q Plot - Fluoranthene



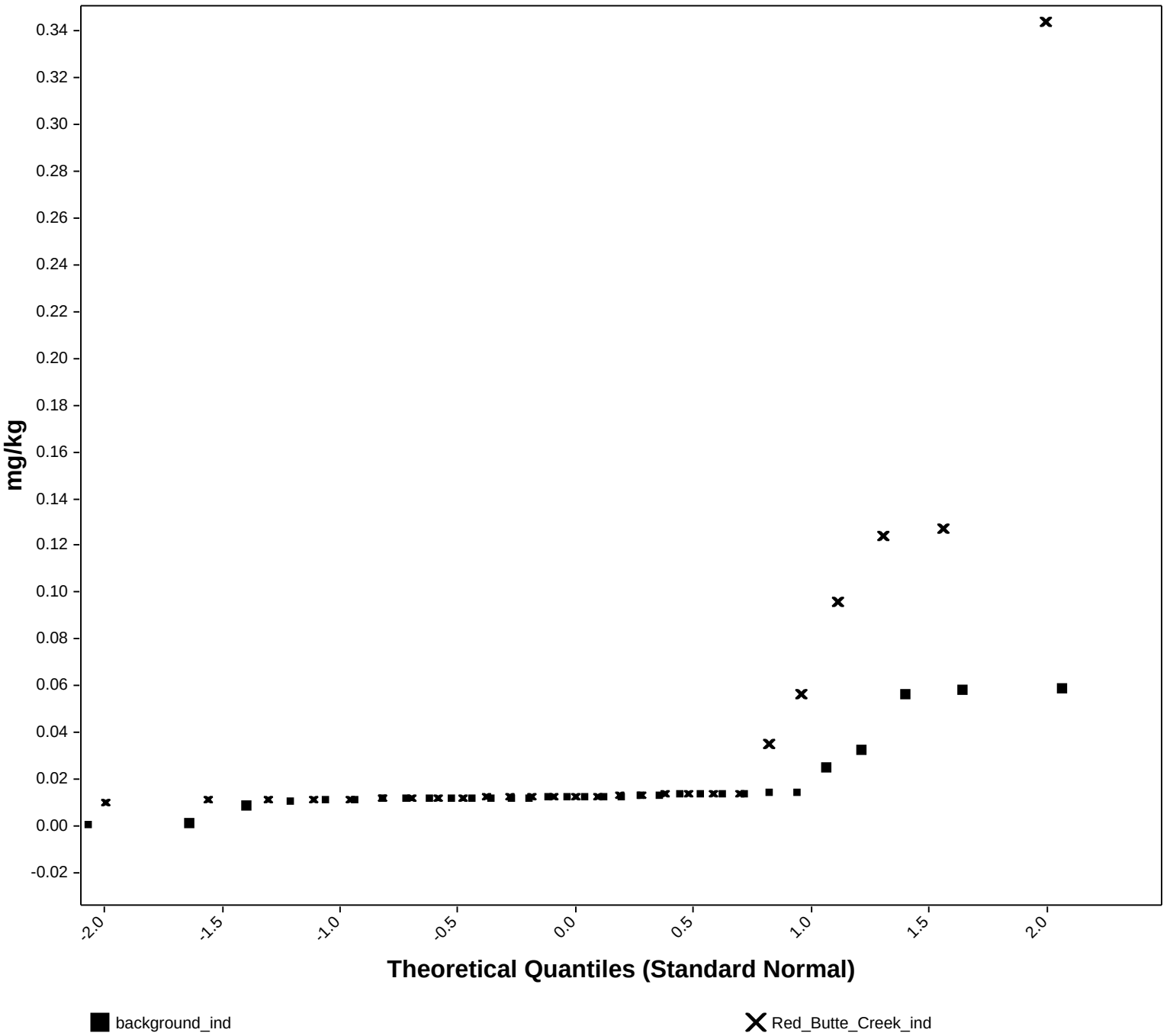
background_flu

- Total Number of Data = 32
- Number of Non-Detects = 10
- Number of Detects = 22
- Mean = 0.0825
- Sd = 0.1040
- Slope = 0.0902
- Intercept = 0.0825
- Correlation, R = 0.8444

Red_Butte_Creek_flu

- Total Number of Data = 27
- Number of Non-Detects = 11
- Number of Detects = 16
- Mean = 0.0884
- Sd = 0.1631
- Slope = 0.1189
- Intercept = 0.0884
- Correlation, R = 0.7077

Q-Q Plot - Indeno(1,2,3-cd)pyrene



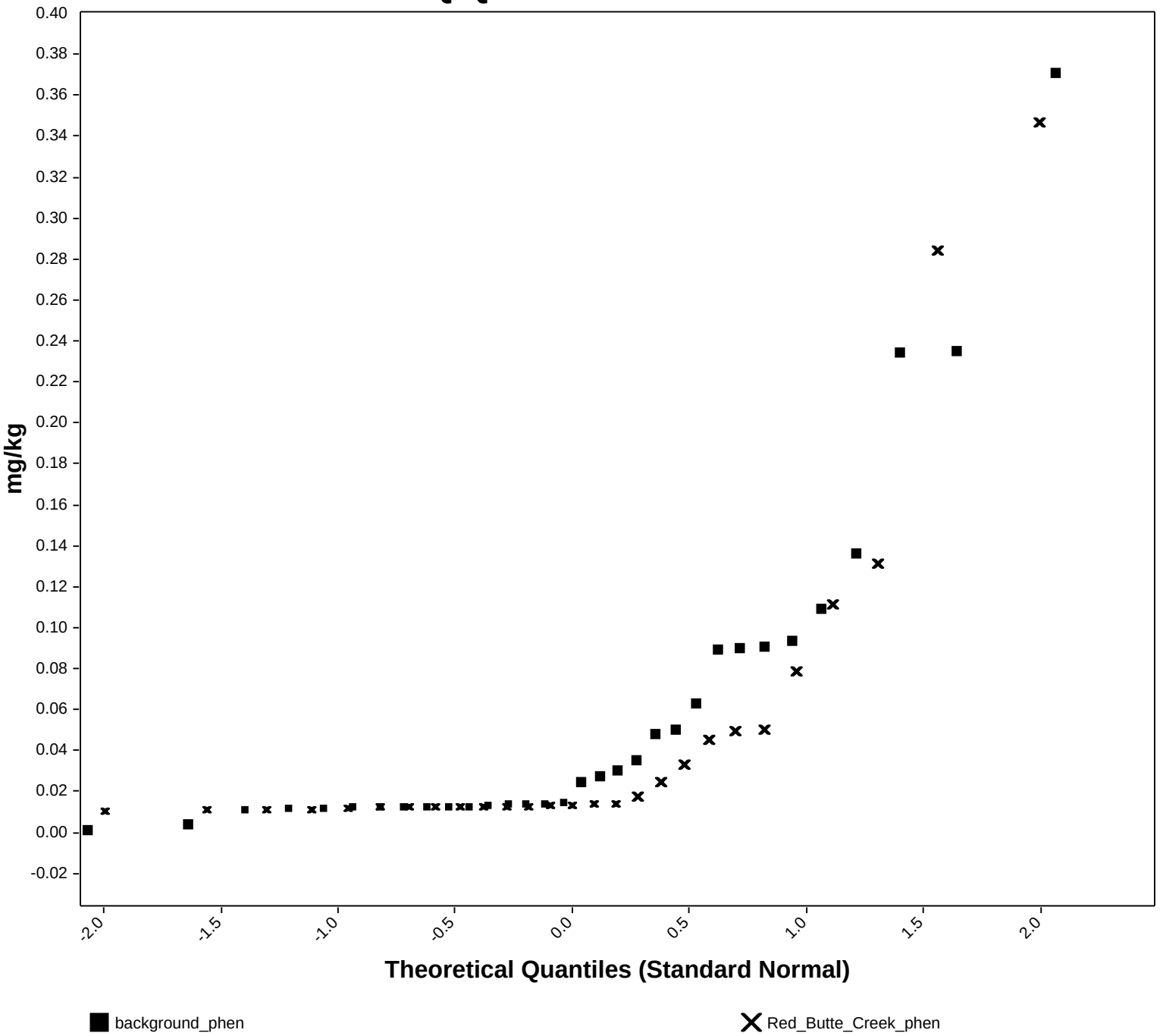
background_ind

- Total Number of Data = 32
- Number of Non-Detects = 25
- Number of Detects = 7
- Mean = 0.0171
- Sd = 0.0143
- Slope = 0.0113
- Intercept = 0.0171
- Correlation, R = 0.7671

Red_Butte_Creek_ind

- Total Number of Data = 27
- Number of Non-Detects = 21
- Number of Detects = 6
- Mean = 0.0387
- Sd = 0.0697
- Slope = 0.0471
- Intercept = 0.0387
- Correlation, R = 0.6557

Q-Q Plot - Phenanthrene



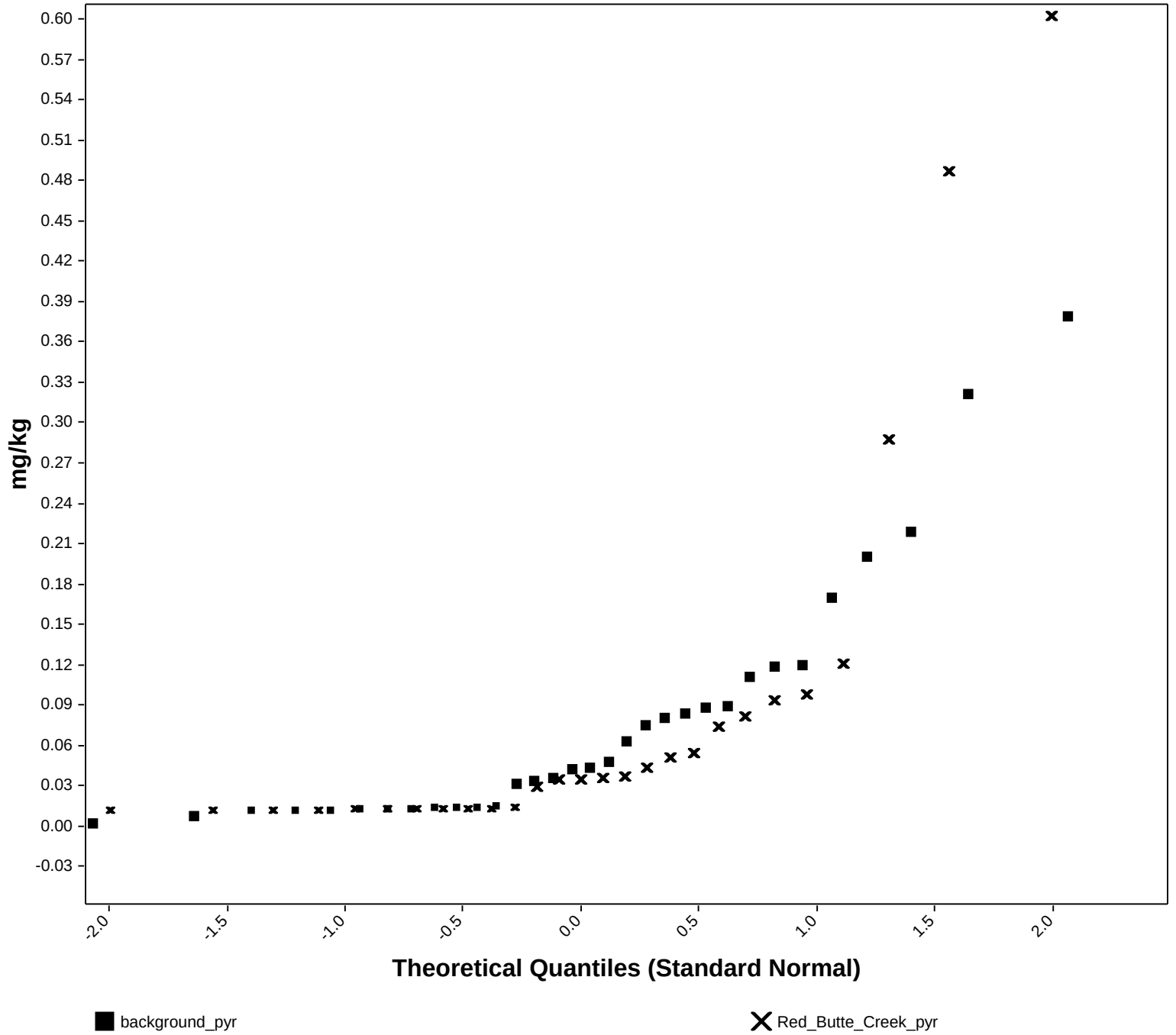
background_phen

- Total Number of Data = 32
- Number of Non-Detects = 14
- Number of Detects = 18
- Mean = 0.0597
- Sd = 0.0826
- Slope = 0.0687
- Intercept = 0.0597
- Correlation, R = 0.8100

Red_Butte_Creek_phen

- Total Number of Data = 27
- Number of Non-Detects = 16
- Number of Detects = 11
- Mean = 0.0507
- Sd = 0.0829
- Slope = 0.0621
- Intercept = 0.0507
- Correlation, R = 0.7263

Q-Q Plot - Pyrene



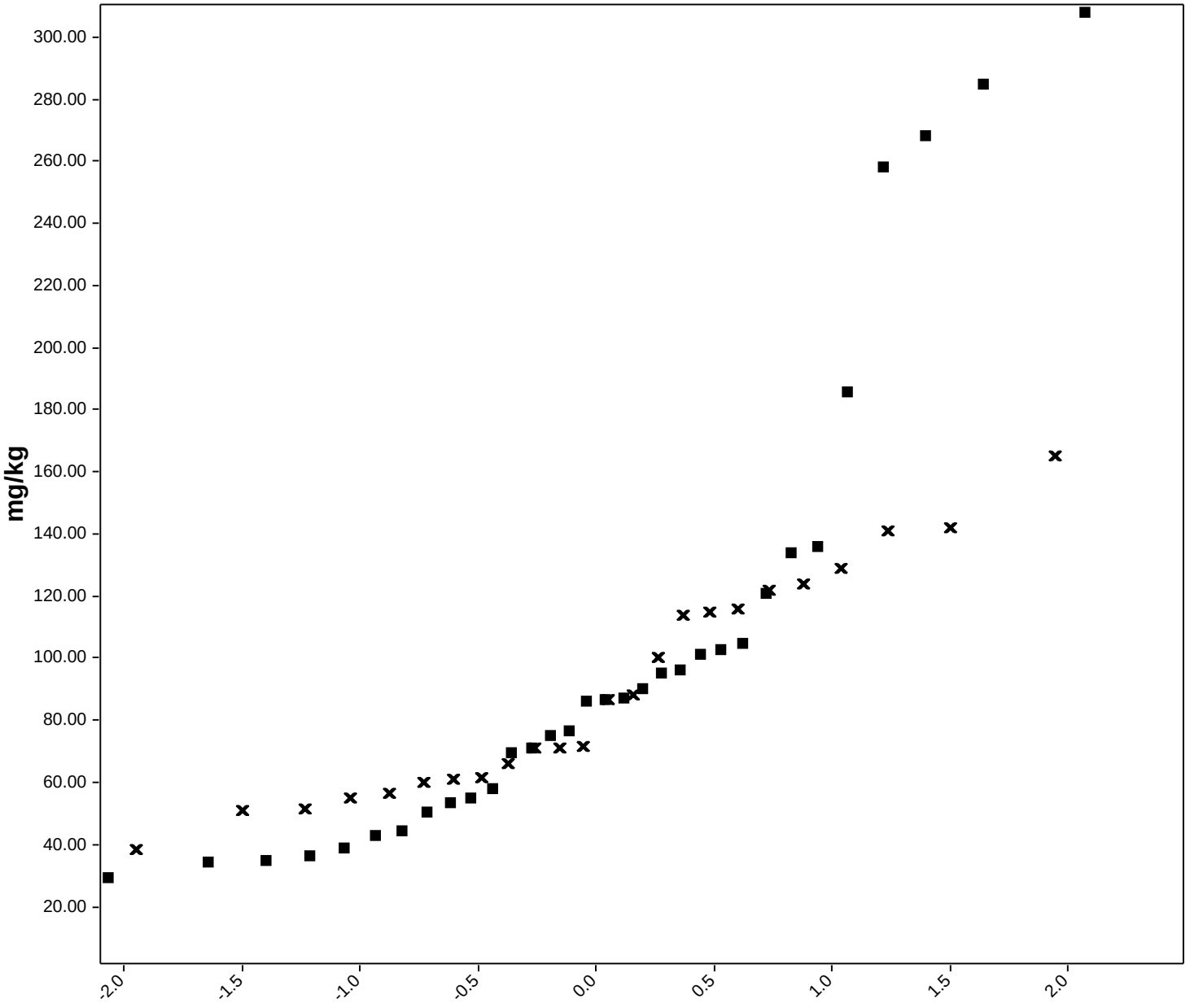
background_pyr

- Total Number of Data = 32
- Number of Non-Detects = 10
- Number of Detects = 22
- Mean = 0.0778
- Sd = 0.0916
- Slope = 0.0815
- Intercept = 0.0778
- Correlation, R = 0.8666

Red_Butte_Creek_pyr

- Total Number of Data = 27
- Number of Non-Detects = 11
- Number of Detects = 16
- Mean = 0.0852
- Sd = 0.1449
- Slope = 0.1093
- Intercept = 0.0852
- Correlation, R = 0.7317

Q-Q Plot- Diesel Range Organics



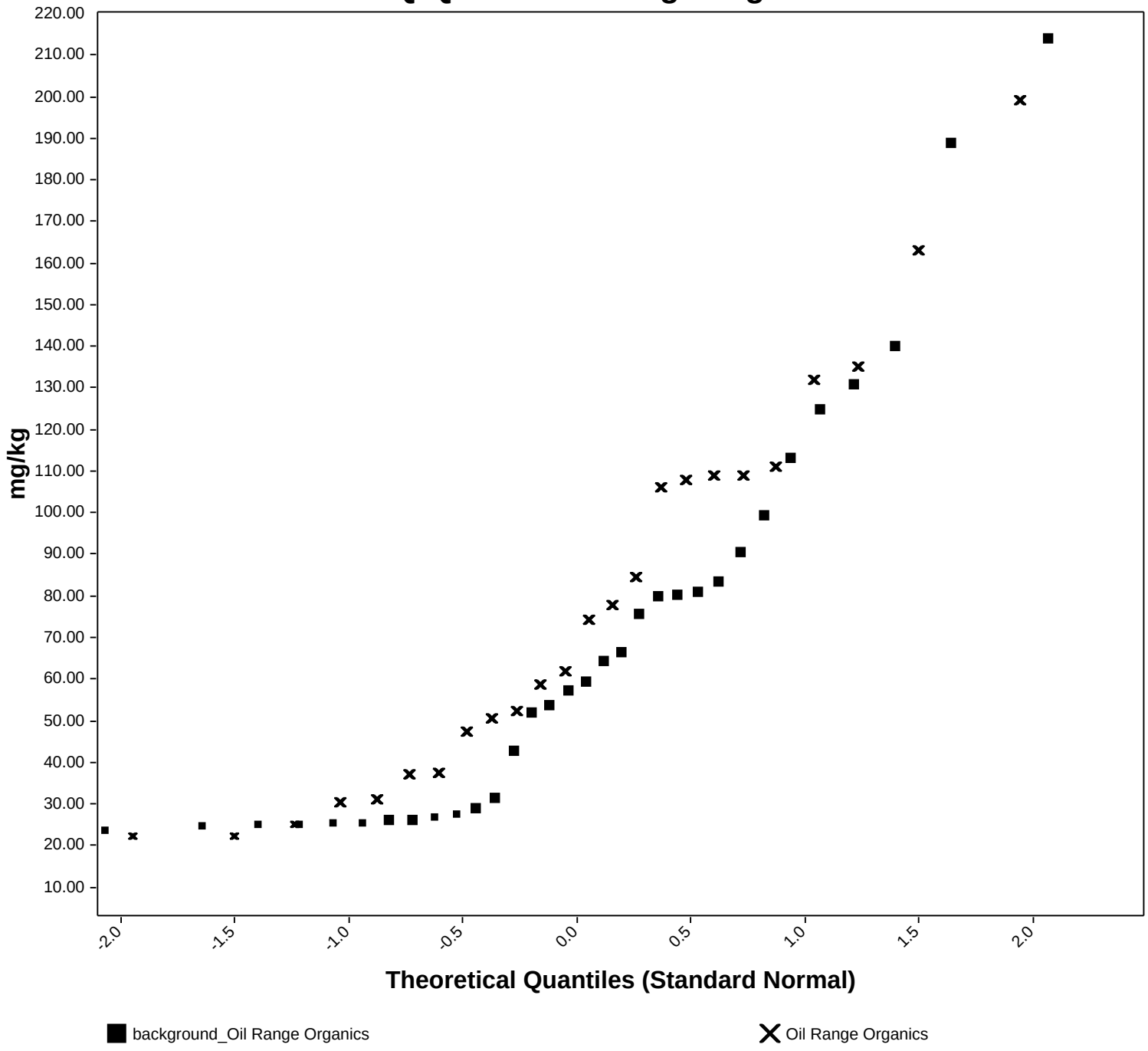
background_Diesel Range Organics

Total Number of Data = 32
Number of Non-Detects = 0
Number of Detects = 32
Mean = 103.6594
Sd = 76.2457
Slope = 69.5610
Intercept = 103.6594
Correlation, R = 0.8887

Diesel Range Organics

Total Number of Data = 24
Number of Non-Detects = 0
Number of Detects = 24
Mean = 89.9167
Sd = 35.3850
Slope = 35.3802
Intercept = 89.9167
Correlation, R = 0.9678

Q-Q Plot- Oil Range Organics



background_Oil Range Organics

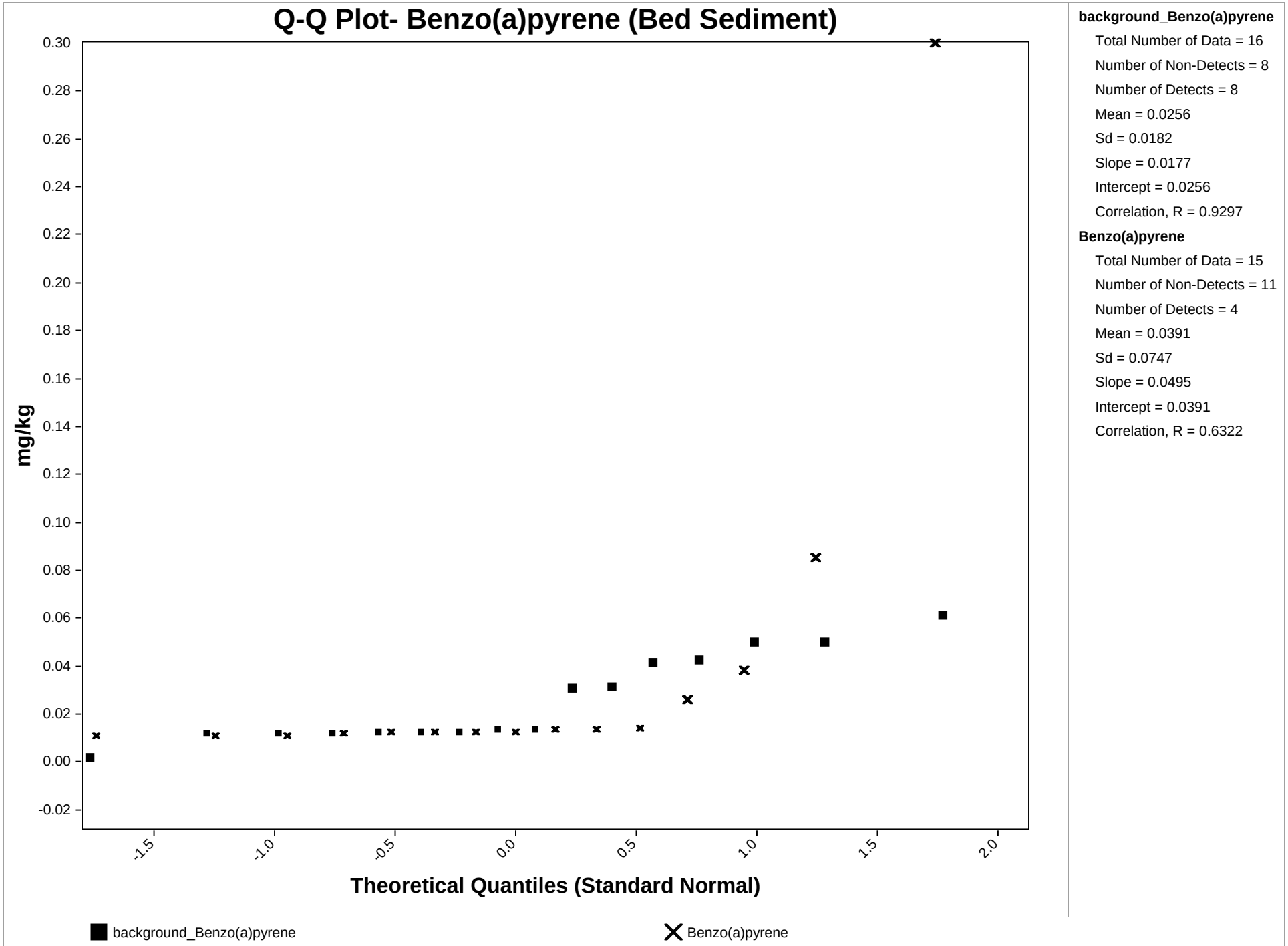
Total Number of Data = 32
Number of Non-Detects = 8
Number of Detects = 24
Mean = 69.2000
Sd = 49.0929
Slope = 46.3370
Intercept = 69.2000
Correlation, R = 0.9194

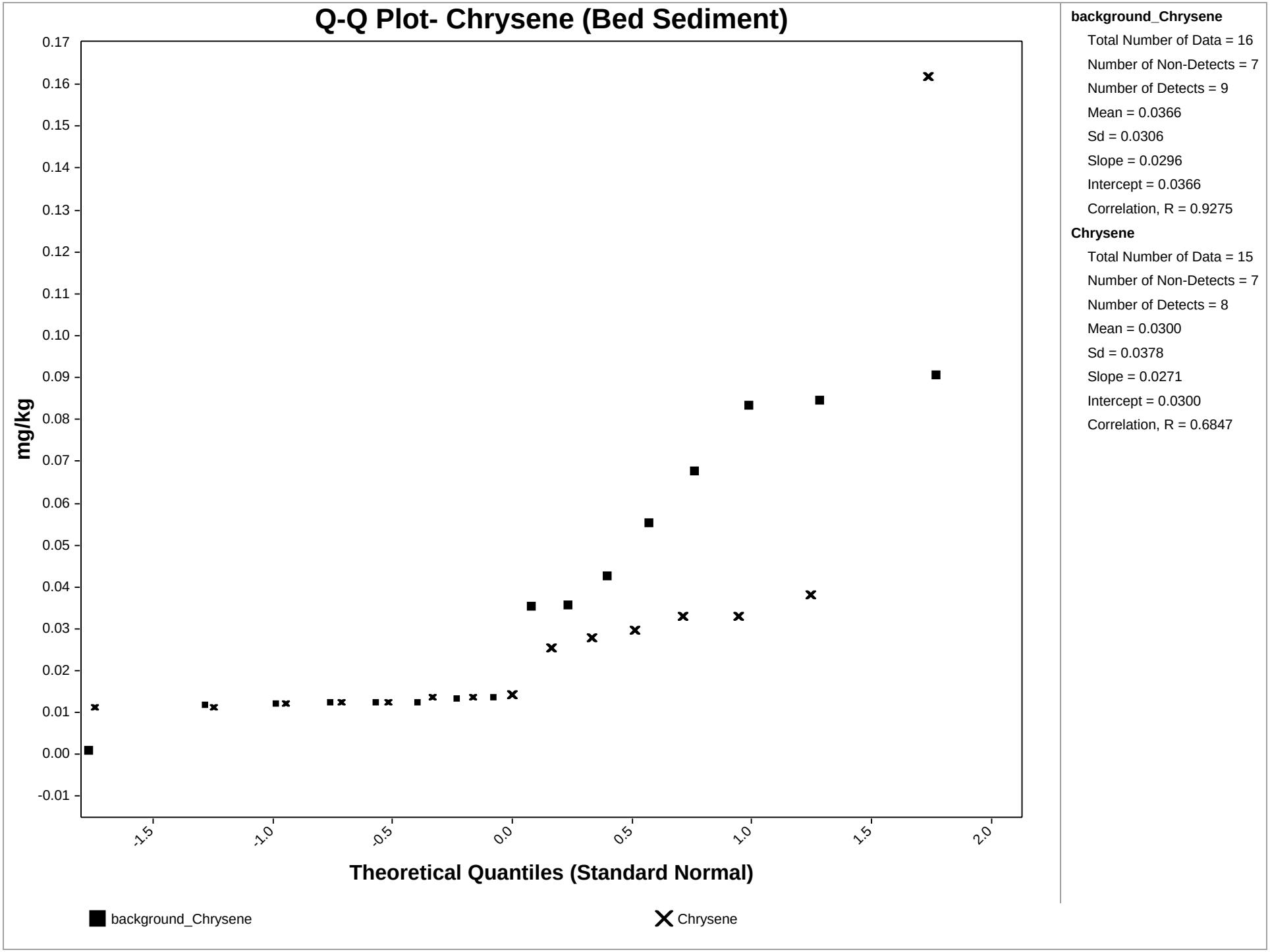
Oil Range Organics

Total Number of Data = 24
Number of Non-Detects = 3
Number of Detects = 21
Mean = 78.5500
Sd = 47.7936
Slope = 47.5095
Intercept = 78.5500
Correlation, R = 0.9622

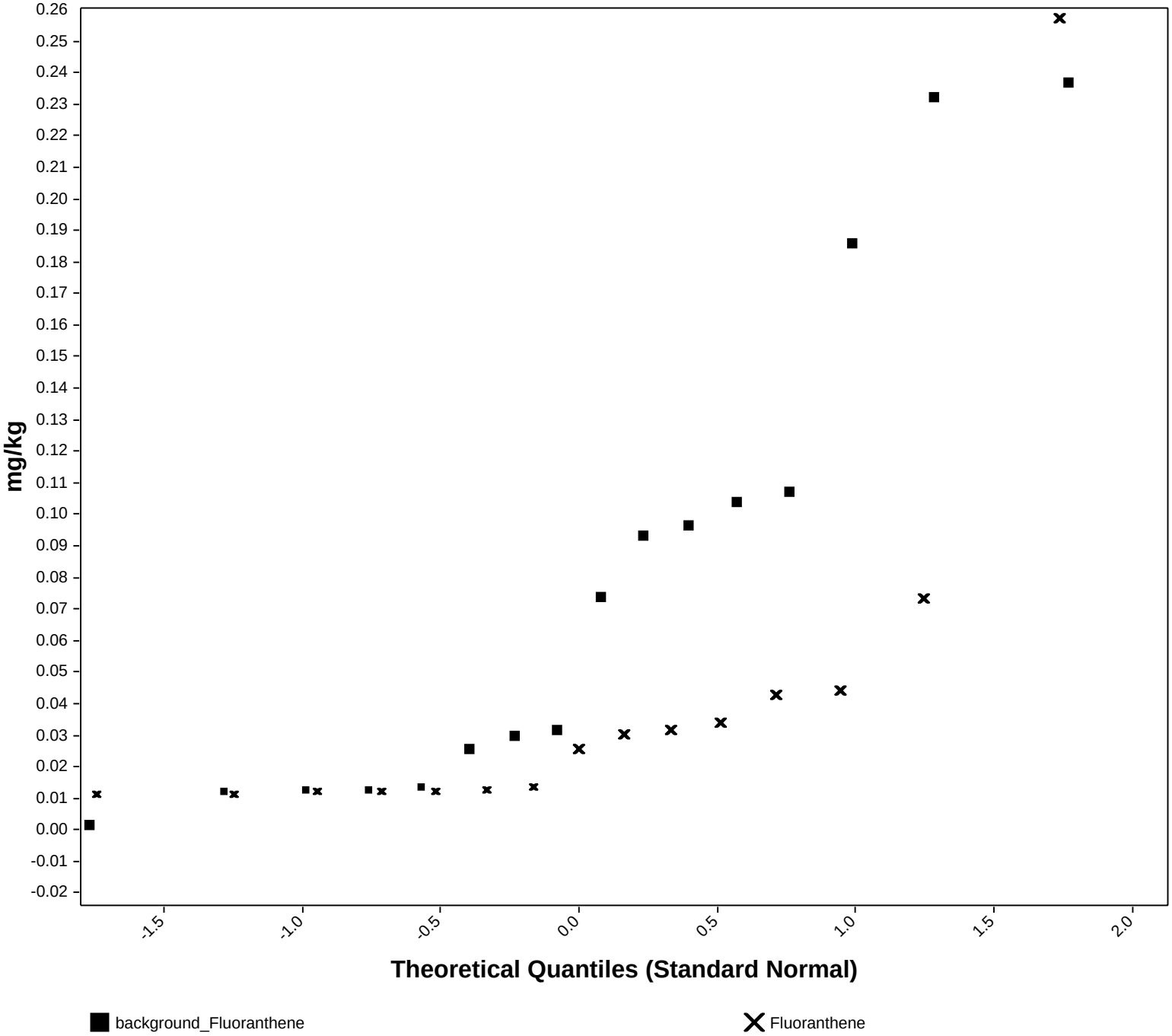
Attachment 2

Q-Q Plots, Bed Sediment


Q-Q Plot- Benzo(a)pyrene (Bed Sediment)
mg/kg
0.30
0.28
0.26
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
-0.02
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
Theoretical Quantiles (Standard Normal)
background_Benzo(a)pyrene
Benzo(a)pyrene
background_Benzo(a)pyrene
Total Number of Data = 16
Number of Non-Detects = 8
Number of Detects = 8
Mean = 0.0256
Sd = 0.0182
Slope = 0.0177
Intercept = 0.0256
Correlation, R = 0.9297
Benzo(a)pyrene
Total Number of Data = 15
Number of Non-Detects = 11
Number of Detects = 4
Mean = 0.0391
Sd = 0.0747
Slope = 0.0495
Intercept = 0.0391
Correlation, R = 0.6322


Q-Q Plot- Chrysene (Bed Sediment)
mg/kg
0.17
0.16
0.15
0.14
0.13
0.12
0.11
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
-0.01
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
Theoretical Quantiles (Standard Normal)
background_Chrysene
Chrysene
background_Chrysene
Total Number of Data = 16
Number of Non-Detects = 7
Number of Detects = 9
Mean = 0.0366
Sd = 0.0306
Slope = 0.0296
Intercept = 0.0366
Correlation, R = 0.9275
Chrysene
Total Number of Data = 15
Number of Non-Detects = 7
Number of Detects = 8
Mean = 0.0300
Sd = 0.0378
Slope = 0.0271
Intercept = 0.0300
Correlation, R = 0.6847

Q-Q Plot- Fluoranthene (Bed Sediment)



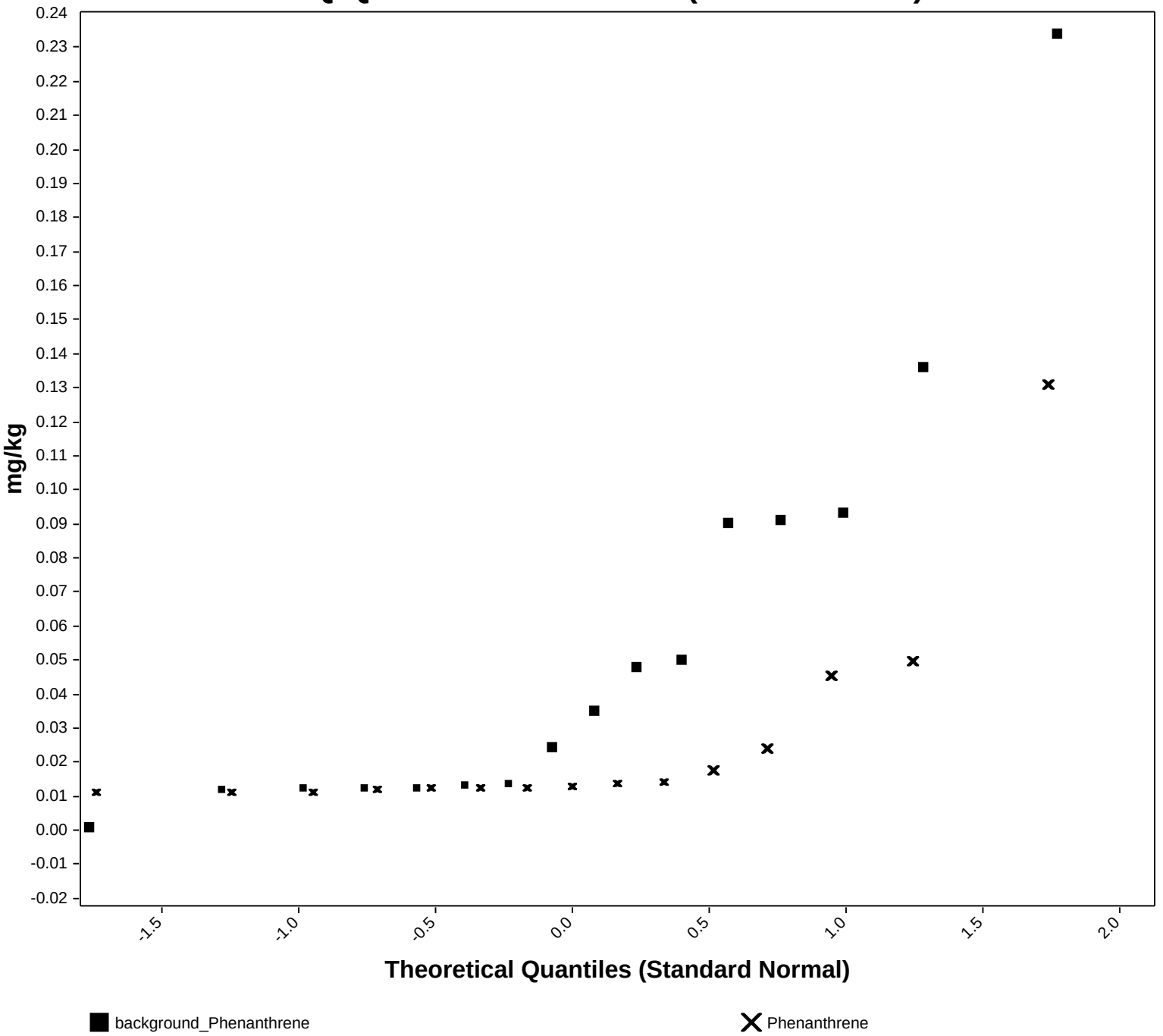
background_Fluoranthene

Total Number of Data = 16
Number of Non-Detects = 4
Number of Detects = 12
Mean = 0.0793
Sd = 0.0786
Slope = 0.0756
Intercept = 0.0793
Correlation, R = 0.9199

Fluoranthene

Total Number of Data = 15
Number of Non-Detects = 7
Number of Detects = 8
Mean = 0.0416
Sd = 0.0621
Slope = 0.0452
Intercept = 0.0416
Correlation, R = 0.6954

Q-Q Plot- Phenanthrene (Bed Sediment)



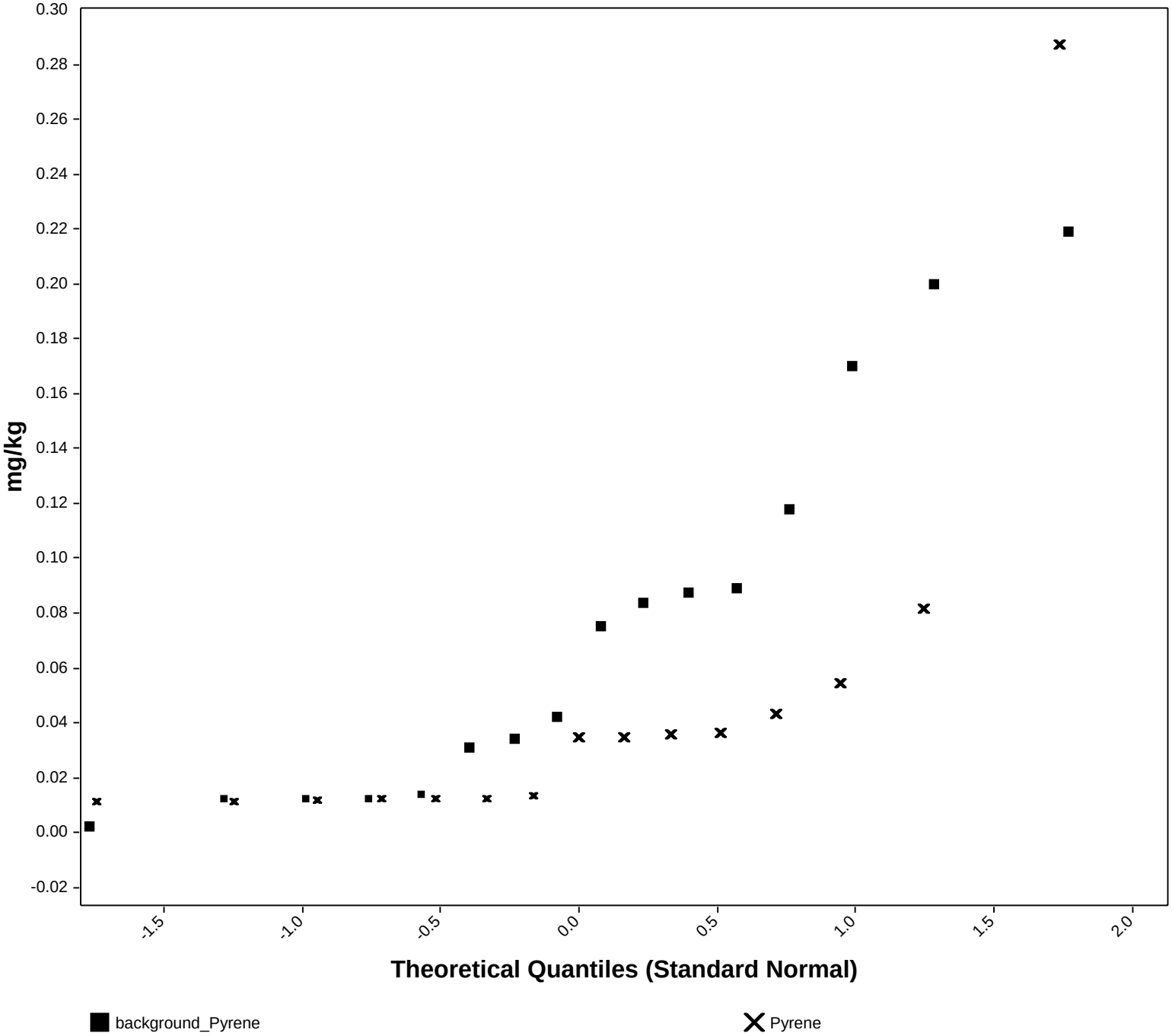
background_Phenanthrene

Total Number of Data = 16
Number of Non-Detects = 6
Number of Detects = 10
Mean = 0.0550
Sd = 0.0620
Slope = 0.0566
Intercept = 0.0550
Correlation, R = 0.8746

Phenanthrene

Total Number of Data = 15
Number of Non-Detects = 10
Number of Detects = 5
Mean = 0.0261
Sd = 0.0315
Slope = 0.0235
Intercept = 0.0261
Correlation, R = 0.7133

Q-Q Plot- Pyrene (Bed Sediment)



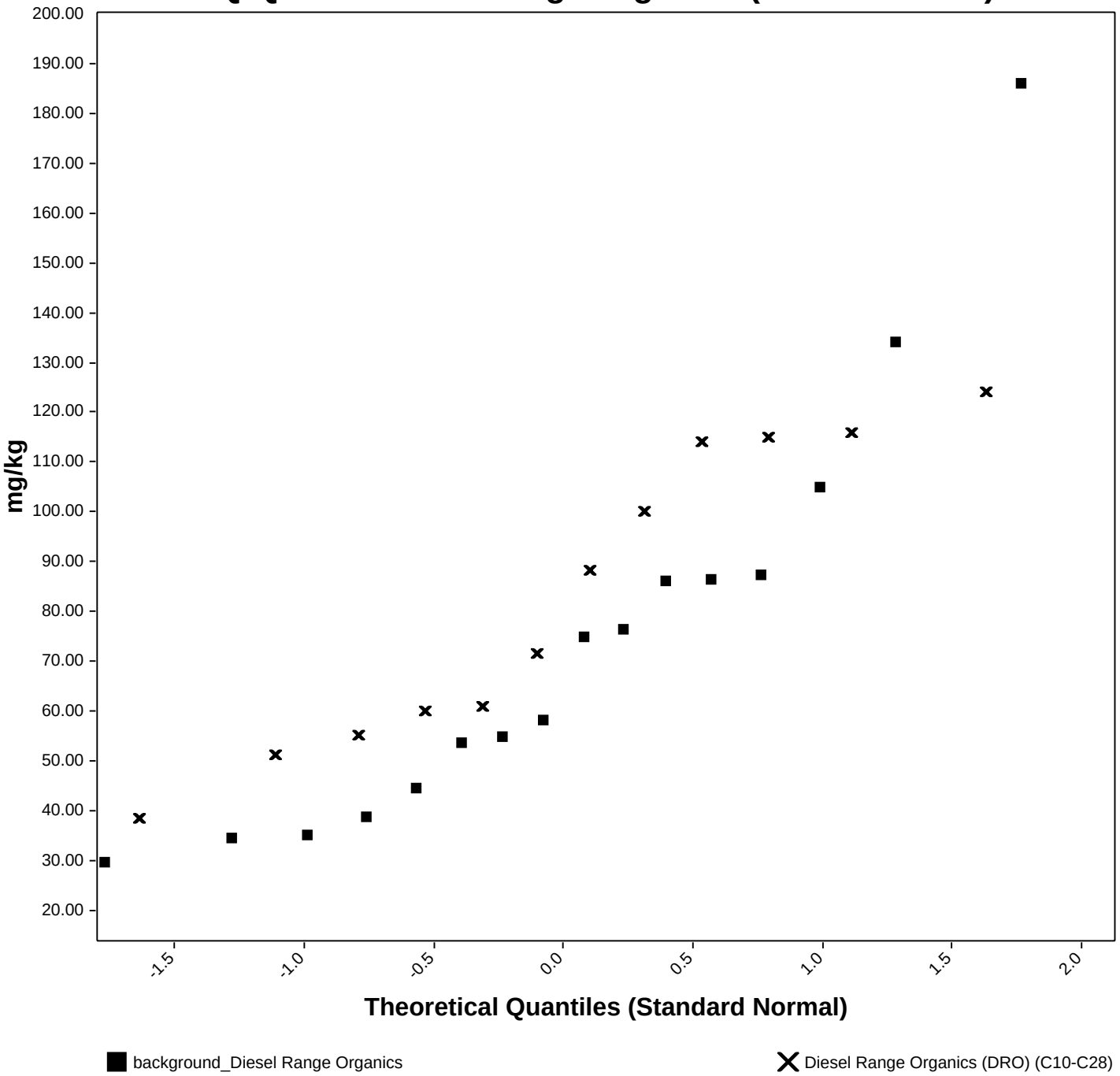
background_Pyrene

Total Number of Data = 16
Number of Non-Detects = 4
Number of Detects = 12
Mean = 0.0752
Sd = 0.0698
Slope = 0.0684
Intercept = 0.0752
Correlation, R = 0.9373

Pyrene

Total Number of Data = 15
Number of Non-Detects = 7
Number of Detects = 8
Mean = 0.0463
Sd = 0.0696
Slope = 0.0512
Intercept = 0.0463
Correlation, R = 0.7019

Q-Q Plot- Diesel Range Organics (Bed Sediment)



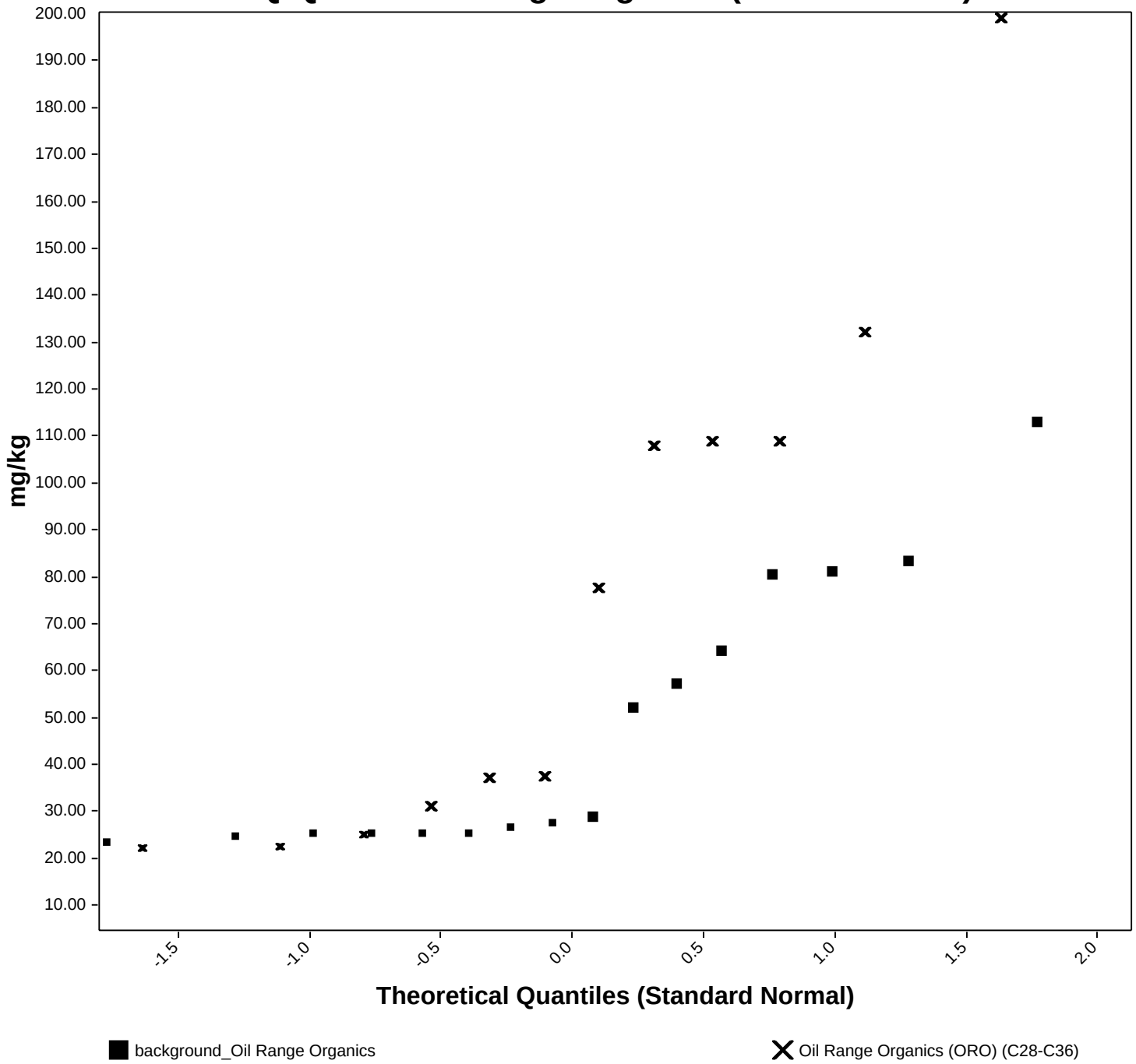
background_Diesel Range Organics

- Total Number of Data = 16
- Number of Non-Detects = 0
- Number of Detects = 16
- Mean = 74.0688
- Sd = 41.4699
- Slope = 40.2923
- Intercept = 74.0688
- Correlation, R = 0.9298

Diesel Range Organics (DRO) (C10-C28)

- Total Number of Data = 12
- Number of Non-Detects = 0
- Number of Detects = 12
- Mean = 82.8917
- Sd = 30.1151
- Slope = 30.5941
- Intercept = 82.8917
- Correlation, R = 0.9624

Q-Q Plot- Oil Range Organics (Bed Sediment)



background_Oil Range Organics

- Total Number of Data = 16
- Number of Non-Detects = 8
- Number of Detects = 8
- Mean = 47.7313
- Sd = 28.7578
- Slope = 27.0245
- Intercept = 47.7313
- Correlation, R = 0.8993

Oil Range Organics (ORO) (C28-C36)

- Total Number of Data = 12
- Number of Non-Detects = 3
- Number of Detects = 9
- Mean = 75.8250
- Sd = 56.2930
- Slope = 55.2708
- Intercept = 75.8250
- Correlation, R = 0.9302

Appendix E

Ecological Risk Analyses

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Table E-1a
Red Butte Creek Water COPEC Selection
Ecological Risk Assessment
Red Butte Creek
Salt Lake City, Utah

Analyte	Num_Detects	Num_NDs	Frequency of Detection	Min_ND	Max_ND	Min_Detect	Max_Detect	EPC	Screening Value	Units	Source	Exceeds Screening Criteria?	COPEC?
1,1,1,2-Tetrachloroethane	18	0	0%	2	2					ug/L			NO
1,1,1-Trichloroethane	18	0	0%	2	2					ug/L			NO
1,1,2,2-Tetrachloroethane	18	0	0%	2	2					ug/L			NO
1,1,2-Trichloro-1,2,2-trifluoroethane	18	0	0%	2	2					ug/L			NO
1,1,2-Trichloroethane	18	0	0%	2	2					ug/L			NO
1,1´-Biphenyl	18	0	0%	10	10					ug/L			NO
1,1-Dichloroethane	18	0	0%	2	2					ug/L			NO
1,1-Dichloroethene	18	0	0%	2	2					ug/L			NO
1,1-Dichloropropene	18	0	0%	2	2					ug/L			NO
1,2,3-Trichlorobenzene	18	0	0%	2	2					ug/L			NO
1,2,3-Trichloropropane	18	0	0%	2	2					ug/L			NO
1,2,3-Trimethylbenzene	18	0	0%	2	2					ug/L			NO
1,2,4,5-Tetrachlorobenzene	18	0	0%	10	10					ug/L			NO
1,2,4-Trichlorobenzene	18	0	0%	2	2					ug/L			NO
1,2,4-Trimethylbenzene	18	0	0%	2	2					ug/L			NO
1,2-Dibromo-3-chloropropane	18	0	0%	2	5					ug/L			NO
1,2-Dibromoethane	18	0	0%	2	2					ug/L			NO
1,2-Dichlorobenzene	19	0	0%	2	10					ug/L			NO
1,2-Dichloroethane	18	0	0%	2	2					ug/L			NO
1,2-Dichloropropane	18	0	0%	2	2					ug/L			NO
1,3,5-Trimethylbenzene	18	0	0%	2	2					ug/L			NO
1,3,5-Trinitrobenzene	18	0	0%	10	10					ug/L			NO
1,3-Dichlorobenzene	18	0	0%	2	2					ug/L			NO
1,3-Dichloropropane	18	0	0%	2	2					ug/L			NO
1,3-Dinitrobenzene	18	0	0%	10	10					ug/L			NO
1,4-Dichlorobenzene	18	0	0%	2	2					ug/L			NO
1,4-Dinitrobenzene	16	0	0%	10	10					ug/L			NO
1,4-Dioxane	18	0	0%	40	50					ug/L			NO
1,4-Naphthoquinone	18	0	0%	10	10					ug/L			NO
1,4-Phenylenediamine	18	0	0%	10	10					ug/L			NO
1-Chloronaphthalene	18	0	0%	10	10					ug/L			NO
1-Methylnaphthalene	18	0	0%	0.1	10					ug/L			NO
1-Naphthylamine	18	0	0%	10	10					ug/L			NO
2,2-Dichloropropane	17	0	0%	2	2					ug/L			NO
2,3,4,6-Tetrachlorophenol	18	0	0%	10	10					ug/L			NO
2,4,5-Trichlorophenol	18	0	0%	10	10					ug/L			NO
2,4,6-Trichlorophenol	18	0	0%	10	10					ug/L			NO
2,4-Dichlorophenol	18	0	0%	10	10					ug/L			NO
2,4-Dimethylphenol	18	0	0%	10	10					ug/L			NO
2,4-Dinitrophenol	18	0	0%	20	20					ug/L			NO
2,4-Dinitrotoluene	18	0	0%	10	10					ug/L			NO
2,6-Dichlorophenol	18	0	0%	10	10					ug/L			NO
2,6-Dinitrotoluene	18	0	0%	10	10					ug/L			NO

Table E-1a
Red Butte Creek Water COPEC Selection
Ecological Risk Assessment
Red Butte Creek
Salt Lake City, Utah

Analyte	Num_Detects	Num_NDs	Frequency of Detection	Min_ND	Max_ND	Min_Detect	Max_Detect	EPC	Screening Value	Units	Source	Exceeds Screening Criteria?	COPEC?
2-Acetylaminofluorene	18	0	0%	10	10					ug/L			NO
2-Butanone	18	0	0%	10	10					ug/L			NO
2-Chloroethyl vinyl ether	18	0	0%	5	5					ug/L			NO
2-Chloronaphthalene	18	0	0%	10	10					ug/L			NO
2-Chlorophenol	18	0	0%	10	10					ug/L			NO
2-Chlorotoluene	18	0	0%	2	2					ug/L			NO
2-Hexanone	18	0	0%	5	5					ug/L			NO
2-Methylnaphthalene	18	0	0%	0.1	10					ug/L			NO
2-Methylphenol	18	0	0%	10	10					ug/L			NO
2-Naphthylamine	18	0	0%	10	10					ug/L			NO
2-Nitroaniline	18	0	0%	10	10					ug/L			NO
2-Nitrophenol	18	0	0%	10	10					ug/L			NO
2-Nitropropane	18	0	0%	2	5					ug/L			NO
2-Picoline	18	0	0%	10	10					ug/L			NO
3&4-Methylphenol	18	0	0%	10	10					ug/L			NO
3,3´-Dichlorobenzidine	18	0	0%	10	10					ug/L			NO
3,3´-Dimethylbenzidine	18	0	0%	10	10					ug/L			NO
3-Methylcholanthrene	18	0	0%	10	10					ug/L			NO
3-Nitroaniline	18	0	0%	10	10					ug/L			NO
4,6-Dinitro-2-methylphenol	18	0	0%	10	10					ug/L			NO
4-Aminobiphenyl	18	0	0%	10	10					ug/L			NO
4-Bromophenyl phenyl ether	18	0	0%	10	10					ug/L			NO
4-Chloro-3-methylphenol	18	0	0%	10	10					ug/L			NO
4-Chloroaniline	18	0	0%	10	10					ug/L			NO
4-Chlorophenyl phenyl ether	18	0	0%	10	10					ug/L			NO
4-Chlorotoluene	18	0	0%	2	2					ug/L			NO
4-Isopropyltoluene	18	0	0%	2	2					ug/L			NO
4-Methyl-2-pentanone	18	0	0%	5	5					ug/L			NO
4-Nitroaniline	18	0	0%	10	10					ug/L			NO
4-Nitrophenol	18	0	0%	10	10					ug/L			NO
5-Nitro-o-toluidine	18	0	0%	10	10					ug/L			NO
7,12-Dimethylbenz(a)anthracene	18	0	0%	10	10					ug/L			NO
a,a-Dimethylphenethylamine	18	0	0%	10	10					ug/L			NO
Acenaphthene	18	0	0%	0.1	10					ug/L			NO
Acenaphthylene	18	0	0%	0.1	10					ug/L			NO
Acetone	18	0	0%	10	10					ug/L			NO
Acetonitrile	18	0	0%	5	5					ug/L			NO
Acetophenone	18	0	0%	10	10					ug/L			NO
Acrolein	18	0	0%	5	5					ug/L			NO
Acrylonitrile	18	0	0%	10	10					ug/L			NO
Allyl chloride	18	0	0%	5	5					ug/L			NO
alpha-Terpineol	18	0	0%	10	10					ug/L			NO
Aniline	18	0	0%	10	10					ug/L			NO

Table E-1a
Red Butte Creek Water COPEC Selection
Ecological Risk Assessment
Red Butte Creek
Salt Lake City, Utah

Analyte	Num_Detects	Num_NDs	Frequency of Detection	Min_ND	Max_ND	Min_Detect	Max_Detect	EPC	Screening Value	Units	Source	Exceeds Screening Criteria?	COPEC?
Anthracene	18	0	0%	0.1	10					ug/L			NO
Aramite	18	0	0%	10	10					ug/L			NO
Azobenzene	18	0	0%	10	10					ug/L			NO
Benz(a)anthracene	18	0	0%	0.1	10					ug/L			NO
Benzene	18	0	0%	2	2					ug/L			NO
Benzidine	18	0	0%	10	10					ug/L			NO
Benzo(a)pyrene	18	0	0%	0.1	10					ug/L			NO
Benzo(b)fluoranthene	18	0	0%	0.1	10					ug/L			NO
Benzo(g,h,i)perylene	18	0	0%	0.1	10					ug/L			NO
Benzo(k)fluoranthene	18	0	0%	0.1	10					ug/L			NO
Benzoic acid	18	0	0%	20	20					ug/L			NO
Benzyl alcohol	18	0	0%	10	10					ug/L			NO
Benzyl chloride	18	0	0%	5	5					ug/L			NO
Bis(2-chloroethoxy)methane	18	0	0%	10	10					ug/L			NO
Bis(2-chloroethyl) ether	18	0	0%	10	10					ug/L			NO
Bis(2-chloroisopropyl) ether	18	0	0%	5	5					ug/L			NO
Bis(2-ethylhexyl) phthalate	18	1	6%	10	10	0	27.6	28	3.0	ug/L	USEPA Tier II - Freshwater	Yes	YES
bis(2-ethylhexyl)adipate	18	0	0%	10	10					ug/L			NO
Bromobenzene	18	0	0%	2	2					ug/L			NO
Bromochloromethane	18	0	0%	2	2					ug/L			NO
Bromodichloromethane	18	0	0%	2	2					ug/L			NO
Bromoform	18	1	6%	2	2	0	5.8	5.8	293	ug/L	USEPA Tier II - Freshwater	No	NO
Bromomethane	18	0	0%	5	5					ug/L			NO
Butyl acetate	18	0	0%	5	5					ug/L			NO
Butyl benzyl phthalate	18	0	0%	10	10					ug/L			NO
C11-C12 Aliphatic hydrocarbons	2	0	0%	10	10					ug/L			NO
C11-C13 Alkyl Naphthalenes	2	0	0%	10	10					ug/L			NO
C13-C16 Aliphatic hydrocarbons	2	0	0%	10	10					ug/L			NO
C17-C21 Aliphatic hydrocarbons	2	0	0%	10	10					ug/L			NO
C22-C35 Aliphatic hydrocarbons	2	0	0%	10	10					ug/L			NO
Carbazole	18	0	0%	10	10					ug/L			NO
Carbon disulfide	18	0	0%	2	2					ug/L			NO
Carbon tetrachloride	18	0	0%	2	2					ug/L			NO
Chlorobenzene	18	0	0%	2	2					ug/L			NO
Chlorobenzilate	18	0	0%	10	10					ug/L			NO
Chloroethane	18	0	0%	2	2					ug/L			NO
Chloroform	18	0	0%	2	2					ug/L			NO
Chloromethane	18	0	0%	3	5					ug/L			NO
Chloroprene	18	0	0%	2	2					ug/L			NO
Chrysene	18	0	0%	0.1	10					ug/L			NO
cis-1,2-Dichloroethene	18	0	0%	2	2					ug/L			NO
cis-1,3-Dichloropropene	18	0	0%	2	2					ug/L			NO
Cyclohexane	18	0	0%	2	2					ug/L			NO

Table E-1a
Red Butte Creek Water COPEC Selection
Ecological Risk Assessment
Red Butte Creek
Salt Lake City, Utah

Analyte	Num_Detects	Num_NDs	Frequency of Detection	Min_ND	Max_ND	Min_Detect	Max_Detect	EPC	Screening Value	Units	Source	Exceeds Screening Criteria?	COPEC?
Cyclohexanone	18	0	0%	50	50					ug/L			NO
Diallate (cis or trans)	18	0	0%	10	10					ug/L			NO
Dibenz(a,h)anthracene	18	0	0%	0.1	10					ug/L			NO
Dibenzofuran	18	0	0%	10	10					ug/L			NO
Dibromochloromethane	18	0	0%	2	2					ug/L			NO
Dibromomethane	18	0	0%	2	2					ug/L			NO
Dichlorodifluoromethane	18	0	0%	2	2					ug/L			NO
Diesel Range Organics (DRO) (C10-C28)	18	0	0%	0.5	0.5					mg/L			NO
Diethyl phthalate	18	0	0%	10	10					ug/L			NO
Dimethoate	18	0	0%	10	10					ug/L			NO
Dimethyl phthalate	18	0	0%	10	10					ug/L			NO
Dimethylaminoazobenzene	18	0	0%	10	10					ug/L			NO
Di-n-butyl phthalate	18	0	0%	10	10					ug/L			NO
Di-n-octyl phthalate	18	0	0%	10	10					ug/L			NO
Dinoseb	18	0	0%	10	10					ug/L			NO
Diphenylamine	18	0	0%	10	10					ug/L			NO
Disulfoton	18	0	0%	10	10					ug/L			NO
Ethyl acetate	18	0	0%	10	10					ug/L			NO
Ethyl ether	18	0	0%	10	10					ug/L			NO
Ethyl methacrylate	18	0	0%	2	2					ug/L			NO
Ethyl methanesulfonate	18	0	0%	10	10					ug/L			NO
Ethylbenzene	18	0	0%	2	2					ug/L			NO
Famphur	18	0	0%	10	10					ug/L			NO
Fluoranthene	18	0	0%	0.1	10					ug/L			NO
Fluorene	18	0	0%	0.1	10					ug/L			NO
Hexachlorobenzene	18	0	0%	10	10					ug/L			NO
Hexachlorobutadiene	18	0	0%	2	2					ug/L			NO
Hexachlorocyclopentadiene	18	0	0%	10	10					ug/L			NO
Hexachloroethane	18	0	0%	10	10					ug/L			NO
Hexachlorophene	18	0	0%	10	10					ug/L			NO
Hexachloropropene	18	0	0%	10	10					ug/L			NO
Indene	18	0	0%	0.1	10					ug/L			NO
Indeno(1,2,3-cd)pyrene	18	0	0%	0.1	10					ug/L			NO
Iodomethane	18	0	0%	5	5					ug/L			NO
Isobutyl alcohol	18	0	0%	100	100					ug/L			NO
Isodrin	18	0	0%	10	10					ug/L			NO
Isophorone	18	0	0%	10	10					ug/L			NO
Isopropyl acetate	18	0	0%	2	2					ug/L			NO
Isopropyl alcohol	18	0	0%	25	25					ug/L			NO
Isopropylbenzene	18	0	0%	2	2					ug/L			NO
Isopropyltoluene	16	0	0%	2	2					ug/L			NO
Isosafrole	18	0	0%	10	10					ug/L			NO
Kepone	18	0	0%	10	10					ug/L			NO

Table E-1a
Red Butte Creek Water COPEC Selection
Ecological Risk Assessment
Red Butte Creek
Salt Lake City, Utah

Analyte	Num_Detects	Num_NDs	Frequency of Detection	Min_ND	Max_ND	Min_Detect	Max_Detect	EPC	Screening Value	Units	Source	Exceeds Screening Criteria?	COPEC?
m,p-Xylene	18	0	0%	2	2					ug/L			NO
Methacrylonitrile	18	0	0%	5	5					ug/L			NO
Methapyrilene	18	0	0%	10	10					ug/L			NO
Methyl Acetate	18	0	0%	5	5					ug/L			NO
Methyl methacrylate	18	0	0%	5	5					ug/L			NO
Methyl methanesulfonate	18	0	0%	10	10					ug/L			NO
Methyl parathion	18	0	0%	10	10					ug/L			NO
Methyl tert-butyl ether	18	0	0%	2	2					ug/L			NO
Methylcyclohexane	18	0	0%	2	2					ug/L			NO
Methylene chloride	18	0	0%	2	2					ug/L			NO
n-Amyl acetate	18	0	0%	2	2					ug/L			NO
Naphthalene	18	0	0%	0.1	2					ug/L			NO
n-Butyl alcohol	18	0	0%	25	50					ug/L			NO
n-Butylbenzene	18	0	0%	2	2					ug/L			NO
n-Decane	18	0	0%	10	10					ug/L			NO
n-Hexane	18	0	0%	2	2					ug/L			NO
Nitrobenzene	18	0	0%	10	10					ug/L			NO
Nitroquinoline-1-oxide	18	0	0%	10	10					ug/L			NO
N-Nitrosodiethylamine	18	0	0%	10	10					ug/L			NO
N-Nitrosodimethylamine	18	0	0%	10	10					ug/L			NO
N-Nitrosodi-n-butylamine	18	0	0%	10	10					ug/L			NO
N-Nitrosodi-n-propylamine	18	0	0%	10	10					ug/L			NO
N-Nitrosodiphenylamine	18	0	0%	10	10					ug/L			NO
N-Nitrosomethylethylamine	18	0	0%	10	10					ug/L			NO
N-Nitrosomorpholine	18	0	0%	10	10					ug/L			NO
N-Nitrosopiperidine	18	0	0%	10	10					ug/L			NO
N-Nitrosopyrrolidine	18	0	0%	10	10					ug/L			NO
n-Octadecane	18	0	0%	10	10					ug/L			NO
n-Octane	18	0	0%	2	2					ug/L			NO
n-Propylbenzene	18	0	0%	2	2					ug/L			NO
O,O,O-Triethyl phosphorothioate	18	0	0%	10	10					ug/L			NO
Oil Range Organics (ORO) (C28-C36)	18	0	0%	0.5	0.5					mg/L			NO
o-Toluidine	18	0	0%	10	10					ug/L			NO
o-Xylene	18	0	0%	2	2					ug/L			NO
Parathion	18	0	0%	10	10					ug/L			NO
Pentachlorobenzene	18	0	0%	10	10					ug/L			NO
Pentachloroethane	18	0	0%	2	5					ug/L			NO
Pentachloronitrobenzene	18	0	0%	10	10					ug/L			NO
Pentachlorophenol	18	0	0%	10	10					ug/L			NO
Phenacetin	18	0	0%	10	10					ug/L			NO
Phenanthrene	18	0	0%	0.1	10					ug/L			NO
Phenol	18	0	0%	10	10					ug/L			NO
Phorate	18	0	0%	10	10					ug/L			NO

Table E-1a
Red Butte Creek Water COPEC Selection
Ecological Risk Assessment
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Salt Lake City, Utah

Analyte	Num_Detects	Num_NDs	Frequency of Detection	Min_ND	Max_ND	Min_Detect	Max_Detect	EPC	Screening Value	Units	Source	Exceeds Screening Criteria?	COPEC?
Pronamide	18	0	0%	10	10					ug/L			NO
Propionitrile	18	0	0%	25	25					ug/L			NO
Propyl acetate	18	0	0%	2	2					ug/L			NO
Pyrene	18	0	0%	0.1	10					ug/L			NO
Pyridine	18	0	0%	10	10					ug/L			NO
Quinoline	18	0	0%	10	10					ug/L			NO
Safrole	18	0	0%	10	10					ug/L			NO
sec-Butylbenzene	18	0	0%	2	2					ug/L			NO
Styrene	18	0	0%	2	2					ug/L			NO
tert-Butyl alcohol	18	0	0%	20	20					ug/L			NO
tert-Butylbenzene	18	0	0%	2	2					ug/L			NO
Tetrachloroethene	18	0	0%	2	2					ug/L			NO
Tetraethyl dithiopyrophosphate	18	0	0%	10	10					ug/L			NO
Tetrahydrofuran	18	0	0%	2	2					ug/L			NO
Thionazin	18	0	0%	10	10					ug/L			NO
Toluene	18	0	0%	2	2					ug/L			NO
Total C12-C22 PAH**	2	0	0%	10	10					ug/L			NO
Total Recoverable Petroleum Hydrocarbons	2	1	50%	3	3	0	4.88			mg/L	TRPH not suitable for risk assessment		NO
trans-1,2-Dichloroethene	18	0	0%	2	2					ug/L			NO
trans-1,3-Dichloropropene	18	0	0%	2	2					ug/L			NO
trans-1,4-Dichloro-2-butene	18	0	0%	2	2					ug/L			NO
Trichloroethene	18	0	0%	2	2					ug/L			NO
Trichlorofluoromethane	18	0	0%	2	2					ug/L			NO
Vinyl acetate	18	0	0%	5	10					ug/L			NO
Vinyl chloride	18	0	0%	1	1					ug/L			NO
Xylenes, Total	18	0	0%	2	2					ug/L			NO

Table E-1b
Reference Creek Water COPEC Selection
Ecological Risk Assessment
Red Butte Creek
Salt Lake City, Utah

Analyte	Num_Detects	Num_NDs	Frequency of Detection	Min_ND	Max_ND	Min_Detect	Max_Detect	EPC	Screening Value	Units	Source	Exceeds Screening Criteria?	Red Butte Creek COPEC?
#6 Fuel Oil	2	0	0%	1	1					ug/L			NO
1,1,1,2-Tetrachloroethane	18	0	0%	2	2					ug/L			NO
1,1,1-Trichloroethane	18	0	0%	2	2					ug/L			NO
1,1,2,2-Tetrachloroethane	18	0	0%	2	2					ug/L			NO
1,1,2-Trichloro-1,2,2-trifluoro	18	0	0%	2	2					ug/L			NO
1,1,2-Trichloroethane	18	0	0%	2	2					ug/L			NO
1,1´-Biphenyl	18	0	0%	10	10					ug/L			NO
1,1-Dichloroethane	18	0	0%	2	2					ug/L			NO
1,1-Dichloroethene	18	0	0%	2	2					ug/L			NO
1,1-Dichloropropene	18	0	0%	2	2					ug/L			NO
1,2,3-Trichlorobenzene	18	0	0%	2	2					ug/L			NO
1,2,3-Trichloropropane	18	0	0%	2	2					ug/L			NO
1,2,3-Trimethylbenzene	18	0	0%	2	2					ug/L			NO
1,2,4,5-Tetrachlorobenzene	18	0	0%	10	10					ug/L			NO
1,2,4-Trichlorobenzene	18	0	0%	2	2					ug/L			NO
1,2,4-Trimethylbenzene	18	0	0%	2	2					ug/L			NO
1,2-Dibromo-3-chloropropan	18	0	0%	5	5					ug/L			NO
1,2-Dibromoethane	18	0	0%	2	2					ug/L			NO
1,2-Dichlorobenzene	18	0	0%	2	2					ug/L			NO
1,2-Dichloroethane	18	0	0%	2	2					ug/L			NO
1,2-Dichloropropane	18	0	0%	2	2					ug/L			NO
1,3,5-Trimethylbenzene	18	0	0%	2	2					ug/L			NO
1,3,5-Trinitrobenzene	18	0	0%	10	10					ug/L			NO
1,3-Dichlorobenzene	18	0	0%	2	2					ug/L			NO
1,3-Dichloropropane	18	0	0%	2	2					ug/L			NO
1,3-Dinitrobenzene	18	0	0%	10	10					ug/L			NO
1,4-Dichlorobenzene	18	0	0%	2	2					ug/L			NO
1,4-Dinitrobenzene	18	0	0%	10	10					ug/L			NO
1,4-Dioxane	18	0	0%	50	50					ug/L			NO
1,4-Naphthoquinone	18	0	0%	10	10					ug/L			NO
1,4-Phenylenediamine	18	0	0%	10	10					ug/L			NO
1-Chloronaphthalene	18	0	0%	10	10					ug/L			NO
1-Methylnaphthalene	18	0	0%	0.1	0.1					ug/L			NO
1-Naphthylamine	18	0	0%	10	10					ug/L			NO
2,2-Dichloropropane	18	0	0%	2	2					ug/L			NO
2,3,4,6-Tetrachlorophenol	18	0	0%	10	10					ug/L			NO
2,4,5-Trichlorophenol	18	0	0%	10	10					ug/L			NO
2,4,6-Trichlorophenol	18	0	0%	10	10					ug/L			NO
2,4-Dichlorophenol	18	0	0%	10	10					ug/L			NO
2,4-Dimethylphenol	18	0	0%	10	10					ug/L			NO
2,4-Dinitrophenol	18	0	0%	20	20					ug/L			NO
2,4-Dinitrotoluene	18	0	0%	10	10					ug/L			NO
2,6-Dichlorophenol	18	0	0%	10	10					ug/L			NO

Table E-1b
Reference Creek Water COPEC Selection
Ecological Risk Assessment
Red Butte Creek
Salt Lake City, Utah

Analyte	Num_Detects	Num_NDs	Frequency of Detection	Min_ND	Max_ND	Min_Detect	Max_Detect	EPC	Screening Value	Units	Source	Exceeds Screening Criteria?	Red Butte Creek COPEC?
2,6-Dinitrotoluene	18	0	0%	10	10					ug/L			NO
2-Acetylaminofluorene	18	0	0%	10	10					ug/L			NO
2-Butanone	18	0	0%	10	10					ug/L			NO
2-Chloroethyl vinyl ether	18	0	0%	5	5					ug/L			NO
2-Chloronaphthalene	18	0	0%	10	10					ug/L			NO
2-Chlorophenol	18	0	0%	10	10					ug/L			NO
2-Chlorotoluene	18	0	0%	2	2					ug/L			NO
2-Hexanone	18	0	0%	5	5					ug/L			NO
2-Methylnaphthalene	18	0	0%	0.1	0.1					ug/L			NO
2-Methylphenol	18	0	0%	10	10					ug/L			NO
2-Naphthylamine	18	0	0%	10	10					ug/L			NO
2-Nitroaniline	18	0	0%	10	10					ug/L			NO
2-Nitrophenol	18	0	0%	10	10					ug/L			NO
2-Nitropropane	18	0	0%	5	5					ug/L			NO
2-Picoline	18	0	0%	10	10					ug/L			NO
3&4-Methylphenol	18	0	0%	10	10					ug/L			NO
3,3´-Dichlorobenzidine	18	0	0%	10	10					ug/L			NO
3,3´-Dimethylbenzidine	18	0	0%	10	10					ug/L			NO
3-Methylcholanthrene	18	0	0%	10	10					ug/L			NO
3-Nitroaniline	18	0	0%	10	10					ug/L			NO
4,6-Dinitro-2-methylphenol	18	0	0%	10	10					ug/L			NO
4-Aminobiphenyl	18	0	0%	10	10					ug/L			NO
4-Bromophenyl phenyl ether	18	0	0%	10	10					ug/L			NO
4-Chloro-3-methylphenol	18	0	0%	10	10					ug/L			NO
4-Chloroaniline	18	0	0%	10	10					ug/L			NO
4-Chlorophenyl phenyl ether	18	0	0%	10	10					ug/L			NO
4-Chlorotoluene	18	0	0%	2	2					ug/L			NO
4-Isopropyltoluene	18	0	0%	2	2					ug/L			NO
4-Methyl-2-pentanone	18	0	0%	5	5					ug/L			NO
4-Nitroaniline	18	0	0%	10	10					ug/L			NO
4-Nitrophenol	18	0	0%	10	10					ug/L			NO
5-Nitro-o-toluidine	18	0	0%	10	10					ug/L			NO
7,12-Dimethylbenz(a)anthrac	18	0	0%	10	10					ug/L			NO
a,a-Dimethylphenethylamine	18	0	0%	10	10					ug/L			NO
Acenaphthene	19	0	0%	0.0098	0.1					ug/L			NO
Acenaphthylene	19	0	0%	0.0098	0.1					ug/L			NO
Acetone	18	0	0%	10	10					ug/L			NO
Acetonitrile	18	0	0%	5	5					ug/L			NO
Acetophenone	18	0	0%	10	10					ug/L			NO
Acrolein	18	0	0%	5	5					ug/L			NO
Acrylonitrile	18	0	0%	10	10					ug/L			NO
Allyl chloride	18	0	0%	5	5					ug/L			NO
alpha-Terpineol	18	0	0%	10	10					ug/L			NO

Table E-1b
Reference Creek Water COPEC Selection
Ecological Risk Assessment
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Analyte	Num_Detects	Num_NDs	Frequency of Detection	Min_ND	Max_ND	Min_Detect	Max_Detect	EPC	Screening Value	Units	Source	Exceeds Screening Criteria?	Red Butte Creek COPEC?
Aniline	18	0	0%	10	10					ug/L			NO
Anthracene	19	0	0%	0.0098	0.1					ug/L			NO
Aramite	18	0	0%	10	10					ug/L			NO
Azobenzene	18	0	0%	10	10					ug/L			NO
Benz(a)anthracene	18	0	0%	0.1	0.1					ug/L			NO
Benzene	20	0	0%	0.1	2					ug/L			NO
Benzidine	18	0	0%	10	10					ug/L			NO
Benzo(a)anthracene	1	0	0%	0.0098	0.0098					ug/L			NO
Benzo(a)pyrene	19	0	0%	0.0098	0.1					ug/L			NO
Benzo(b)fluoranthene	19	0	0%	0.0098	0.1					ug/L			NO
Benzo(g,h,i)perylene	19	0	0%	0.0098	0.1					ug/L			NO
Benzo(k)fluoranthene	19	0	0%	0.0098	0.1					ug/L			NO
Benzoic acid	18	0	0%	20	20					ug/L			NO
Benzyl alcohol	18	0	0%	10	10					ug/L			NO
Benzyl chloride	18	0	0%	5	5					ug/L			NO
Bis(2-chloroethoxy)methane	18	0	0%	10	10					ug/L			NO
Bis(2-chloroethyl) ether	18	0	0%	10	10					ug/L			YES
Bis(2-chloroisopropyl) ether	18	0	0%	5	5					ug/L			NO
Bis(2-ethylhexyl) phthalate	18	0	0%	10	10					ug/L			NO
bis(2-ethylhexyl)adipate	18	0	0%	10	10					ug/L			NO
Bromobenzene	18	0	0%	2	2					ug/L			NO
Bromochloromethane	18	0	0%	2	2					ug/L			NO
Bromodichloromethane	18	0	0%	2	2					ug/L			NO
Bromoform	18	0	0%	2	2					ug/L			NO
Bromomethane	18	0	0%	5	5					ug/L			NO
Butyl acetate	18	0	0%	5	5					ug/L			NO
Butyl benzyl phthalate	18	0	0%	10	10					ug/L			NO
Carbazole	18	0	0%	10	10					ug/L			NO
Carbon disulfide	18	0	0%	2	2					ug/L			NO
Carbon tetrachloride	18	0	0%	2	2					ug/L			NO
Chlorobenzene	18	0	0%	2	2					ug/L			NO
Chlorobenzilate	18	0	0%	10	10					ug/L			NO
Chloroethane	18	0	0%	2	2					ug/L			NO
Chloroform	18	0	0%	2	2					ug/L			NO
Chloromethane	18	0	0%	3	3					ug/L			NO
Chloroprene	18	0	0%	2	2					ug/L			NO
Chrysene	19	0	0%	0.0098	0.1					ug/L			NO
cis-1,2-Dichloroethene	18	0	0%	2	2					ug/L			NO
cis-1,3-Dichloropropene	18	0	0%	2	2					ug/L			NO
Coal Tar Oil	1	0	0%	0.2	0.2					ug/L			NO
Cyclohexane	18	0	0%	2	2					ug/L			NO
Cyclohexanone	18	0	0%	50	50					ug/L			NO
Diallate (cis or trans)	18	0	0%	10	10					ug/L			NO

Table E-1b
Reference Creek Water COPEC Selection
Ecological Risk Assessment
Red Butte Creek
Salt Lake City, Utah

Analyte	Num_Detects	Num_NDs	Frequency of Detection	Min_ND	Max_ND	Min_Detect	Max_Detect	EPC	Screening Value	Units	Source	Exceeds Screening Criteria?	Red Butte Creek COPEC?
Dibenz(a,h)anthracene	19	0	0%	0.0098	0.1					ug/L			NO
Dibenzofuran	18	0	0%	10	10					ug/L			NO
Dibromochloromethane	18	0	0%	2	2					ug/L			NO
Dibromomethane	18	0	0%	2	2					ug/L			NO
Dichlorodifluoromethane	18	0	0%	2	2					ug/L			NO
Diesel Range Organics (DRO	18	0	0%	0.5	0.5					ug/L			NO
Diesel/#2 Fuel	1	0	0%	0.2	0.2					ug/L			NO
Diethyl phthalate	18	0	0%	10	10					mg/L			NO
Dimethoate	18	0	0%	10	10					ug/L			NO
Dimethyl phthalate	18	0	0%	10	10					ug/L			NO
Dimethylaminoazobenzene	18	0	0%	10	10					ug/L			NO
Di-n-butyl phthalate	18	0	0%	10	10					ug/L			NO
Di-n-octyl phthalate	18	0	0%	10	10					ug/L			NO
Dinoseb	18	0	0%	10	10					ug/L			NO
Diphenylamine	18	0	0%	10	10					ug/L			NO
Disulfoton	18	0	0%	10	10					ug/L			NO
Ethyl acetate	18	0	0%	10	10					ug/L			NO
Ethyl ether	18	0	0%	10	10					ug/L			NO
Ethyl methacrylate	18	0	0%	2	2					ug/L			NO
Ethyl methanesulfonate	18	0	0%	10	10					ug/L			NO
Ethylbenzene	20	0	0%	0.1	2					ug/L			NO
Famphur	18	0	0%	10	10					ug/L			NO
Fluoranthene	19	0	0%	0.0098	0.1					ug/L			NO
Fluorene	19	0	0%	0.0098	0.1					ug/L			NO
Gasoline	1	0	0%	0.2	0.2					ug/L			NO
Hexachlorobenzene	18	0	0%	10	10					ug/L			NO
Hexachlorobutadiene	18	0	0%	2	2					ug/L			NO
Hexachlorocyclopentadiene	18	0	0%	10	10					ug/L			NO
Hexachloroethane	18	0	0%	10	10					ug/L			NO
Hexachlorophene	18	0	0%	10	10					ug/L			NO
Hexachloropropene	18	0	0%	10	10					ug/L			NO
Indene	18	0	0%	0.1	0.1					ug/L			NO
Indeno(1,2,3-cd)pyrene	19	0	0%	0.0098	0.1					ug/L			NO
Iodomethane	18	0	0%	5	5					ug/L			NO
Isobutyl alcohol	18	0	0%	100	100					ug/L			NO
Isodrin	18	0	0%	10	10					ug/L			NO
Isophorone	18	0	0%	10	10					ug/L			NO
Isopropyl acetate	18	0	0%	2	2					ug/L			NO
Isopropyl alcohol	18	0	0%	25	25					ug/L			NO
Isopropylbenzene	18	0	0%	2	2					ug/L			NO
Isopropyltoluene	8	0	0%	2	2					ug/L			NO
Isosafrole	18	0	0%	10	10					ug/L			NO
Kepone	18	0	0%	10	10					ug/L			NO

Table E-1b
Reference Creek Water COPEC Selection
Ecological Risk Assessment
Red Butte Creek
Salt Lake City, Utah

Analyte	Num_Detects	Num_NDs	Frequency of Detection	Min_ND	Max_ND	Min_Detect	Max_Detect	EPC	Screening Value	Units	Source	Exceeds Screening Criteria?	Red Butte Creek COPEC?
Kerosene	1	0	0%	0.2	0.2					ug/L			NO
m,p-Xylene	18	0	0%	2	2					ug/L			NO
Methacrylonitrile	18	0	0%	5	5					ug/L			NO
Methapyrilene	18	0	0%	10	10					ug/L			NO
Methyl Acetate	18	0	0%	5	5					ug/L			NO
Methyl methacrylate	18	0	0%	5	5					ug/L			NO
Methyl methanesulfonate	18	0	0%	10	10					ug/L			NO
Methyl parathion	18	0	0%	10	10					ug/L			NO
Methyl tert-butyl ether	18	0	0%	2	2					ug/L			NO
Methylcyclohexane	18	0	0%	2	2					ug/L			NO
Methylene chloride	18	0	0%	2	2					ug/L			NO
Mineral Spirits	1	0	0%	0.2	0.2					ug/L			NO
Motor Oil	1	0	0%	1	1					ug/L			NO
n-Amyl acetate	18	0	0%	2	2					ug/L			NO
Naphthalene	19	0	0%	0.0098	0.1					ug/L			NO
n-Butyl alcohol	18	0	0%	50	50					ug/L			NO
n-Butylbenzene	18	0	0%	2	2					ug/L			NO
n-Decane	18	0	0%	10	10					ug/L			NO
n-Hexane	18	0	0%	2	2					ug/L			NO
Nitrobenzene	18	0	0%	10	10					ug/L			NO
Nitroquinoline-1-oxide	18	0	0%	10	10					ug/L			NO
N-Nitrosodiethylamine	18	0	0%	10	10					ug/L			NO
N-Nitrosodimethylamine	18	0	0%	10	10					ug/L			NO
N-Nitrosodi-n-butylamine	18	0	0%	10	10					ug/L			NO
N-Nitrosodi-n-propylamine	18	0	0%	10	10					ug/L			NO
N-Nitrosodiphenylamine	18	0	0%	10	10					ug/L			NO
N-Nitrosomethylethylamine	18	0	0%	10	10					ug/L			NO
N-Nitrosomorpholine	18	0	0%	10	10					ug/L			NO
N-Nitrosopiperidine	18	0	0%	10	10					ug/L			NO
N-Nitrosopyrrolidine	18	0	0%	10	10					ug/L			NO
n-Octadecane	18	0	0%	10	10					ug/L			NO
n-Octane	18	0	0%	2	2					mg/L			NO
n-Propylbenzene	18	0	0%	2	2					ug/L			NO
O,O,O-Triethyl phosphoroth	18	0	0%	10	10					ug/L			NO
Oil Range Organics (ORO) (C	18	0	0%	0.5	0.5					ug/L			NO
o-Toluidine	18	0	0%	10	10					ug/L			NO
o-Xylene	18	0	0%	2	2					ug/L			NO
Parathion	18	0	0%	10	10					ug/L			NO
Pentachlorobenzene	18	0	0%	10	10					ug/L			NO
Pentachloroethane	18	0	0%	5	5					ug/L			NO
Pentachloronitrobenzene	18	0	0%	10	10					ug/L			NO
Pentachlorophenol	18	0	0%	10	10					ug/L			NO
Phenacetin	18	0	0%	10	10					ug/L			NO

Table E-1b
Reference Creek Water COPEC Selection
Ecological Risk Assessment
Red Butte Creek
Salt Lake City, Utah

Analyte	Num_Detects	Num_NDs	Frequency of Detection	Min_ND	Max_ND	Min_Detect	Max_Detect	EPC	Screening Value	Units	Source	Exceeds Screening Criteria?	Red Butte Creek COPEC?
Phenanthrene	19	0	0%	0.0098	0.1					ug/L			NO
Phenol	18	0	0%	10	10					ug/L			NO
Phorate	18	0	0%	10	10					ug/L			NO
Pronamide	18	0	0%	10	10					ug/L			NO
Propionitrile	18	0	0%	25	25					ug/L			NO
Propyl acetate	18	0	0%	2	2					ug/L			NO
Pyrene	19	0	0%	0.0098	0.1					ug/L			NO
Pyridine	18	0	0%	10	10					ug/L			NO
Quinoline	18	0	0%	10	10					ug/L			NO
Safrole	18	0	0%	10	10					ug/L			NO
sec-Butylbenzene	18	0	0%	2	2					ug/L			NO
Styrene	18	0	0%	2	2					ug/L			NO
tert-Butyl alcohol	18	0	0%	20	20					ug/L			NO
tert-Butylbenzene	18	0	0%	2	2					ug/L			NO
Tetrachloroethene	18	0	0%	2	2					ug/L			NO
Tetraethyl dithiopyrophosph	18	0	0%	10	10					ug/L			NO
Tetrahydrofuran	18	0	0%	2	2					ug/L			NO
Thionazin	18	0	0%	10	10					mg/L			NO
Toluene	20	0	0%	0.1	2					ug/L			NO
trans-1,2-Dichloroethene	18	0	0%	2	2					ug/L			NO
trans-1,3-Dichloropropene	18	0	0%	2	2					ug/L			NO
trans-1,4-Dichloro-2-butene	18	0	0%	2	2					ug/L			NO
Trichloroethene	18	0	0%	2	2					ug/L			NO
Trichlorofluoromethane	18	0	0%	2	2					ug/L			NO
Vinyl acetate	18	0	0%	10	10					ug/L			NO
Vinyl chloride	18	0	0%	1	1					ug/L			NO
Xylenes, Total	20	0	0%	0.1	2								

Table E-2a
Bed Sediments Benthos COPEC Selection
Ecological Risk Assessment
Red Butte Creek
Salt Lake City, Utah

Chemical Name	Num_Detects	Num_NDs	Frequency of Detection	Min_ND	Max_ND	Min_Detect	Max_Detect	Mean_Detects	Median_Detects	StdDev_Detects	Distribution	UCL Calc Method	95 UCL	EPC	>5%	Screening value (mg/kg)	Reference	Exceeds benchmark?	COPEC?	Reason
1,1,1,2-Tetrachloroethane	0	15	0%	0.00226	0.00289										NO				NO	ND
1,1,1-Trichloroethane	0	15	0%	0.00226	0.00289										NO				NO	ND
1,1,2,2-Tetrachloroethane	0	15	0%	0.00226	0.00289										NO				NO	ND
1,1,2-Trichloroethane	0	15	0%	0.00226	0.00289										NO				NO	ND
1,1,2-Trichlorotrifluoroethane	0	15	0%	0.00226	0.00289										NO				NO	ND
1,1-Dichloroethane	0	15	0%	0.00226	0.00289										NO				NO	ND
1,1-Dichloroethene	0	15	0%	0.00226	0.00289										NO				NO	ND
1,1-Dichloropropene	0	15	0%	0.00226	0.00289										NO				NO	ND
1,2,3-Trichlorobenzene	0	15	0%	0.00226	0.00289										NO				NO	ND
1,2,3-Trichloropropane	0	15	0%	0.00226	0.00289										NO				NO	ND
1,2,4-Trichlorobenzene	0	15	0%	0.00226	0.00289										NO				NO	ND
1,2,4-Trimethylbenzene	0	15	0%	0.00226	0.00289										NO				NO	ND
1,2-Dibromo-3-chloropropane	0	15	0%	0.00564	0.00723										NO				NO	ND
1,2-Dibromoethane	0	15	0%	0.00226	0.00289										NO				NO	ND
1,2-Dichlorobenzene	0	15	0%	0.00226	0.00289										NO				NO	ND
1,2-Dichloroethane	0	15	0%	0.00226	0.00289										NO				NO	ND
1,2-Dichloropropane	0	15	0%	0.00226	0.00289										NO				NO	ND
1,3,5-Trimethylbenzene	0	15	0%	0.00226	0.00289										NO				NO	ND
1,3,5-Trinitrobenzene	0	12	0%	0.38	0.483										NO				NO	ND
1,3-Dichlorobenzene	0	15	0%	0.00226	0.00289										NO				NO	ND
1,3-Dichloropropane	0	15	0%	0.00226	0.00289										NO				NO	ND
1,3-Dinitrobenzene	0	12	0%	0.38	0.483										NO				NO	ND
1,4-Dichlorobenzene	0	15	0%	0.00226	0.00289										NO				NO	ND
1,4-Dioxane	0	15	0%	0.0564	0.0723										NO				NO	ND
1-Methylnaphthalene	3	15	20%	0.0112	0.0142	0.0142	0.0256	0.0184	0.0154	0.00626	non-parametric	KM (t)	0.0166	0.0166	YES	0.176	1- surr. (Napthalene)	No	NO	BSL
2,2-Dichloropropane	0	15	0%	0.00226	0.00289										NO				NO	ND
2,3,4,6-Tetrachlorophenol	0	12	0%	0.38	0.483										NO				NO	ND
2,4,5-Trichlorophenol	0	12	0%	0.38	0.483										NO				NO	ND
2,4,6-Trichlorophenol	0	12	0%	0.38	0.483										NO				NO	ND
2,4-Dichlorophenol	0	12	0%	0.38	0.483										NO				NO	ND
2,4-Dimethylphenol	0	12	0%	0.38	0.483										NO				NO	ND
2,4-Dinitrophenol	0	12	0%	0.749	0.951										NO				NO	ND
2,4-Dinitrotoluene	0	12	0%	0.38	0.483										NO				NO	ND
2,6-Dinitrotoluene	0	12	0%	0.38	0.483										NO				NO	ND
2-Butanone	0	15	0%	0.0113	0.0145										NO				NO	ND
2-Chloroethyl vinyl ether	0	15	0%	0.00564	0.00723										NO				NO	ND
2-Chloronaphthalene	0	12	0%	0.38	0.483										NO				NO	ND
2-Chlorophenol	0	12	0%	0.38	0.483										NO				NO	ND
2-Chlorotoluene	0	15	0%	0.00226	0.00289										NO				NO	ND
2-Hexanone	0	15	0%	0.00564	0.00723										NO				NO	ND
2-Methylaniline	0	12	0%	0.38	0.483										NO				NO	ND
2-Methylnaphthalene	1	15	7%	0.0112	0.0145	0.024	0.024							0.024	YES	0.176	1- surr. (Napthalene)	No	NO	BSL
2-Methylphenol	0	12	0%	0.38	0.483										NO				NO	ND
2-Nitroaniline	0	12	0%	0.38	0.483										NO				NO	ND
2-Nitrophenol	0	12	0%	0.38	0.483										NO				NO	ND
2-Nitropropane	0	15	0%	0.00564	0.00723										NO				NO	ND
3,3-Dichlorobenzidine	0	12	0%	0.38	0.483										NO				NO	ND
3/4-Methylphenol	0	12	0%	0.38	0.483										NO				NO	ND
3-Chloropropene	0	15	0%	0.00564	0.00723										NO				NO	ND
3-Nitroaniline	0	12	0%	1.12	1.42										NO				NO	ND
4,6-Dinitro-2-methylphenol	0	12	0%	0.749	0.951										NO				NO	ND
4-Bromophenyl phenyl ether	0	12	0%	0.38	0.483										NO				NO	ND
4-Chloro-3-methylphenol	0	12	0%	0.38	0.483										NO				NO	ND
4-Chloroaniline	0	12	0%	0.38	0.483										NO				NO	ND
4-Chlorophenyl phenyl ether	0	12	0%	0.38	0.483										NO				NO	ND
4-Chlorotoluene	0	15	0%	0.00226	0.00289										NO				NO	ND
4-Methyl-2-pentanone	0	15	0%	0.00564	0.00723										NO				NO	ND
4-Nitroaniline	0	12	0%	1.12	1.42										NO				NO	ND
4-Nitrophenol	0	12	0%	0.749	0.951										NO				NO	ND
Acenaphthene	0	15	0%	0.0112	0.0145										NO				NO	ND
Acenaphthylene	0	15	0%	0.0112	0.0145										NO				NO	ND
Acetone	1	15	7%	0.011	0.015	0.020	0.020							0.02	YES	0.0087	5	Yes	YES	ASL

Table E-2a
Bed Sediments Benthos COPEC Selection
Ecological Risk Assessment
Red Butte Creek
Salt Lake City, Utah

Chemical Name	Num_Detects	Num_NDs	Frequency of Detection	Min_ND	Max_ND	Min_Detect	Max_Detect	Mean_Detects	Median_Detects	StdDev_Detects	Distribution	UCL Calc Method	95 UCL	EPC	>5%	Screening value (mg/kg)	Reference	Exceeds benchmark?	COPEC?	Reason
Aniline	0	12	0%	0.749	0.951										NO				NO	ND
Anthracene	2	15	13%	0.011	0.014	0.014	0.090	0.052	0.052	0.054	non-parametric	NA	NA	0.09	YES	0.057	1	Yes	YES	ASL
Azobenzene	0	12	0%	0.38	0.483										NO				NO	ND
Benzene	0	15	0%	0.00226	0.00289										NO				NO	ND
Benzidine	0	12	0%	1.49	1.9										NO				NO	ND
Benzo(a)anthracene	3	15	20%	0.011	0.014	0.027	0.19	0.091	0.052	0.090	non-parametric	KM (t)	0.063	0.06	YES	0.11	1	Yes	YES	ASL
Benzo(a)pyrene	4	15	27%	0.011	0.014	0.026	0.30	0.11	0.062	0.13	non-parametric	KM (t)	0.085	0.09	YES	0.15	1	Yes	YES	ASL
Benzo(b)fluoranthene	3	15	20%	0.011	0.014	0.034	0.25	0.12	0.083	0.11	non-parametric	KM (t)	0.082	0.08	YES	0.027	2 - surr. Benzo(k)fluoranthene	Yes	YES	ASL
Benzo(g,h,i)perylene	3	15	20%	0.011	0.014	0.019	0.27	0.12	0.072	0.13	non-parametric	KM (t)	0.074	0.074	YES	0.17	LEL	Yes	YES	ASL
Benzo(k)fluoranthene	3	15	20%	0.011	0.014	0.016	0.15	0.064	0.032	0.070	non-parametric	KM (t)	0.044	0.044	YES	0.027	2 - surr. Benzo(k)fluoranthene	Yes	YES	ASL
Benzoic acid	0	12	0%	1.12	1.42										NO				NO	ND
Benzyl alcohol	0	12	0%	0.38	0.483										NO				NO	ND
Benzyl chloride	0	15	0%	0.00564	0.00723										NO				NO	ND
Bis(2-chloroethoxy)methane	0	12	0%	0.38	0.483										NO				NO	ND
Bis(2-chloroethyl)ether	0	12	0%	0.38	0.483										NO				NO	ND
Bis(2-chloroisopropyl)ether	0	15	0%	0.00564	0.00723										NO				NO	ND
Bis(2-ethylhexyl)phthalate	0	12	0%	0.38	0.483										NO				NO	ND
Bromobenzene	0	15	0%	0.00226	0.00289										NO				NO	ND
Bromochloromethane	0	15	0%	0.00226	0.00289										NO				NO	ND
Bromodichloromethane	0	15	0%	0.00226	0.00289										NO				NO	ND
Bromoform	0	15	0%	0.00226	0.00289										NO				NO	ND
Bromomethane	0	15	0%	0.00564	0.00723										NO				NO	ND
Butylbenzylphthalate	0	12	0%	0.38	0.483										NO				NO	ND
Carbon disulfide	0	15	0%	0.00226	0.00289										NO				NO	ND
Carbon tetrachloride	0	15	0%	0.00226	0.00289										NO				NO	ND
Chlorobenzene	0	15	0%	0.00226	0.00289										NO				NO	ND
Chloroethane	0	15	0%	0.00226	0.00289										NO				NO	ND
Chloroform	0	15	0%	0.00226	0.00289										NO				NO	ND
Chloromethane	0	15	0%	0.00564	0.00723										NO				NO	ND
Chrysene	8	15	53%	0.0112	0.0137	0.0142	0.162	0.0454	0.0313	0.0476	non-parametric	KM (t)	0.0484	0.0484	YES	0.166	1	No	NO	BSL
cis-1,2-Dichloroethene	0	15	0%	0.00226	0.00289										NO				NO	ND
cis-1,3-Dichloropropene	0	15	0%	0.00226	0.00289										NO				NO	ND
Cyclohexane	0	15	0%	0.00226	0.00289										NO				NO	ND
Dibenzo(a,h)anthracene	3	15	20%	0.011	0.014	0.02	0.20	0.086	0.039	0.099	non-parametric	KM (t)	0.058	0.058	YES	0.033	1	Yes	YES	ASL
Dibenzofuran	0	12	0%	0.38	0.483										NO				NO	ND
Dibromochloromethane	0	15	0%	0.00226	0.00289										NO				NO	ND
Dibromomethane	0	15	0%	0.00226	0.00289										NO				NO	ND
Dichlorodifluoromethane	0	15	0%	0.00226	0.00289										NO				NO	ND
Diethyl phthalate	0	12	0%	0.38	0.483										NO				NO	ND
Dimethyl phthalate	0	12	0%	0.38	0.483										NO				NO	ND
Di-n-butylphthalate	0	12	0%	0.38	0.483										NO				NO	ND
Di-n-octylphthalate	0	12	0%	0.38	0.483										NO				NO	ND
Ethyl acetate	0	15	0%	0.0113	0.0145										NO				NO	ND
Ethyl ether	0	15	0%	0.0113	0.0145										NO				NO	ND
Ethylbenzene	0	15	0%	0.00226	0.00289										NO				NO	ND
Fluoranthene	8	15	53%	0.0112	0.0137	0.0254	0.257	0.0674	0.0385	0.0781	non-parametric	KM (t)	0.0756	0.0756	YES	0.423	1	No	NO	BSL
Fluorene	1	15	7%	0.0112	0.0142	0.0212	0.0212							0.0212	YES	77.4	1	No	NO	BSL
Hexachlorobenzene	0	12	0%	0.38	0.483										NO				NO	ND
Hexachlorobutadiene	0	15	0%	0.00226	0.00289										NO				NO	ND
Hexachlorocyclopentadiene	0	12	0%	0.38	0.483										NO				NO	ND
Hexachloroethane	0	12	0%	0.38	0.483										NO				NO	ND
Hexane	0	15	0%	0.00226	0.00289										NO				NO	ND
Indeno(1,2,3-cd)pyrene	3	15	20%	0.011	0.014	0.057	0.34	0.18	0.13	0.15	non-parametric	KM (t)	0.12	0.12	YES	0.017	2	Yes	YES	ASL
Isobutyl alcohol	0	15	0%	0.113	0.145										NO				NO	ND
Isophorone	0	12	0%	0.38	0.483										NO				NO	ND
Isopropyl alcohol	0	15	0%	0.0451	0.0578										NO				NO	ND
Isopropylbenzene	0	15	0%	0.00226	0.00289										NO				NO	ND
m&p-Xylenes	0	15	0%	0.00226	0.00289										NO				NO	ND
Methyl tert-butyl ether	0	15	0%	0.00226	0.00289										NO				NO	ND
Methylene chloride	1	15	7%	0.00564	0.00723	0.0078	0.0078								YES	0.018	4	No	NO	BSL
Naphthalene	3	15	20%	0.00226	0.00284	0.0142	0.0273	0.0196	0.0173	0.00685	non-parametric	KM (t)	0.0171	0.0171	YES	0.176	1	No	NO	BSL
n-Butylalcohol	0	15	0%	0.113	0.145										NO				NO	ND
n-Butylbenzene	0	15	0%	0.00226	0.00289										NO				NO	ND

Table E-2a
Bed Sediments Benthos COPEC Selection
Ecological Risk Assessment
Red Butte Creek
Salt Lake City, Utah

Chemical Name	Num_Detects	Num_NDs	Frequency of Detection	Min_ND	Max_ND	Min_Detect	Max_Detect	Mean_Detects	Median_Detects	StdDev_Detects	Distribution	UCL Calc Method	95 UCL	EPC	>5%	Screening value (mg/kg)	Reference	Exceeds benchmark?	COPEC?	Reason
Nitrobenzene	0	12	0%	0.38	0.483										NO				NO	ND
N-Nitrosodimethylamine	0	12	0%	0.749	0.951										NO				NO	ND
N-Nitroso-di-n-propylamine	0	12	0%	0.38	0.483										NO				NO	ND
N-Nitrosodiphenylamine	0	12	0%	0.38	0.483										NO				NO	ND
n-Propylbenzene	0	15	0%	0.00226	0.00289										NO				NO	ND
o-Xylene	0	15	0%	0.00226	0.00289										NO				NO	ND
Pentachlorobenzene	0	12	0%	0.38	0.483										NO				NO	ND
Pentachlorophenol	0	12	0%	0.38	0.483										NO				NO	ND
Phenanthrene	5	15	33%	0.0112	0.0142	0.0174	0.131	0.0535	0.0452	0.0454	non-parametric	KM (t)	0.0442	0.0442	YES	0.204	1	No	NO	BSL
Phenol	0	12	0%	0.38	0.483										NO				NO	ND
p-Isopropyltoluene	0	15	0%	0.00226	0.00289										NO				NO	ND
p-Isopropyltoluene	0	15	0%	0.00226	0.00289										NO				NO	ND
Pyrene	8	15	53%	0.011	0.014	0.035	0.29	0.076	0.040	0.087	non-parametric	KM (t)	0.087	0.087	YES	0.20	1	Yes	YES	ASL
Pyridine	0	12	0%	0.749	0.951										NO				NO	ND
Quinoline	0	12	0%	0.38	0.483										NO				NO	ND
sec-Butylbenzene	0	15	0%	0.00226	0.00289										NO				NO	ND
Styrene	0	15	0%	0.00226	0.00289										NO				NO	ND
tert-Butylbenzene	0	15	0%	0.00226	0.00289										NO				NO	ND
Tetrachloroethene	1	15	7%	0.002	0.003	0.0069	0.0069							0.0069	YES	0.0020	4	Yes	YES	ASL
Tetrahydrofuran	0	15	0%	0.00226	0.00289										NO				NO	ND
Toluene	1	15	7%	0.00226	0.00284	0.00948	0.00948							0.00948	YES	0.01	4	No	NO	BSL
TPH Diesel	12	12	100%			39	124	83	80	30	normal	95% Student's t	99	99	YES				YES	
Aromatics							62							49	YES	0.286	3	Yes	YES	ASL
Aliphatics							62							49	YES	9.9	3	Yes	YES	ASL
TPH Motor Oil	9	12	75%	22	25	31	199	93	108	55	normal	KM (t)	106	106	YES				YES	
Aromatics							100							53	YES				YES	ASL
Aliphatics							100							53	YES	30.8	3	Yes	YES	ASL
trans-1,2-Dichloroethene	0	15	0%	0.00226	0.00289										NO				NO	ND
trans-1,3-Dichloropropene	0	15	0%	0.00226	0.00289										NO				NO	ND
Trichloroethene	0	15	0%	0.00226	0.00289										NO				NO	ND
Trichlorofluoromethane	0	15	0%	0.00226	0.00289										NO				NO	ND
Vinyl acetate	0	15	0%	0.0113	0.0145										NO				NO	ND
Vinyl chloride	0	15	0%	0.00113	0.00145										NO				NO	ND
Xylenes (total)	0	15	0%	0.00226	0.00289										NO				NO	ND
C11-C13 alkyl naphthalenes	0	3	0%	0.421	0.492										NO				NO	ND
C12-C22 PAHs	0	3	0%	0.421	0.492										NO				NO	ND
C11-C12 aliphatics	0	3	0%	0.421	0.492										NO				NO	ND
C13-C16 aliphatics	0	3	0%	0.421	0.492										NO				NO	ND
C17-C21 aliphatics	0	3	0%	0.421	0.492										NO				NO	ND
C22-C35 aliphatics	0	3	0%	0.421	0.492										NO				NO	ND

NOTES
Units in mg/kg

1. TEC from MacDonald, D.D., C.G. Ingersoll, T.A. Berger. 2000. Development of evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. *Archives of Environmental Contamination and Toxicology* . 39: 20-31
2. ARCS values from Buchman, M.F. 2008. NOAA Screening Quick Reference Tables NOAA OR&R Report 08-1, Seattle WA, Office of Response and Restoration Division, National Oceanic and Atmospheric Administration, 34 pages.
3. Massachusetts Deparment of Environmental Protection (MaDEP). 2002. Characterizing Risks Posed by Petroleum Contaminated Sites: Implementation of the MaDEP VPH/EPH approach. Boston, MA and Massachusetts Department of Environmental Protection (MaDEP). 2007. Sediment Toxicity of Petroleum Hydrocarbon Fractions. Boston, MA.
4. Dutch Target. NOAA Screening Quick Reference Tables NOAA OR&R Report 08-1, Seattle WA, Office of Response and Restoration Division, National Oceanic and Atmospheric Administration, 34 pages.
5. Secondary chronic value from Jones, D.S., G.W. Sutter II, and R.N. Hull. 1997. Toxicological benchmarks for screening potential contaminants of concern for effects on sediment-associated biota. 1997 revision. Health Sciences Research Division, Oak Ridge National Laboratory (ORNL). Oak Ridge TN.

ND = not detected
BSL = below screening level; maximum detection less than screening level
ASL = above screening level; maximum detection greater than screening level

Table E-2b
Bed Sediments Benthos for Reference Creeks
Ecological Risk Assessment
Red Butte Creek
Salt Lake City, Utah

Chemical Name	Num_Detects	N	Frequency of Detection	Min_ND	Max_ND	Min_Detect	Max_Detect	Mean_Detects	Median_Detects	StdDev_Detects	Distribution	UCL Calc Method	95 UCL	EPC	>5%	Screening value (mg/kg)	Reference	Exceeds benchmark?	Red Butte Creek COPC?
1,1,1,2-Tetrachloroethane	0	12	0%	0.00235	0.00295										NO				NO
1,1,1-Trichloroethane	0	12	0%	0.00235	0.00295										NO				NO
1,1,2,2-Tetrachloroethane	0	12	0%	0.00235	0.00295										NO				NO
1,1,2-Trichloroethane	0	12	0%	0.00235	0.00295										NO				NO
1,1,2-Trichlorotrifluoroethane	0	12	0%	0.00235	0.00295										NO				NO
1,1-Dichloroethane	0	12	0%	0.00235	0.00295										NO				NO
1,1-Dichloroethene	0	12	0%	0.00235	0.00295										NO				NO
1,1-Dichloropropene	0	12	0%	0.00235	0.00295										NO				NO
1,2,3-Trichlorobenzene	0	12	0%	0.00235	0.00295										NO				NO
1,2,3-Trichloropropane	0	12	0%	0.00235	0.00295										NO				NO
1,2,4-Trichlorobenzene	0	12	0%	0.00235	0.00295										NO				NO
1,2,4-Trimethylbenzene	0	12	0%	0.00235	0.00295										NO				NO
1,2-Dibromo-3-chloropropane	0	12	0%	0.00588	0.00737										NO				NO
1,2-Dibromoethane	0	12	0%	0.00235	0.00295										NO				NO
1,2-Dichlorobenzene	0	12	0%	0.00235	0.00295										NO				NO
1,2-Dichloroethane	0	12	0%	0.00235	0.00295										NO				NO
1,2-Dichloropropane	0	12	0%	0.00235	0.00295										NO				NO
1,3,5-Trimethylbenzene	0	12	0%	0.00235	0.00295										NO				NO
1,3,5-Trinitrobenzene	0	12	0%	0.4	0.501										NO				NO
1,3-Dichlorobenzene	0	12	0%	0.00235	0.00295										NO				NO
1,3-Dichloropropane	0	12	0%	0.00235	0.00295										NO				NO
1,3-Dinitrobenzene	0	12	0%	0.4	0.501										NO				NO
1,4-Dichlorobenzene	0	12	0%	0.00235	0.00295										NO				NO
1,4-Dioxane	0	12	0%	0.0588	0.0737										NO				NO
1-Methylnaphthalene	1	12	8%	0.0118	0.0147	0.0531	0.0531						0.0531	0.0531	YES				NO
2,2-Dichloropropane	0	12	0%	0.00235	0.00295										NO				NO
2,3,4,6-Tetrachlorophenol	0	12	0%	0.4	0.501										NO				NO
2,4,5-Trichlorophenol	0	12	0%	0.4	0.501										NO				NO
2,4,6-Trichlorophenol	0	12	0%	0.4	0.501										NO				NO
2,4-Dichlorophenol	0	12	0%	0.4	0.501										NO				NO
2,4-Dimethylphenol	0	12	0%	0.4	0.501										NO				NO
2,4-Dinitrophenol	0	12	0%	0.788	0.988										NO				NO
2,4-Dinitrotoluene	0	12	0%	0.4	0.501										NO				NO
2,6-Dinitrotoluene	0	12	0%	0.4	0.501										NO				NO
2-Butanone	0	12	0%	0.0118	0.0147										NO				NO
2-Chloroethyl vinyl ether	0	12	0%	0.00588	0.00737										NO				NO
2-Chloronaphthalene	0	12	0%	0.4	0.501										NO				NO
2-Chlorophenol	0	12	0%	0.4	0.501										NO				NO
2-Chlorotoluene	0	12	0%	0.00235	0.00295										NO				NO
2-Hexanone	0	12	0%	0.00588	0.00737										NO				NO
2-Methylaniline	0	12	0%	0.4	0.501										NO				NO
2-Methylnaphthalene	0	12	0%	0.0118	0.0147										NO				NO
2-Methylphenol	0	12	0%	0.4	0.501										NO				NO
2-Nitroaniline	0	12	0%	0.4	0.501										NO				NO
2-Nitrophenol	0	12	0%	0.4	0.501										NO				NO
2-Nitropropane	0	12	0%	0.00588	0.00737										NO				NO
3,3-Dichlorobenzidine	0	12	0%	0.4	0.501										NO				NO
3/4-Methylphenol	0	12	0%	0.4	0.501										NO				NO
3-Chloropropene	0	12	0%	0.00588	0.00737										NO				NO
3-Nitroaniline	0	12	0%	1.18	1.47										NO				NO
4,6-Dinitro-2-methylphenol	0	12	0%	0.788	0.988										NO				NO
4-Bromophenyl phenyl ether	0	12	0%	0.4	0.501										NO				NO
4-Chloro-3-methylphenol	0	12	0%	0.4	0.501										NO				NO
4-Chloroaniline	0	12	0%	0.4	0.501										NO				NO
4-Chlorophenyl phenyl ether	0	12	0%	0.4	0.501										NO				NO
4-Chlorotoluene	0	12	0%	0.00235	0.00295										NO				NO
4-Methyl-2-pentanone	0	12	0%	0.00588	0.00737										NO				NO
4-Nitroaniline	0	12	0%	1.18	1.47										NO				NO
4-Nitrophenol	0	12	0%	0.788	0.988										NO				NO
Acenaphthene	0	12	0%	0.0118	0.0147										NO				NO
Acenaphthylene	0	12	0%	0.0059	0.0147										NO				NO

Table E-2b
Bed Sediments Benthos for Reference Creeks
Ecological Risk Assessment
Red Butte Creek
Salt Lake City, Utah

Chemical Name	Num_Detects	N	Frequency of Detection	Min_ND	Max_ND	Min_Detect	Max_Detect	Mean_Detects	Median_Detects	StdDev_Detects	Distribution	UCL Calc Method	95 UCL	EPC	>5%	Screening value (mg/kg)	Reference	Exceeds benchmark?	Red Butte Creek COPC?
Acetone	0	12	0%	0.0118	0.0147										NO	0.0087	5	No	YES
Aniline	0	12	0%	0.788	0.988										NO				NO
Anthracene	1	12	8%	0.0118	0.0147	0.0059	0.0059							0.0059	YES	0.057	1	No	YES
Azobenzene	0	12	0%	0.4	0.501										NO				NO
Benzene	0	12	0%	0.0005	0.00295										NO				NO
Benzidine	0	12	0%	1.58	1.98										NO				NO
Benzo(a)anthracene	6	12	50%	0.0118	0.0134	0.0306	0.0882	0.0593	0.057	0.0218	non-parametric	95% KM (t) UCL	0.0564	0.0564	YES	0.11	1	No	YES
Benzo(a)pyrene	5	12	42%	0.0118	0.0134	0.0306	0.0501	0.0428	0.0423	0.00801	non-parametric	95% KM (t) UCL	0.0401	0.0401	YES	0.15	1	No	YES
Benzo(b)fluoranthene	6	12	50%	0.0118	0.0134	0.0282	0.0953	0.0597	0.0521	0.0249	non-parametric	95% KM (t) UCL	0.0567	0.0567	YES	0.027	2 - surr. Benzo(k)fluoranthene	Yes	YES
Benzo(g,h,i)perylene	1	12	8%	0.0118	0.0147	0.031	0.031							0.031	YES	0.17	LEL	No	YES
Benzo(k)fluoranthene	1	12	8%	0.0118	0.0147	0.027	0.027							0.027	YES	0.027	2 - surr. Benzo(k)fluoranthene	No	YES
Benzoic acid	1	12	8%	1.18	1.41	1.53	1.53							1.53	YES				NO
Benzyl alcohol	0	12	0%	0.4	0.501										NO				NO
Benzyl chloride	0	12	0%	0.00588	0.00737										NO				NO
Bis(2-chloroethoxy)methane	0	12	0%	0.4	0.501										NO				NO
Bis(2-chloroethyl)ether	0	12	0%	0.4	0.501										NO				NO
Bis(2-chloroisopropyl)ether	0	12	0%	0.00588	0.00737										NO				NO
Bis(2-ethylhexyl)phthalate	2	12	17%	0.4	0.501	0.581	2.98	1.781	1.781	1.696	non-parametric			2.98	YES				NO
Bromobenzene	0	12	0%	0.00235	0.00295										NO				NO
Bromochloromethane	0	12	0%	0.00235	0.00295										NO				NO
Bromodichloromethane	0	12	0%	0.00235	0.00295										NO				NO
Bromoform	0	12	0%	0.00235	0.00295										NO				NO
Bromomethane	0	12	0%	0.00588	0.00737										NO				NO
Butylbenzylphthalate	0	12	0%	0.4	0.501										NO				NO
Carbon disulfide	0	12	0%	0.00235	0.00295										NO				NO
Carbon tetrachloride	0	12	0%	0.00235	0.00295										NO				NO
Chlorobenzene	0	12	0%	0.00235	0.00295										NO				NO
Chloroethane	0	12	0%	0.00235	0.00295										NO				NO
Chloroform	0	12	0%	0.00235	0.00295										NO				NO
Chloromethane	0	12	0%	0.00588	0.00737										NO				NO
Chrysene	6	12	50%	0.0118	0.0134	0.0353	0.0907	0.0627	0.0616	0.0223	non-parametric	95% KM (t) UCL	0.0603	0.0603	YES				NO
cis-1,2-Dichloroethene	0	12	0%	0.00235	0.00295										NO				NO
cis-1,3-Dichloropropene	0	12	0%	0.00235	0.00295										NO				NO
Cyclohexane	0	12	0%	0.00235	0.00295										NO				NO
Dibenzo(a,h)anthracene	0	12	0%	0.0118	0.0147										NO	0.033	1	No	YES
Dibenzofuran	0	12	0%	0.4	0.501										NO				NO
Dibromochloromethane	0	12	0%	0.00235	0.00295										NO				NO
Dibromomethane	0	12	0%	0.00235	0.00295										NO				NO
Dichlorodifluoromethane	0	12	0%	0.00235	0.00295										NO				NO
Diethyl phthalate	0	12	0%	0.4	0.501										NO				NO
Dimethyl phthalate	0	12	0%	0.4	0.501										NO				NO
Di-n-butylphthalate	0	12	0%	0.4	0.501										NO				NO
Di-n-octylphthalate	1	12	8%	0.4	0.501	0.48	0.48							0.48	YES				NO
Ethyl acetate	0	12	0%	0.0118	0.0147										NO				NO
Ethyl ether	0	12	0%	0.0118	0.0147										NO				NO
Ethylbenzene	0	12	0%	0.0009	0.00295										NO				NO
Fluoranthene	9	12	75%	0.0124	0.0126	0.0258	0.232	0.0981	0.0932	0.0713	normal	95% KM (t) UCL	0.116	0.116	YES				NO
Fluorene	0	12	0%	0.0118	0.0147										NO				NO
Hexachlorobenzene	0	12	0%	0.4	0.501										NO				NO
Hexachlorobutadiene	0	12	0%	0.00235	0.00295										NO				NO
Hexachlorocyclopentadiene	0	12	0%	0.4	0.501										NO				NO
Hexachloroethane	0	12	0%	0.4	0.501										NO				NO
Hexane	0	12	0%	0.00235	0.00295										NO				NO
Indeno(1,2,3-cd)pyrene	1	12	8%	0.0118	0.0147	0.0325	0.0325							0.0325	YES	0.017	2	Yes	YES
Isobutyl alcohol	0	12	0%	0.118	0.147										NO				NO
Isophorone	0	12	0%	0.4	0.501										NO				NO
Isopropyl alcohol	0	12	0%	0.047	0.059										NO				NO
Isopropylbenzene	0	12	0%	0.00235	0.00295										NO				NO
m&p-Xylenes	0	12	0%	0.00235	0.00295										NO				NO
Methyl tert-butyl ether	0	12	0%	0.00235	0.00295										NO				NO
Methylene chloride	0	12	0%	0.00588	0.00737										NO				NO
Naphthalene	1	12	8%	0.00235	0.00295	0.0488	0.0488							0.0488	YES				NO

Table E-2b
Bed Sediments Benthos for Reference Creeks
Ecological Risk Assessment
Red Butte Creek
Salt Lake City, Utah

Chemical Name	Num_Detects	N	Frequency of Detection	Min_ND	Max_ND	Min_Detect	Max_Detect	Mean_Detects	Median_Detects	StdDev_Detects	Distribution	UCL Calc Method	95 UCL	EPC	>5%	Screening value (mg/kg)	Reference	Exceeds benchmark?	Red Butte Creek COPC?
n-Butylalcohol	0	12	0%	0.118	0.147										NO				NO
n-Butylbenzene	0	12	0%	0.00235	0.00295										NO				NO
Nitrobenzene	0	12	0%	0.4	0.501										NO				NO
N-Nitrosodimethylamine	0	12	0%	0.788	0.988										NO				NO
N-Nitroso-di-n-propylamine	0	12	0%	0.4	0.501										NO				NO
N-Nitrosodiphenylamine	0	12	0%	0.4	0.501										NO				NO
n-Propylbenzene	0	12	0%	0.00235	0.00295										NO				NO
o-Xylene	0	12	0%	0.00235	0.00295										NO				NO
Pentachlorobenzene	0	12	0%	0.4	0.501										NO				NO
Pentachlorophenol	0	12	0%	0.4	0.501										NO				NO
Phenanthrene	7	12	58%	0.0122	0.0134	0.0243	0.136	0.0683	0.0502	0.0398	lognormal	95% KM (t) UCL	0.070	0.070	YES				NO
Phenol	1	12	8%	0.4	0.479	0.64	0.64						0.11	0.64	YES				NO
p-Isopropyltoluene	1	12	8%	0.00235	0.00295	0.00266	0.00266							0.0027	YES				NO
Pyrene	9	12	75%	0.0124	0.0126	0.0312	0.2	0.0942	0.0876	0.0594	normal	95% KM (t) UCL	0.11	0.11	YES	0.2	1	No	YES
Pyridine	0	12	0%	0.788	0.988										NO				NO
Quinoline	0	12	0%	0.4	0.501										NO				NO
sec-Butylbenzene	0	12	0%	0.00235	0.00295										NO				NO
Styrene	0	12	0%	0.00235	0.00295										NO				NO
tert-Butylbenzene	0	12	0%	0.00235	0.00295										NO				NO
Tetrachloroethene	1	12	8%	0.00235	0.00295	0.00458	0.00458							0.00458	YES	0.002	4	Yes	YES
Tetrahydrofuran	0	12	0%	0.00235	0.00295										NO				NO
Toluene	1	12	8%	0.00235	0.00295	0.0741	0.0741							0.0741	YES				NO
TPH Diesel	12	12	100%			34.4	186	82.23	80.55	44.04	normal	95% Student's-t UCL	105	105	YES				YES
Aromatics							93							53	NO	0.3	3	No	YES
Aliphatics							93							53	NO	9.9	3	No	YES
TPH Motor Oil	7	12	58%	23.5	26.7	29	113	68.43	64.2	26.84	non-parametric	95% KM (t) UCL	67	67	YES				YES
Aromatics							56.5							34	NO			No	YES
Aliphatics							56.5							34	NO	30.8	3	No	YES
trans-1,2-Dichloroethene	0	12	0%	0.00235	0.00295										NO				NO
trans-1,3-Dichloropropene	0	12	0%	0.00235	0.00295										NO				NO
Trichloroethene	0	12	0%	0.00235	0.00295										NO				NO
Trichlorofluoromethane	0	12	0%	0.00235	0.00295										NO				NO
Vinyl acetate	0	12	0%	0.0118	0.0147										NO				NO
Vinyl chloride	0	12	0%	0.00118	0.00147										NO				NO
Xylenes (total)	0	12	0%	0.0009	0.00295										NO				NO

NOTES

Units in mg/kg

1. TEC from MacDonald, D.D., C.G. Ingersoll, T.A. Berger. 2000. Development of evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. *Archives of Environmental Contamination and Toxicology* . 39: 20-31
2. ARCS values from Buchman, M.F. 2008. NOAA Screening Quick Reference Tables NOAA OR&R Report 08-1, Seattle WA, Office of Response and Restoration Division, National Oceanic and Atmospheric Administration, 34 pages.
3. Massachusetts Deparment of Environmental Protection (MaDEP). 2002. Characterizing Risks Posed by Petroleum Contaminated Sites: Implementation of the MaDEP VPH/EPH approach. Boston, MA and Massachusetts Department of Environmental Protection (MaDEP). 2007. Sediment Toxicity of Petroleum Hydrocarbon Fractions. Boston, MA.
4. Dutch Target. NOAA Screening Quick Reference Tables NOAA OR&R Report 08-1, Seattle WA, Office of Response and Restoration Division, National Oceanic and Atmospheric Administration, 34 pages.
5. Secondary chronic value from Jones, D.S., G.W. Sutter II, and R.N. Hull. 1997. Toxicological benchmarks for screening potential contaminants of concern for effects on sediment-associated biota. 1997 revision. Health Sciences Research Division, Oak Ridge National Laboratory (ORNL). Oak Ridge TN.

Chemical Name	Num_Detects	Num_NDs	Frequency of Detection	Min_ND	Max_ND	Min_Detect	Max_Detect	Mean_Detects	Median_Detects	StdDev_Detects	Distribution	UCL Calc Method	95 UCL	EPC	>5%	Screening value (mg/kg)	Reference	Exceeds benchmark?	COPEC?	Reason
1,1,1,2-Tetrachloroethane	0	27	0%	0.00202	0.00289										NO				NO	ND
1,1,1-Trichloroethane	0	27	0%	0.00202	0.00289										NO				NO	ND
1,1,2,2-Tetrachloroethane	0	27	0%	0.00202	0.00289										NO				NO	ND
1,1,2-Trichloroethane	0	27	0%	0.00202	0.00289										NO				NO	ND
1,1,2-Trichlorotrifluoroethane	0	27	0%	0.00202	0.00289										NO				NO	ND
1,1-Dichloroethane	0	27	0%	0.00202	0.00289										NO				NO	ND
1,1-Dichloroethene	0	27	0%	0.00202	0.00289										NO				NO	ND
1,1-Dichloropropene	0	27	0%	0.00202	0.00289										NO				NO	ND
1,2,3-Trichlorobenzene	0	27	0%	0.00202	0.00289										NO				NO	ND
1,2,3-Trichloropropane	0	27	0%	0.00202	0.00289										NO				NO	ND
1,2,4-Trichlorobenzene	0	27	0%	0.00202	0.00289										NO				NO	ND
1,2,4-Trimethylbenzene	0	27	0%	0.00202	0.00289										NO				NO	ND
1,2-Dibromo-3-chloropropane	0	27	0%	0.00506	0.00723										NO				NO	ND
1,2-Dibromoethane	0	27	0%	0.00202	0.00289										NO				NO	ND
1,2-Dichlorobenzene	0	27	0%	0.00202	0.00289										NO				NO	ND
1,2-Dichloroethane	0	27	0%	0.00202	0.00289										NO				NO	ND
1,2-Dichloropropane	0	27	0%	0.00202	0.00289										NO				NO	ND
1,3,5-Trimethylbenzene	0	27	0%	0.00202	0.00289										NO				NO	ND
1,3,5-Trinitrobenzene	0	24	0%	0.344	0.483										NO				NO	ND
1,3-Dichlorobenzene	0	27	0%	0.00202	0.00289										NO				NO	ND
1,3-Dichloropropane	0	27	0%	0.00202	0.00289										NO				NO	ND
1,3-Dinitrobenzene	0	24	0%	0.344	0.483										NO				NO	ND
1,4-Dichlorobenzene	0	27	0%	0.00202	0.00289										NO				NO	ND
1,4-Dioxane	0	27	0%	0.0506	0.0723										NO				NO	ND
1-Methylnaphthalene	3	27	11%	0.010	0.014	0.014	0.026	0.018	0.015	0.0063	non-parametric	KM (t)	0.016	0.016	YES	100	1 - LMW	No	NO	BSL
2,2-Dichloropropane	0	27	0%	0.00202	0.00289										NO				NO	ND
2,3,4,6-Tetrachlorophenol	0	24	0%	0.344	0.483										NO				NO	ND
2,4,5-Trichlorophenol	0	24	0%	0.344	0.483										NO				NO	ND
2,4,6-Trichlorophenol	0	24	0%	0.344	0.483										NO				NO	ND
2,4-Dichlorophenol	0	24	0%	0.344	0.483										NO				NO	ND
2,4-Dimethylphenol	0	24	0%	0.344	0.483										NO				NO	ND
2,4-Dinitrophenol	0	24	0%	0.678	0.951										NO				NO	ND
2,4-Dinitrotoluene	0	24	0%	0.344	0.483										NO				NO	ND
2,6-Dinitrotoluene	0	24	0%	0.344	0.483										NO				NO	ND
2-Butanone	0	27	0%	0.0101	0.0145										NO				NO	ND
2-Chloroethyl vinyl ether	0	27	0%	0.00506	0.00723										NO				NO	ND
2-Chloronaphthalene	0	24	0%	0.344	0.483										NO				NO	ND
2-Chlorophenol	0	24	0%	0.344	0.483										NO				NO	ND
2-Chlorotoluene	0	27	0%	0.00202	0.00289										NO				NO	ND
2-Hexanone	0	27	0%	0.00506	0.00723										NO				NO	ND
2-Methylaniline	0	24	0%	0.344	0.483										NO				NO	ND
2-Methylnaphthalene	1	27	4%	0.010	0.015	0.024	0.024							0.024	NO				NO	<5%
2-Methylphenol	0	23	0%	0.344	0.483										NO				NO	ND
2-Nitroaniline	0	24	0%	0.344	0.483										NO				NO	ND
2-Nitrophenol	0	24	0%	0.344	0.483										NO				NO	ND
2-Nitropropane	0	27	0%	0.00506	0.00723										NO				NO	ND
3,3-Dichlorobenzidine	0	24	0%	0.344	0.483										NO				NO	ND
3/4-Methylphenol	0	24	0%	0.344	0.483										NO				NO	ND
3-Chloropropene	0	27	0%	0.00506	0.00723										NO				NO	ND
3-Nitroaniline	0	24	0%	1.01	1.42										NO				NO	ND
4,6-Dinitro-2-methylphenol	0	24	0%	0.678	0.951										NO				NO	ND
4-Bromophenyl phenyl ether	0	24	0%	0.344	0.483										NO				NO	ND
4-Chloro-3-methylphenol	0	24	0%	0.344	0.483										NO				NO	ND
4-Chloroaniline	0	24	0%	0.344	0.483										NO				NO	ND
4-Chlorophenyl phenyl ether	0	24	0%	0.344	0.483										NO				NO	ND
4-Chlorotoluene	0	27	0%	0.00202	0.00289										NO				NO	ND
4-Methyl-2-pentanone	0	27	0%	0.00506	0.00723										NO				NO	ND
4-Nitroaniline	0	24	0%	1.01	1.42										NO				NO	ND
4-Nitrophenol	0	24	0%	0.678	0.951										NO				NO	ND
Acenaphthene	0	27	0%	0.0101	0.0145										NO				NO	ND

Table E-3a
Bed + Bank Sediments Wildlife COPEC Selection
Ecological Risk Assessment
Red Butte Creek
Salt Lake City, Utah

Chemical Name	Num_Detects	Num_NDs	Frequency of Detection	Min_ND	Max_ND	Min_Detect	Max_Detect	Mean_Detects	Median_Detects	StdDev_Detects	Distribution	UCL Calc Method	95 UCL	EPC	>5%	Screening value (mg/kg)	Reference	Exceeds benchmark?	COPEC?	Reason
Acenaphthylene	0	27	0%	0.0101	0.0145										NO				NO	ND
Acetone	1	27	4%	0.010	0.015	0.020	0.020								NO				NO	<5%
Aniline	0	24	0%	0.678	0.951										NO				NO	ND
Anthracene	5	27	19%	0.010	0.014	0.014	0.090	0.05	0.058	0.031	non-parametric	KM (t)	0.028	0.028	YES	100	1 - LMW	No	NO	BSL
Azobenzene	0	24	0%	0.344	0.483										NO				NO	ND
Benzene	0	27	0%	0.00202	0.00289										NO				NO	ND
Benzidine	0	24	0%	1.36	1.9										NO				NO	ND
Benzo(a)anthracene	10	27	37%	0.010	0.014	0.026	0.37	0.11	0.052	0.12	non-parametric	KM (t)	0.086	0.086	YES	1.1	1 - HMW	No	NO	BSL
Benzo(a)pyrene	9	27	33%	0.010	0.014	0.026	0.30	0.11	0.042	0.11	non-parametric	KM (t)	0.080	0.080	YES	1.1	1 - HMW	No	NO	BSL
Benzo(b)fluoranthene	9	27	33%	0.010	0.014	0.030	0.35	0.13	0.056	0.13	non-parametric	KM (t)	0.093	0.093	YES	1.1	1 - HMW	No	NO	BSL
Benzo(g,h,i)perylene	4	27	15%	0.010	0.014	0.019	0.27	0.097	0.050	0.12	non-parametric	KM (t)	0.049	0.049	YES	1.1	1 - HMW	No	NO	BSL
Benzo(k)fluoranthene	5	27	19%	0.010	0.014	0.016	0.15	0.088	0.11	0.060	non-parametric	KM (t)	0.043	0.043	YES	1.1	1 - HMW	No	NO	BSL
Benzoic acid	0	24	0%	1.01	1.42										NO				NO	ND
Benzyl alcohol	0	23	0%	0.344	0.483										NO				NO	ND
Benzyl chloride	0	27	0%	0.00506	0.00723										NO				NO	ND
Bis(2-chloroethoxy)methane	0	24	0%	0.344	0.483										NO				NO	ND
Bis(2-chloroethyl)ether	0	24	0%	0.344	0.483										NO				NO	ND
Bis(2-chloroisopropyl)ether	0	28	0%	0.00506	0.432										NO				NO	ND
Bis(2-ethylhexyl)phthalate	1	24	4%	0.344	0.48	0.62	0.62								NO				NO	ND
Bromobenzene	0	27	0%	0.00202	0.00289										NO				NO	ND
Bromochloromethane	0	27	0%	0.00202	0.00289										NO				NO	ND
Bromodichloromethane	0	27	0%	0.00202	0.00289										NO				NO	ND
Bromoform	0	27	0%	0.00202	0.00289										NO				NO	ND
Bromomethane	0	27	0%	0.00506	0.00723										NO				NO	ND
Butylbenzylphthalate	0	24	0%	0.344	0.483										NO				NO	ND
Carbon disulfide	0	27	0%	0.00202	0.00289										NO				NO	ND
Carbon tetrachloride	0	27	0%	0.00202	0.00289										NO				NO	ND
Chlorobenzene	0	27	0%	0.00202	0.00289										NO				NO	ND
Chloroethane	0	27	0%	0.00202	0.00289										NO				NO	ND
Chloroform	3	27	11%	0.0020	0.0029	0.0035	0.0046	0.0041	0.0042	0.00056					YES	1.19	2	No	NO	BSL
Chloromethane	0	27	0%	0.00506	0.00723										NO				NO	ND
Chrysene	16	27	59%	0.011	0.014	0.014	0.37	0.081	0.038	0.10	non-parametric	KM (t)	0.081	0.081	YES	1.1	1 - HMW	No	NO	BSL
cis-1,2-Dichloroethene	0	27	0%	0.00202	0.00289										NO				NO	ND
cis-1,3-Dichloropropene	0	27	0%	0.00202	0.00289										NO				NO	ND
Cyclohexane	0	27	0%	0.00202	0.00289										NO				NO	ND
Dibenzo(a,h)anthracene	3	27	11%	0.010	0.014	0.020	0.20	0.086	0.039	0.099	non-parametric	KM (t)	0.041	0.041	YES	1.1	1 - HMW	No	NO	BSL
Dibenzofuran	0	24	0%	0.344	0.483										NO				NO	ND
Dibromochloromethane	0	27	0%	0.00202	0.00289										NO				NO	ND
Dibromomethane	0	27	0%	0.00202	0.00289										NO				NO	ND
Dichlorodifluoromethane	0	27	0%	0.00202	0.00289										NO				NO	ND
Diethyl phthalate	0	24	0%	0.344	0.483										NO				NO	ND
Dimethyl phthalate	0	24	0%	0.344	0.483										NO				NO	ND
Di-n-butylphthalate	0	24	0%	0.344	0.483										NO				NO	ND
Di-n-octylphthalate	0	23	0%	0.344	0.483										NO				NO	ND
Ethyl acetate	0	27	0%	0.0101	0.0145										NO				NO	ND
Ethyl ether	0	27	0%	0.0101	0.0145										NO				NO	ND
Ethylbenzene	0	27	0%	0.00202	0.00289										NO				NO	ND
Fluoranthene	16	27	59%	0.011	0.014	0.025	0.70	0.14	0.059	0.20	non-parametric	KM (t)	0.15	0.15	YES	1.1	1 - HMW	No	NO	BSL
Fluorene	1	27	4%	0.010	0.014	0.021	0.021							0.021	NO				NO	<5%
Hexachlorobenzene	0	24	0%	0.344	0.483										NO				NO	ND
Hexachlorobutadiene	0	27	0%	0.00202	0.00289										NO				NO	ND
Hexachlorocyclopentadiene	0	24	0%	0.344	0.483										NO				NO	ND
Hexachloroethane	0	24	0%	0.344	0.483										NO				NO	ND
Hexane	0	27	0%	0.00202	0.00289										NO				NO	ND
Indeno(1,2,3-cd)pyrene	6	27	22%	0.010	0.014	0.035	0.34	0.13	0.11	0.111	non-parametric	KM (t)	0.079	0.079	YES	1.1	1 - HMW	No	NO	BSL
Isobutyl alcohol	0	27	0%	0.101	0.145										NO				NO	ND
Isophorone	0	24	0%	0.344	0.483										NO				NO	ND
Isopropyl alcohol	0	27	0%	0.0405	0.0578										NO				NO	ND
Isopropylbenzene	0	27	0%	0.00202	0.00289										NO				NO	ND
m&p-Xylenes	4	27	15%	0.0020	0.0029	0.0035	0.0054	0.0045	0.0045	0.00079	non-parametric	KM (t)	0.0038	0.0038	YES	10	2	No	NO	BSL
Methyl tert-butyl ether	0	27	0%	0.00202	0.00289										NO				NO	ND
Methylene chloride	3	27	11%	0.005	0.0072	0.0065	0.0078	0.0074	0.0078	0.00074					YES	4.05	2	No	NO	BSL

Table E-3a
Bed + Bank Sediments Wildlife COPEC Selection
Ecological Risk Assessment
Red Butte Creek
Salt Lake City, Utah

Chemical Name	Num_Detects	Num_NDs	Frequency of Detection	Min_ND	Max_ND	Min_Detect	Max_Detect	Mean_Detects	Median_Detects	StdDev_Detects	Distribution	UCL Calc Method	95 UCL	EPC	>5%	Screening value (mg/kg)	Reference	Exceeds benchmark?	COPEC?	Reason
Naphthalene	4	27	15%	0.0020	0.0028	0.014	0.029	0.022	0.022	0.0072	non-parametric	KM (t)	0.017	0.017	YES	100	1-LMW	No	NO	BSL
n-Butylalcohol	0	27	0%	0.101	0.145										NO				NO	ND
n-Butylbenzene	0	27	0%	0.00202	0.00289										NO				NO	ND
Nitrobenzene	0	24	0%	0.344	0.483										NO				NO	ND
N-Nitrosodimethylamine	0	24	0%	0.678	0.951										NO				NO	ND
N-Nitroso-di-n-propylamine	0	24	0%	0.344	0.483										NO				NO	ND
N-Nitrosodiphenylamine	0	24	0%	0.344	0.483										NO				NO	ND
n-Propylbenzene	0	27	0%	0.00202	0.00289										NO				NO	ND
o-Xylene	0	27	0%	0.00202	0.00289										NO				NO	ND
Pentachlorobenzene	0	24	0%	0.344	0.483										NO				NO	ND
Pentachlorophenol	0	24	0%	0.344	0.483										NO				NO	ND
Phenanthrene	11	27	41%	0.010	0.014	0.017	0.35	0.11	0.050	0.11	non-parametric	KM (t)	0.081	0.081	YES	100	1-LMW	No	NO	BSL
Phenol	0	24	0%	0.344	0.483										NO				NO	ND
p-Isopropyltoluene	0	27	0%	0.00202	0.00289										NO				NO	ND
p-Isopropyltoluene	0	27	0%	0.00202	0.00289										NO				NO	ND
Pyrene	16	27	59%	0.011	0.014	0.030	0.65	0.15	0.064	0.197	non-parametric	KM (t)	0.15	0.15	YES	1.1	1 - HMW	No	NO	BSL
Pyridine	0	24	0%	0.678	0.951										NO				NO	ND
Quinoline	0	24	0%	0.344	0.483										NO				NO	ND
sec-Butylbenzene	0	27	0%	0.00202	0.00289										NO				NO	ND
Styrene	0	27	0%	0.00202	0.00289										NO				NO	ND
tert-Butylbenzene	0	27	0%	0.00202	0.00289										NO				NO	ND
Tetrachloroethene	4	27	15%	0.0020	0.0029	0.0035	0.0069	0.0051	0.0049	0.00147					YES	9.9	2	No	NO	BSL
Tetrahydrofuran	0	27	0%	0.00202	0.00289										NO				NO	ND
Toluene	6	27	22%	0.0020	0.0028	0.0029	0.0095	0.0063	0.0059	0.00228	non-parametric	KM (t)	0.0043	0.0043	YES	5.5	2	No	NO	BSL
TPH Diesel	24	24	100%			39	165	90	79	35	Normal	95% Student's-t UCL	102	102	YES			Yes	YES	NSL
Aromatics							83							51	YES				YES	NSL
Aliphatics							83							51	YES				YES	NSL
TPH Motor Oil	21	24	88%	22	25	31	199	86	78	46	Normal	KM (t)	96	96	YES			Yes	YES	NSL
Aromatics							100							48	YES				YES	NSL
Aliphatics							100							48	YES				YES	NSL
trans-1,2-Dichloroethene	0	27	0%	0.00202	0.00289										NO				NO	ND
trans-1,3-Dichloropropene	0	27	0%	0.00202	0.00289										NO				NO	ND
Trichloroethene	0	27	0%	0.00202	0.00289										NO				NO	ND
Trichlorofluoromethane	0	27	0%	0.00202	0.00289										NO				NO	ND
Vinyl acetate	0	27	0%	0.0101	0.0145										NO				NO	ND
Vinyl chloride	0	27	0%	0.00101	0.00145										NO				NO	ND
Xylenes (total)	4	27	15%	0.0020	0.0029	0.0035	0.0066	0.0051	0.0051	0.0014	non-parametric	KM (t)	0.0040	0.0040	YES	10	2	No	NO	BSL
C11-C13 alkyl naphthalenes	0	3	0%	0.421	0.492										NO				NO	ND
C12-C22 PAHs	0	3	0%	0.421	0.492										NO				NO	ND
C11-C12 aliphatics	0	3	0%	0.421	0.492										NO				NO	ND
C13-C16 aliphatics	0	3	0%	0.421	0.492										NO				NO	ND
C17-C21 aliphatics	0	3	0%	0.421	0.492										NO				NO	ND
C22-C35 aliphatics	0	3	0%	0.421	0.492										NO				NO	ND

NOTES
Units in mg/kg
References:
1. U.S. Environmental Protection Agency (USEPA). 2007. Ecological Soil Screening Levels for Polycyclic Aromatic Hydrocarbons (PAHs), OSWER Directive 9285.7-78. Office of Solid Waste and Emergency Response, Washington, DC.
2. U.S. Environmental Protection Agency (USEPA), Region 5, RCRA Ecological Screening Levels, August 2003, website: http://epa.gov/region05/waste/cars/pdfs/ecological-screening-levels-200308.pdf

ND = not detected
BSL = below screening level; maximum detection less than screening level
ASL = above screening level; maximum detection greater than screening level
<5% = less than 5 percent detection frequency
NSL = no screening level

Table E-3b
Bed + Bank Sediments for Reference Creeks
Ecological Risk Assessment
Red Butte Creek
Salt Lake City, Utah

Chemical Name	Num_Detects	Number of samples	Frequency of detection	Min_ND	Max_ND	Min_Detect	Max_Detect	Mean_Detects	Median_Detects	StdDev_Detects	Distribution	UCL Calc Method	95 UCL	EPC	>5%	Screening value (mg/kg)	Reference	Exceedance	Red Butte Creek COPC?
1,1,1,2-Tetrachloroethane	0	24	0%	0.0022	0.00295										NO				NO
1,1,1-Trichloroethane	0	24	0%	0.0022	0.00295										NO				NO
1,1,2,2-Tetrachloroethane	0	24	0%	0.0022	0.00295										NO				NO
1,1,2-Trichloroethane	0	24	0%	0.0022	0.00295										NO				NO
1,1,2-Trichlorotrifluoroethane	0	24	0%	0.0022	0.00295										NO				NO
1,1-Dichloroethane	0	24	0%	0.0022	0.00295										NO				NO
1,1-Dichloroethene	0	24	0%	0.0022	0.00295										NO				NO
1,1-Dichloropropene	0	24	0%	0.0022	0.00295										NO				NO
1,2,3-Trichlorobenzene	0	24	0%	0.0022	0.00295										NO				NO
1,2,3-Trichloropropane	0	24	0%	0.0022	0.00295										NO				NO
1,2,4-Trichlorobenzene	0	24	0%	0.0022	0.00295										NO				NO
1,2,4-Trimethylbenzene	0	24	0%	0.0022	0.00295										NO				NO
1,2-Dibromo-3-chloropropane	0	24	0%	0.0054	0.00738										NO				NO
1,2-Dibromoethane	0	24	0%	0.0022	0.00295										NO				NO
1,2-Dichlorobenzene	0	24	0%	0.0022	0.00295										NO				NO
1,2-Dichloroethane	0	24	0%	0.0022	0.00295										NO				NO
1,2-Dichloropropane	0	24	0%	0.0022	0.00295										NO				NO
1,3,5-Trimethylbenzene	0	24	0%	0.0022	0.00295										NO				NO
1,3,5-Trinitrobenzene	0	24	0%	0.3660	0.502										NO				NO
1,3-Dichlorobenzene	0	24	0%	0.0022	0.00295										NO				NO
1,3-Dichloropropane	0	24	0%	0.0022	0.00295										NO				NO
1,3-Dinitrobenzene	0	24	0%	0.3660	0.502										NO				NO
1,4-Dichlorobenzene	0	24	0%	0.0022	0.00295										NO				NO
1,4-Dioxane	0	24	0%	0.0538	0.0738										NO				NO
1-Methylnaphthalene	1	24	4%	0.0108	0.0148	0.0531	0.0531							0.0531	NO				NO
2,2-Dichloropropane	0	24	0%	0.0022	0.00295										NO				NO
2,3,4,6-Tetrachlorophenol	0	24	0%	0.3660	0.502										NO				NO
2,4,5-Trichlorophenol	0	24	0%	0.3660	0.502										NO				NO
2,4,6-Trichlorophenol	0	24	0%	0.3660	0.502										NO				NO
2,4-Dichlorophenol	0	24	0%	0.3660	0.502										NO				NO
2,4-Dimethylphenol	0	24	0%	0.3660	0.502										NO				NO
2,4-Dinitrophenol	0	24	0%	0.7220	0.988										NO				NO
2,4-Dinitrotoluene	0	24	0%	0.3660	0.502										NO				NO
2,6-Dinitrotoluene	0	24	0%	0.3660	0.502										NO				NO
2-Butanone	0	24	0%	0.0108	0.0148										NO				NO
2-Chloroethyl vinyl ether	0	24	0%	0.0054	0.00738										NO				NO
2-Chloronaphthalene	0	24	0%	0.3660	0.502										NO				NO
2-Chlorophenol	0	24	0%	0.3660	0.502										NO				NO
2-Chlorotoluene	0	24	0%	0.0022	0.00295										NO				NO
2-Hexanone	0	24	0%	0.0054	0.00738										NO				NO
2-Methylaniline	0	24	0%	0.3660	0.502										NO				NO
2-Methylnaphthalene	0	24	0%	0.0108	0.0148										NO				NO
2-Methylphenol	0	24	0%	0.3660	0.502										NO				NO
2-Nitroaniline	0	24	0%	0.3660	0.502										NO				NO
2-Nitrophenol	0	24	0%	0.3660	0.502										NO				NO
2-Nitropropane	0	24	0%	0.0054	0.00738										NO				NO
3,3-Dichlorobenzidine	0	24	0%	0.3660	0.502										NO				NO
3/4-Methylphenol	0	24	0%	0.3660	0.502										NO				NO
3-Chloropropene	0	24	0%	0.0054	0.00738										NO				NO
3-Nitroaniline	0	24	0%	1.0800	1.48										NO				NO
4,6-Dinitro-2-methylphenol	0	24	0%	0.7220	0.988										NO				NO
4-Bromophenyl phenyl ether	0	24	0%	0.3660	0.502										NO				NO
4-Chloro-3-methylphenol	0	24	0%	0.3660	0.502										NO				NO
4-Chloroaniline	0	24	0%	0.3660	0.502										NO				NO
4-Chlorophenyl phenyl ether	0	24	0%	0.3660	0.502										NO				NO
4-Chlorotoluene	0	24	0%	0.0022	0.00295										NO				NO
4-Methyl-2-pentanone	0	24	0%	0.0054	0.00738										NO				NO

Table E-3b
Bed + Bank Sediments for Reference Creeks
Ecological Risk Assessment
Red Butte Creek
Salt Lake City, Utah

Chemical Name	Num_Detects	Number of samples	Frequency of detection	Min_ND	Max_ND	Min_Detect	Max_Detect	Mean_Detects	Median_Detects	StdDev_Detects	Distribution	UCL Calc Method	95 UCL	EPC	>5%	Screening value (mg/kg)	Reference	Exceedance	Red Butte Creek COPC?
4-Nitroaniline	0	24	0%	1.0800	1.48										NO				NO
4-Nitrophenol	0	24	0%	0.7220	0.988										NO				NO
Acenaphthene	0	24	0%	0.0033	0.0148										NO				NO
Acenaphthylene	0	24	0%	0.0017	0.0148										NO				NO
Acetone	1	24	4%	0.0108	0.0148	0.023	0.023							0.023	NO				NO
Aniline	0	24	0%	0.7220	0.988										NO				NO
Anthracene	4	24	17%	0.0108	0.0148	0.0054	0.0718	0.0308	0.023	0.0318	non-parametric	KM (t)	0.0158	0.0158	YES				NO
Azobenzene	0	24	0%	0.3660	0.502								0.0678		NO				NO
Benzene	0	24	0%	0.0005	0.00295								0.0498		NO				NO
Benzidine	0	24	0%	1.4400	1.98								0.0699		NO				NO
Benzo(a)anthracene	14	24	58%	0.0114	0.0148	0.0258	0.234	0.0696	0.0487	0.0544	lognormal	KM (t)	0.0678	0.0678	YES				NO
Benzo(a)pyrene	9	24	38%	0.0108	0.0148	0.029	0.125	0.0599	0.05	0.034	non-parametric	KM (t)	0.0498	0.0498	YES				NO
Benzo(b)fluoranthene	14	24	58%	0.0114	0.0148	0.0261	0.205	0.0741	0.0621	0.0494	normal	KM (t)	0.0699	0.0699	YES				NO
Benzo(g,h,i)perylene	2	24	8%	0.0108	0.0148	0.018	0.031	0.0245	0.0245	0.00919	non-parametric	NA	0.031	0.031	YES				NO
Benzo(k)fluoranthene	4	24	17%	0.0108	0.0148	0.015	0.0621	0.0383	0.038	0.0212	non-parametric	KM (t)	0.0235	0.0235	YES				NO
Benzoic acid	1	24	4%	1.0800	1.48	1.53	1.53						0.00387	1.53	NO				NO
Benzyl alcohol	0	24	0%	0.3660	0.502								154.2		NO				NO
Benzyl chloride	0	24	0%	0.0054	0.00738								77.1		NO				NO
Bis(2-chloroethoxy)methane	0	24	0%	0.3660	0.502								77.1		NO				NO
Bis(2-chloroethyl)ether	0	24	0%	0.3660	0.502								98.31		NO				NO
Bis(2-chloroisopropyl)ether	0	24	0%	0.0054	0.00738								49.155		NO				NO
Bis(2-ethylhexyl)phthalate	3	24	13%	0.3660	0.502	0.581	2.98	1.734	1.64	1.202	non-parametric	95% KM (t) UCL	49.155	0.946	YES				NO
Bromobenzene	0	24	0%	0.0022	0.00295										NO				NO
Bromochloromethane	0	24	0%	0.0022	0.00295										NO				NO
Bromodichloromethane	0	24	0%	0.0022	0.00295										NO				NO
Bromoform	0	24	0%	0.0022	0.00295										NO				NO
Bromomethane	0	24	0%	0.0054	0.00738										NO				NO
Butylbenzylphthalate	0	24	0%	0.3660	0.502										NO				NO
Carbon disulfide	0	24	0%	0.0022	0.00295										NO				NO
Carbon tetrachloride	0	24	0%	0.0022	0.00295										NO				NO
Chlorobenzene	0	24	0%	0.0022	0.00295										NO				NO
Chloroethane	0	24	0%	0.0022	0.00295										NO				NO
Chloroform	4	24	17%	0.0023	0.00295	0.00259	0.00453	0.00339	0.00323	0.00089258	non-parametric	95% KM (t) UCL	95% KM (t) UCL	0.0029	YES				NO
Chloromethane	0	24	0%	0.0054	0.00738										NO				NO
Chrysene	15	24	63%	0.0114	0.0148	0.0252	0.223	0.0801	0.0677	0.0531	non-parametric	M (Percentile Bootstr	KM (Percentile Bootstrap	0.0786	YES				NO
cis-1,2-Dichloroethene	0	24	0%	0.0022	0.00295										NO				NO
cis-1,3-Dichloropropene	0	24	0%	0.0022	0.00295										NO				NO
Cyclohexane	0	24	0%	0.0022	0.00295										NO				NO
Dibenzo(a,h)anthracene	1	24	4%	0.0108	0.0148	0.0037	0.0037							0.0037	NO				NO
Dibenzofuran	0	24	0%	0.3660	0.502										NO				NO
Dibromochloromethane	0	24	0%	0.0022	0.00295										NO				NO
Dibromomethane	0	24	0%	0.0022	0.00295										NO				NO
Dichlorodifluoromethane	0	24	0%	0.0022	0.00295										NO				NO
Diethyl phthalate	0	24	0%	0.3660	0.502										NO				NO
Dimethyl phthalate	0	24	0%	0.3660	0.502										NO				NO
Di-n-butylphthalate	0	24	0%	0.3660	0.502										NO				NO
Di-n-octylphthalate	1	24	4%	0.3660	0.502	0.48	0.48							0.48	NO				NO
Ethyl acetate	0	24	0%	0.0108	0.0148										NO				NO
Ethyl ether	0	24	0%	0.0108	0.0148										NO				NO
Ethylbenzene	0	24	0%	0.0009	0.00295										NO				NO
Fluoranthene	18	24	75%	0.0114	0.0148	0.0258	0.472	0.12	0.0986	0.115	lognormal	M (Percentile Bootstr	KM (Percentile Bootstrap	0.136	YES				NO
Fluorene	1	24	4%	0.0033	0.0148	0.0293	0.0293							0.0293	NO				NO
Hexachlorobenzene	0	24	0%	0.3660	0.502										NO				NO
Hexachlorobutadiene	0	24	0%	0.0022	0.00295										NO				NO
Hexachlorocyclopentadiene	0	24	0%	0.3660	0.502										NO				NO
Hexachloroethane	0	24	0%	0.3660	0.502										NO				NO
Hexane	0	24	0%	0.0022	0.00295										NO				NO
Indeno(1,2,3-cd)pyrene	5	24	21%	0.0108	0.0148	0.0091	0.059	0.0431	0.0567	0.022	non-parametric	KM (t)	0.0226	0.0226	YES				NO
Isobutyl alcohol	0	24	0%	0.1080	0.148								0.125		NO				NO

Table E-3b
Bed + Bank Sediments for Reference Creeks
Ecological Risk Assessment
Red Butte Creek
Salt Lake City, Utah

Chemical Name	Num_Detects	Number of samples	Frequency of detection	Min_ND	Max_ND	Min_Detect	Max_Detect	Mean_Detects	Median_Detects	StdDev_Detects	Distribution	UCL Calc Method	95 UCL	EPC	>5%	Screening value (mg/kg)	Reference	Exceedance	Red Butte Creek COPC?
Isophorone	0	24	0%	0.3660	0.502								0.00387		NO				NO
Isopropyl alcohol	0	24	0%	0.0431	0.059								154.2		NO				NO
Isopropylbenzene	0	24	0%	0.0022	0.00295										NO				NO
m&p-Xylenes	3	24	13%	0.0023	0.00295	0.00273	0.00605	0.00384	0.00275	0.00191	non-parametric	KM (t)	KM (t)	0.00315	YES				NO
Methyl tert-butyl ether	0	24	0%	0.0022	0.00295										NO				NO
Methylene chloride	0	24	0%	0.0054	0.00738										NO				NO
Naphthalene	1	24	4%	0.0022	0.00295	0.0488	0.0488							0.0488	NO				NO
n-Butylalcohol	0	24	0%	0.1080	0.148										NO				NO
n-Butylbenzene	0	24	0%	0.0022	0.00295										NO				NO
Nitrobenzene	0	24	0%	0.3660	0.502										NO				NO
N-Nitrosodimethylamine	0	24	0%	0.7220	0.988										NO				NO
N-Nitroso-di-n-propylamine	0	24	0%	0.3660	0.502										NO				NO
N-Nitrosodiphenylamine	0	24	0%	0.3660	0.502										NO				NO
n-Propylbenzene	0	24	0%	0.0022	0.00295										NO				NO
o-Xylene	1	24	4%	0.0022	0.00295	0.004	0.004							0.004	NO				NO
Pentachlorobenzene	0	24	0%	0.3660	0.502										NO				NO
Pentachlorophenol	0	24	0%	0.3660	0.502										NO				NO
Phenanthrene	14	24	58%	0.0108	0.0148	0.0243	0.371	0.1	0.076	0.0961	lognormal	KM (t)	KM (t)	0.0976	YES				NO
Phenol	1	24	4%	0.3660	0.502	0.64	0.64							0.64	NO				NO
p-Isopropyltoluene	2	24	8%	0.0022	0.00295	0.00266	0.0176	0.0101	0.0101	0.0106	non-parametric	NA	NA	0.0176	YES				NO
Pyrene	18	24	75%	0.0114	0.0148	0.0312	0.452	0.118	0.084	0.111	lognormal	M (Percentile Bootstr	KM (Percentile Bootstrap	0.133	YES				NO
Pyridine	0	24	0%	0.7220	0.988										NO				NO
Quinoline	0	24	0%	0.3660	0.502										NO				NO
sec-Butylbenzene	0	24	0%	0.0022	0.00295										NO				NO
Styrene	0	24	0%	0.0022	0.00295										NO				NO
tert-Butylbenzene	0	24	0%	0.0022	0.00295										NO				NO
Tetrachloroethene	5	24	21%	0.0023	0.00295	0.00322	0.00643	0.00483	0.00458	0.00118	non-parametric	95% KM (t) UCL	0.00387	0.00387	YES				NO
Tetrahydrofuran	0	24	0%	0.0022	0.00295										NO				NO
Toluene	5	24	21%	0.0023	0.00295	0.00314	0.0741	0.0221	0.00719	0.0302	non-parametric	KM (t)	KM (t)	0.0128	YES				NO
TPH Diesel	24	24	100%			34.4	308	121.7	95.6	95.6	lognormal	95% H-UCL	154.2	154.2	YES	5.5	2	Yes	YES
Aromatics							154							77.1	NO				YES
Aliphatics							154							77.1	NO				YES
TPH Motor Oil	19	24	79%	23.5000	26.7	29	214	94.02	80.4	48.5	normal	KM (t)	98.31	98.31	YES			Yes	YES
Aromatics							107							49.155	NO				YES
Aliphatics							107							49.155	NO				YES
trans-1,2-Dichloroethene	0	24	0%	0.0022	0.00295										NO				NO
trans-1,3-Dichloropropene	0	24	0%	0.0022	0.00295										NO				NO
Trichloroethene	0	24	0%	0.0022	0.00295										NO				NO
Trichlorofluoromethane	0	24	0%	0.0022	0.00295										NO				NO
Vinyl acetate	0	24	0%	0.0108	0.0148										NO				NO
Vinyl chloride	0	24	0%	0.0011	0.00148										NO				NO
Xylenes (total)	4	24	17%	0.0009	0.00295	0.00273	0.00752	0.00425	0.00338	0.00226	non-parametric	KM (t)	KM (t)	0.00338	YES				NO

NOTES
Units in mg/kg
References:
1. U.S. Environmental Protection Agency (USEPA). 2007. Ecological Soil Screening Levels for Polycyclic Aromatic Hydrocarbons (PAHs), OSWER Directive 9285.7-78. Office of Solid Waste and Emergency Response, Washington, DC.
2. U.S. Environmental Protection Agency (USEPA), Region 5, RCRA Ecological Screening Levels, August 2003, website: http://epa.gov/region05/waste/cars/pdfs/ecological-screening-levels-200308.pdf

Table E-4
Sediment-to-Plant Bioaccumulation Factors
Ecological Risk Assessment
Red Butte Creek
Salt Lake City, Utah

COPEC	Soil log Kow	Source	log BAF	BAF	Source
Aliphatics					
C9-C10 Aliphatics	5.7	surr: nonane (TPHCWG, 2007)	-0.27	0.54	USEPA 2007
C11-C12 Aliphatics	6.9	surr: undecane (TPHCWG, 2007)	-0.57	0.27	USEPA 2007
C13-C16 Aliphatics	8.3	surr: hexadecane (TPHCWG, 2007)	-0.87	0.14	USEPA 2007
C17-C21 Aliphatics	8.3	surr: hexadecane (TPHCWG, 2007)	-0.87	0.14	USEPA 2007
C22-C35 Aliphatics	9.7	surr: heptadecane (TPHCWG, 2007)	-1.2	0.064	USEPA 2007
MAX				0.54	
Aromatics					
C9-C10 Aromatics	4.1	surr: sec-butylbenzene (TPHCWG, 2007)	0.085	1.2	USEPA 2007
C11-C13 Aromatics	5.0	surr: 1,4,5-trimethylnaphthalene (TPHCWG, 2007)	-0.12	0.76	USEPA 2007
C12-C22 Aromatics	7.2	surr: picene (TPHCWG, 2007)	-0.62	0.24	USEPA 2007
MAX				1.2	

BAF - Bioaccumulation Factor
all values in dry weight
log BAF = -0.229*log Kow + 1.0237

Table E-5
Sediment-to-Benthic Invertebrate Bioaccumulation Factors
Ecological Risk Assessment
Red Butte Creek
Salt Lake City, Utah

COPEC	log Kow	Kow	Source	log Kww	Kww (L/kg worm ww)	Kww (L/kg worm dw)	Koc (ml/g)	Source	Kd (L/kg soil dw)	Sed to Invert BAF	Source
Aliphatics											
C9-C10 Aliphatics	5.7	446684	surr: nonane (TPHCWG, 1997)	2.9	823	4116	31600	UDEQ, 2007	316	13	USEPA 2007
C11-C12 Aliphatics	6.9	8709636	surr: undecane (TPHCWG, 1997)	4.0	10909	54547	316000	UDEQ, 2007	3160	17	USEPA 2007
C13-C16 Aliphatics	8.3	177827941	surr: hexadecane (TPHCWG, 1997)	5.2	150487	752437	5000000	UDEQ, 2007	50000	15	USEPA 2007
C17-C21 Aliphatics	8.3	177827941	surr: hexadecane (TPHCWG, 1997)	5.2	150487	752437	400000000	UDEQ, 2007	4000000	0.19	USEPA 2007
C22-C35 Aliphatics	9.7	4897788194	surr: heptadecane (TPHCWG, 1997)	6.4	2693395	13466973	400000000	UDEQ, 2007	4000000	3.4	USEPA 2007
MAX										17	
Aromatics											
C9-C10 Aromatics	4.1	12589	surr: sec-butylbenzene (TPHCWG, 1997)	1.6	37	184	1260	UDEQ, 2007	12.6	15	USEPA 2007
C11-C13 Aromatics	5.0	100000	surr: 1,4,5-trimethylnaphthalene (TPHCWG, 1997)	2.4	224	1119	7060	UDEQ, 2007	70.6	16	USEPA 2007
C12-C22 Aromatics	7.2	15488166	surr: picene (TPHCWG, 1997)	4.3	18001	90006	6290	UDEQ, 2007	62.9	1431	USEPA 2007
MAX										1431	

1 - wet weight to dry weight conversion performed assuming 20% moisture based on the average of site data.
BAF - Bioaccumulation Factor
log Kww = 0.87*log Kow-2.0
Kd= foc*Koc
BAF = Kww (L/kg worm dw)/Kd (L/kg soil dw)

Appendix F

Analysis of Benthic Macroinvertebrate Community Indices

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Red Butte Creek Benthic Community Descriptive Statistics

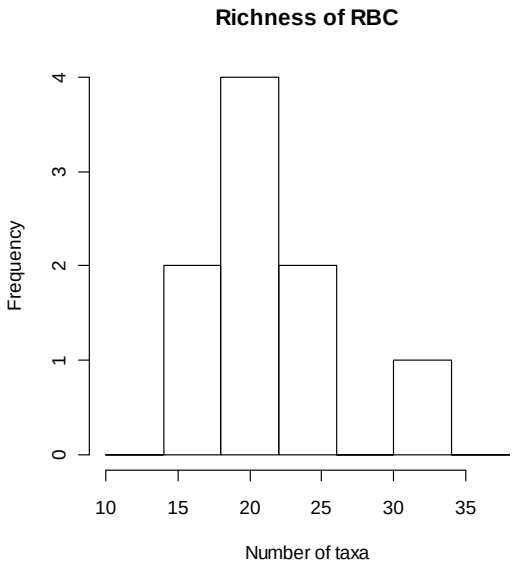
Analyses were performed on the following variables:

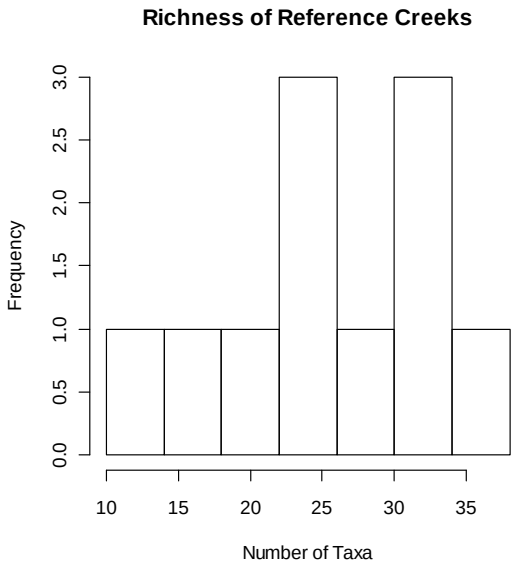
- Richness
- Evenness
- Shannon-Weiner Diversity Index
- Hilsenhoff Biotic Index (HBI)
- Percent Chironomids
- Percent EPT

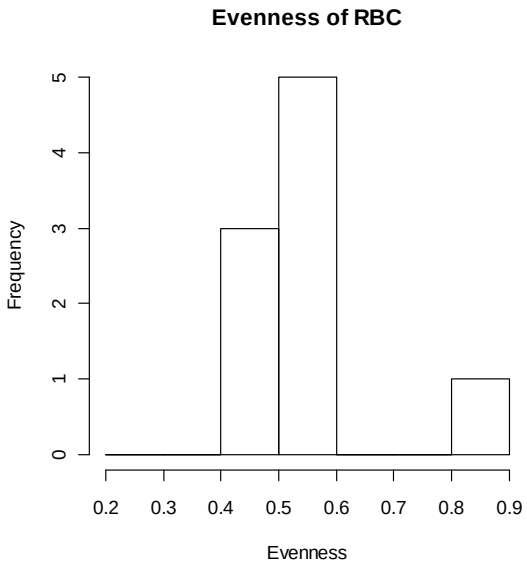
The following analyses were performed and plots generated:

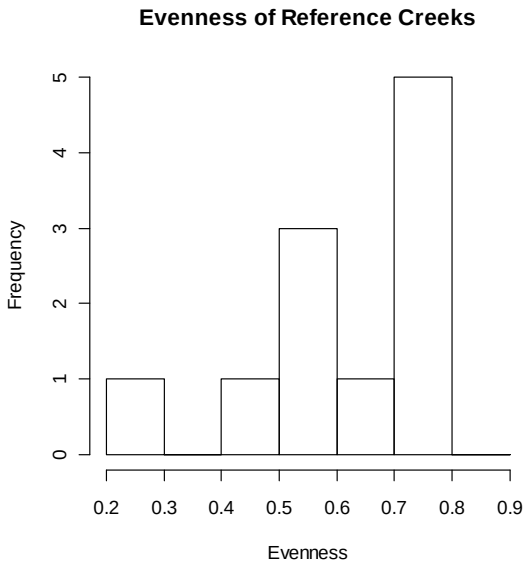
- Box and whisker plots for each creek
- Histograms for Red Butte Creek (RBC) and reference creeks (pooled)
- Descriptive statistics for RBC and reference creeks (pooled)
- Two-way tests comparing RBC and reference creeks using Kruskal Wallis and one-way ANOVAs
- Boxplots of RBC and reference creeks

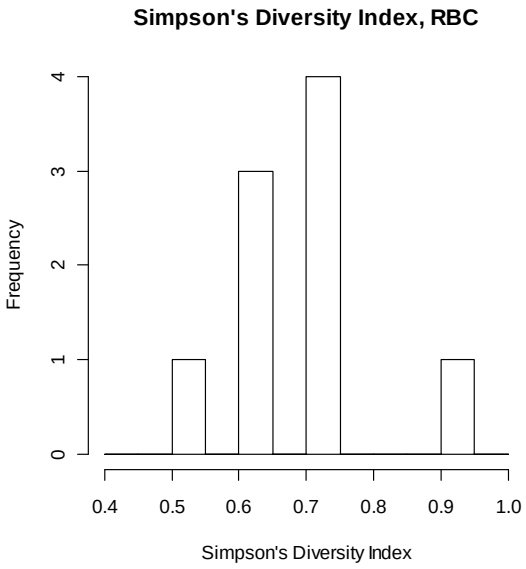
HISTOGRAMS WITH ALL DATA

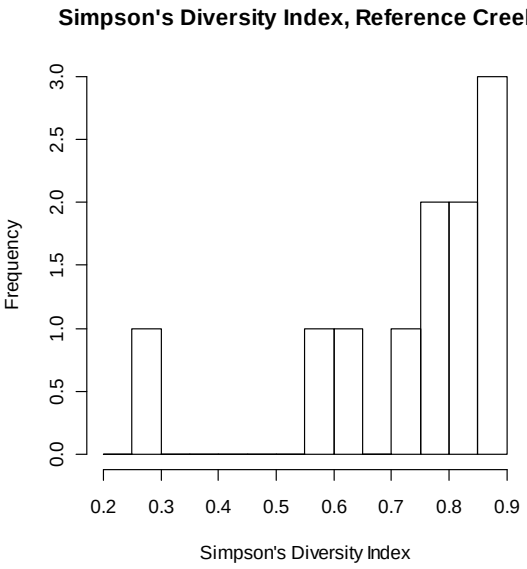


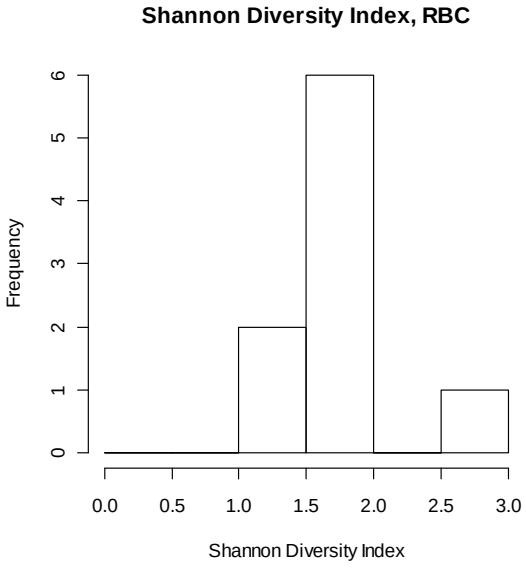


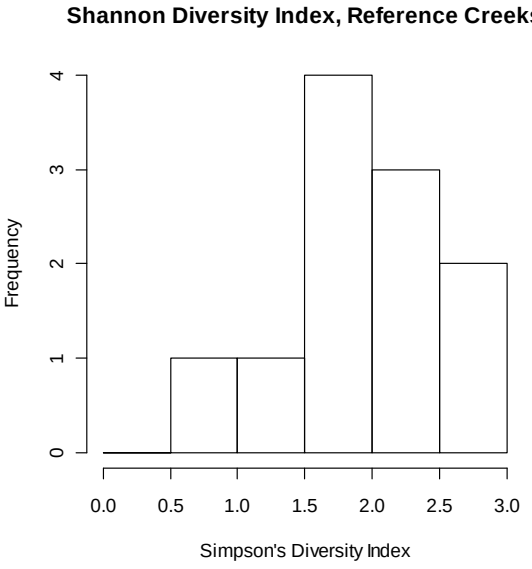


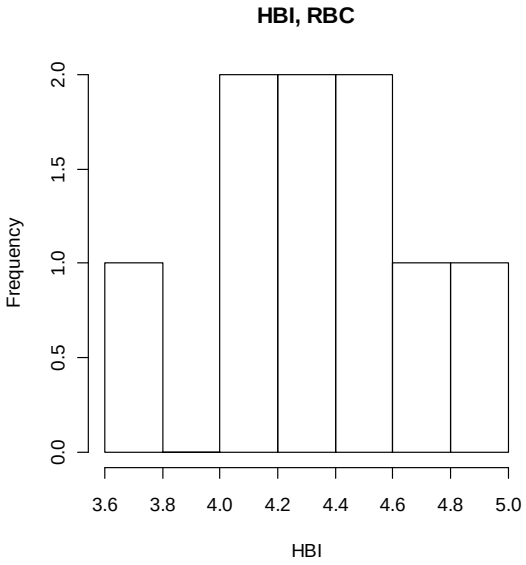


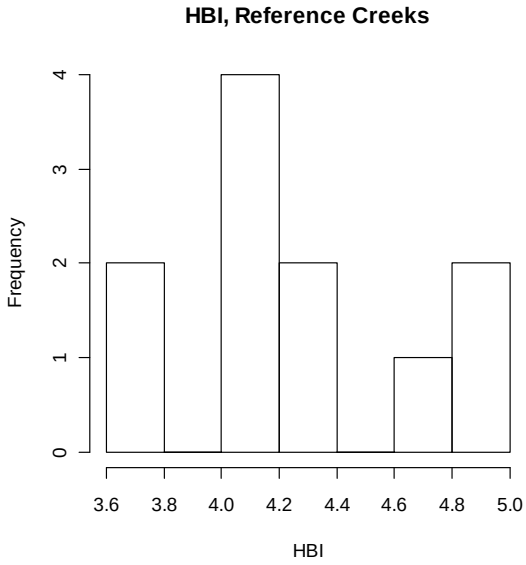

Simpson's Diversity Index, RBC
Frequency
0
1
2
3
4
0.4
0.5
0.6
0.7
0.8
0.9
1.0
Simpson's Diversity Index

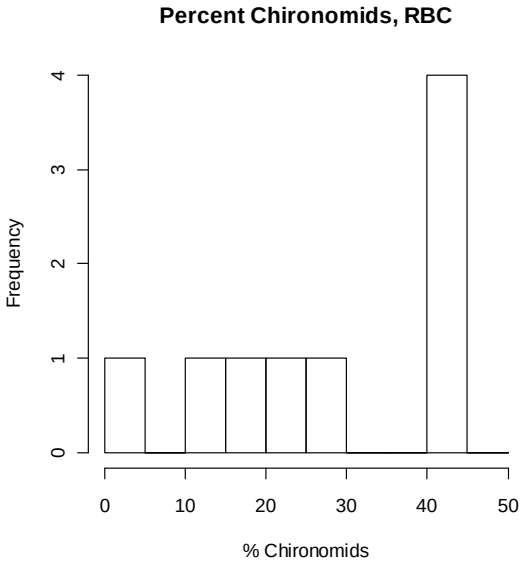

Simpson's Diversity Index, Reference Creeks
Frequency
0.0
0.5
1.0
1.5
2.0
2.5
3.0
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
Simpson's Diversity Index

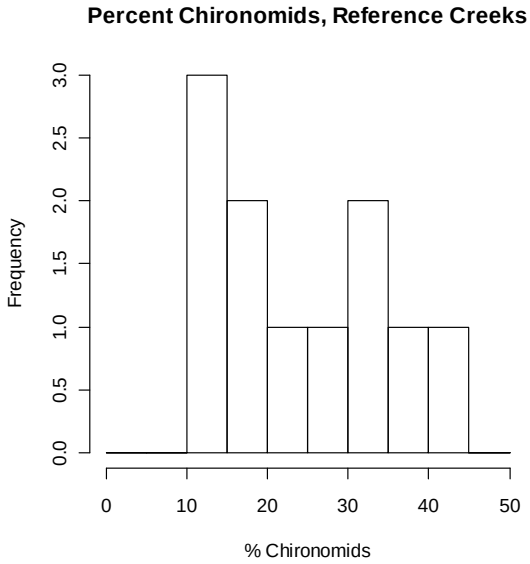

Shannon Diversity Index, RBC
Frequency
0
1
2
3
4
5
6
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Shannon Diversity Index

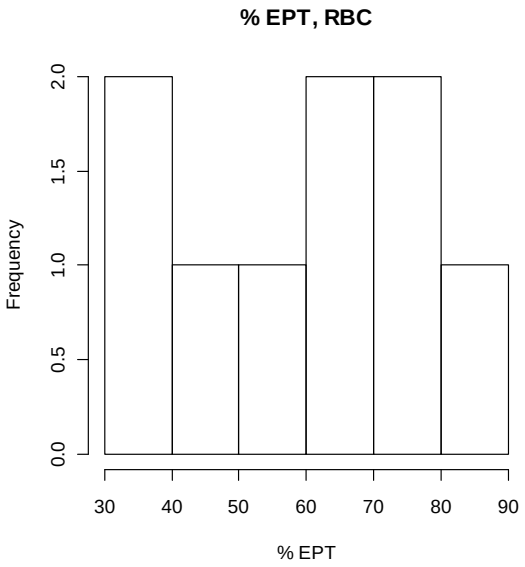

Shannon Diversity Index, Reference Creeks
Frequency
0
1
2
3
4
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Simpson's Diversity Index

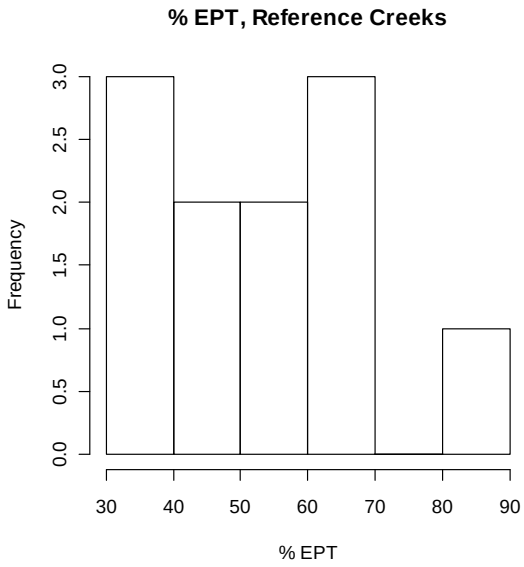

HBI, RBC
Frequency
0.0
0.5
1.0
1.5
2.0
3.6
3.8
4.0
4.2
4.4
4.6
4.8
5.0
HBI


HBI, Reference Creeks
Frequency
0
1
2
3
4
3.6
3.8
4.0
4.2
4.4
4.6
4.8
5.0
HBI


Percent Chironomids, RBC
Frequency
0
1
2
3
4
0
10
20
30
40
50
% Chironomids


Percent Chironomids, Reference Creeks
Frequency
0.0
0.5
1.0
1.5
2.0
2.5
3.0
0
10
20
30
40
50
% Chironomids


% EPT, RBC
Frequency
0.0
0.5
1.0
1.5
2.0
30
40
50
60
70
80
90
% EPT


% EPT, Reference Creeks
Frequency
0.0
0.5
1.0
1.5
2.0
2.5
3.0
30
40
50
60
70
80
90
% EPT

Kruskal Wallis test comparing RBC to Reference Creeks, all data included

	Chi Squared	DF	p
Richness	2.2131	1	0.1368
Evenness	0.6397	1	0.4238
Shannon	1.3016	1	0.2539
HBI	0.283	1	0.5947
%Chironomid	0.3247	1	0.5688
%EPT	0.7633	1	0.3823

ANOVA comparing RBC to Reference Creeks, All data included

	Df	SS	MS	F	P
Richness					
Ref v RBC	1	82.84	82.841	1.9193	0.1829
Residuals	18	776.91	43.162		
Evenness					
Ref v RBC	1	0.007178	0.007178	0.4109	0.5296
Residuals	18	0.314477	0.017471		
Shannon Diversity Index					
Ref v RBC	1	0.2387	0.2387	0.9703	0.3377
Residuals	18	4.4279	0.246		
Hilsenhoff Biotic Index					
Ref v RBC	1	0.03471	0.034709	0.2148	0.6486
Residuals	18	2.90859	0.161588		
Percent Chironomids					
Ref v RBC	1	90.9	90.854	0.4897	0.493
Residuals	18	3339.2	185.514		
Percent EPT					
Ref v RBC	1	148.3	148.29	0.6156	0.4429
Residuals	18	4335.6	240.87		

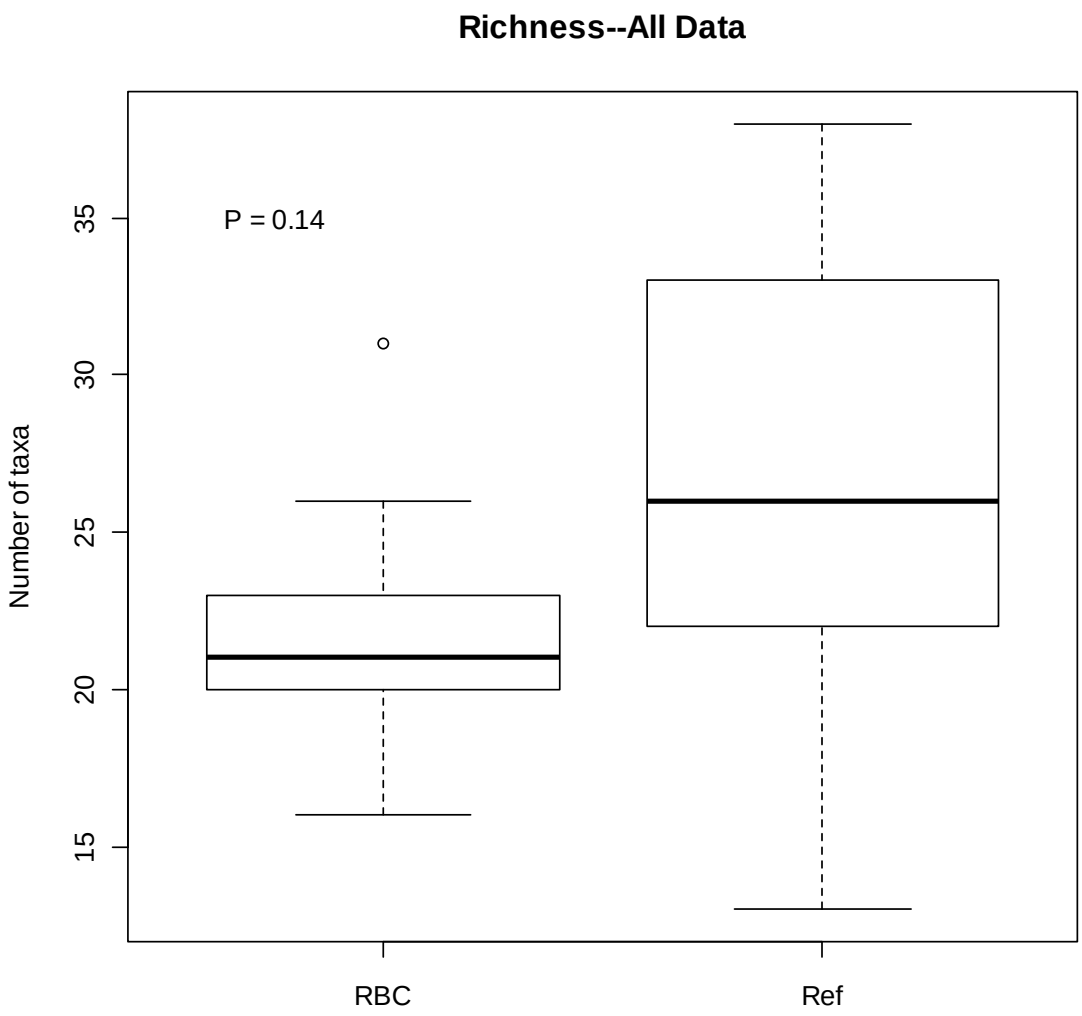
Descriptive Statistics

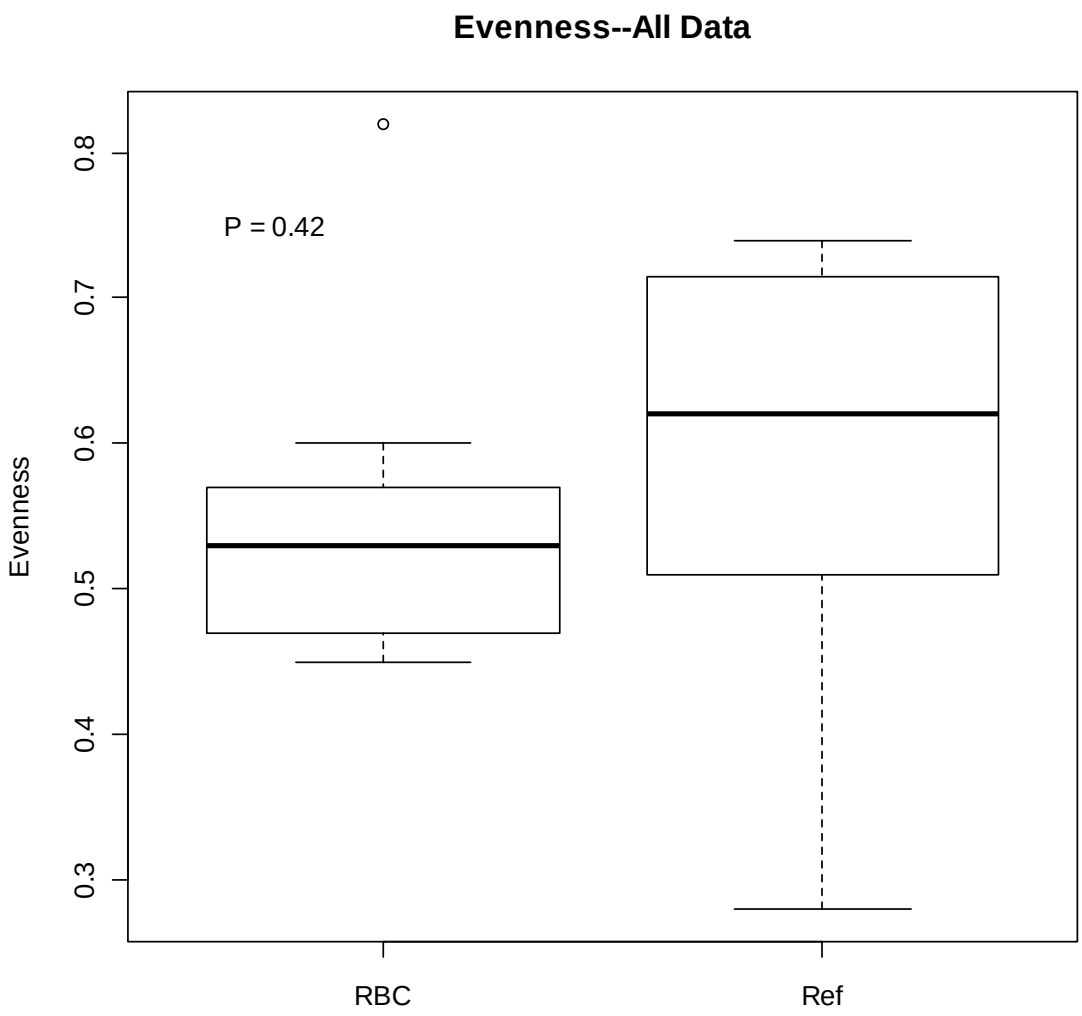
Red Butte Creek, All data included

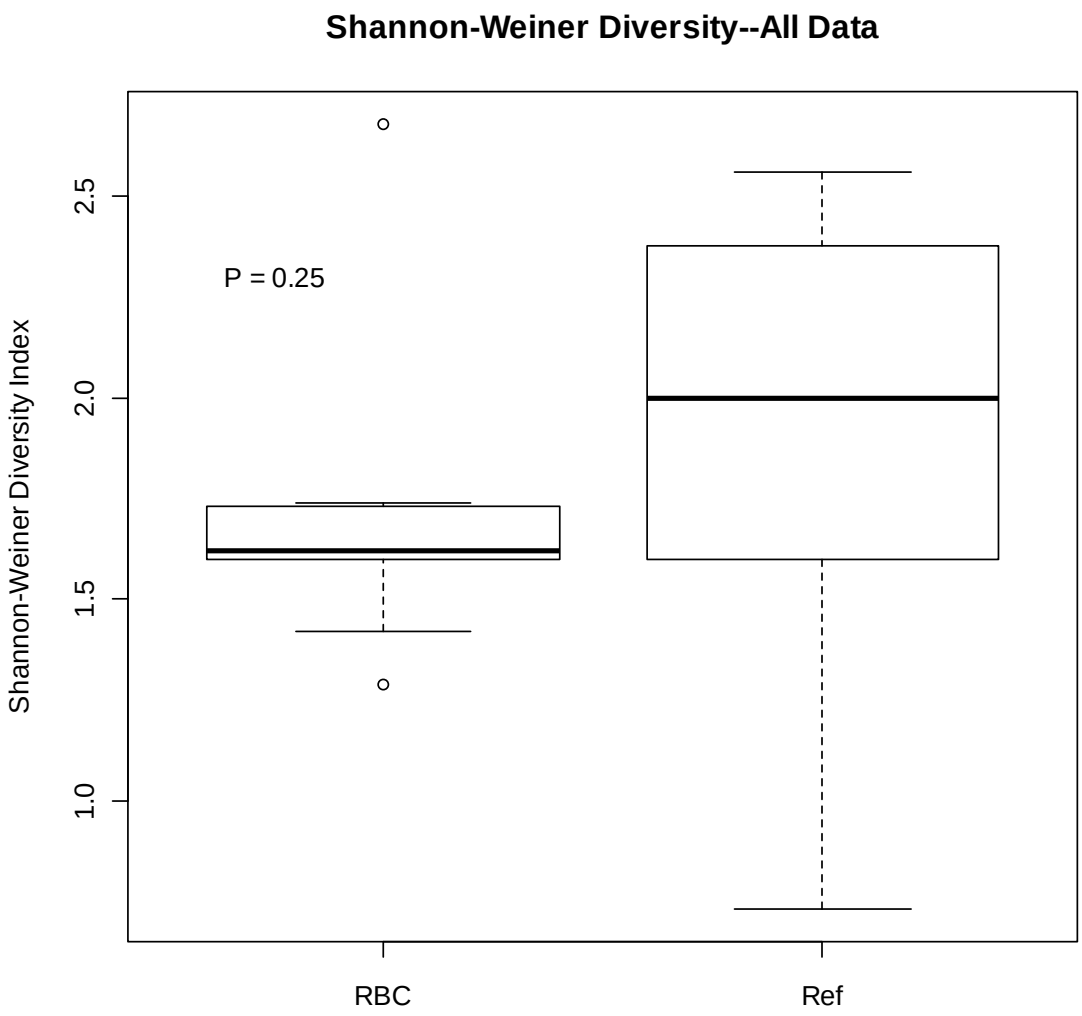
	richness	shannon	even	HBI	%.EPT	%.chironomid
n	9	9	9	9	9	9
min	16	1.290	0.45	3.67	35.541	3.446
max	31	2.680	0.82	4.83	81.242	44.835
range	15	1.390	0.37	1.16	45.701	41.389
sum	198	15.410	5	39.29	531.111	251.656
median	21	1.620	0.53	4.38	64.815	26.344
mean	22.000	1.712	0.556	4.366	59.012	27.962
SE on mean	1.472	0.131	0.037	0.120	5.464	5.244
CI on mean (0.95)	3.394	0.302	0.086	0.277	12.599	12.093
variance	19.500	0.154	0.012	0.130	268.652	247.501
SD	4.416	0.393	0.111	0.360	16.391	15.732
COV	0.201	0.230	0.200	0.083	0.278	0.563
skewness	0.650	1.470	1.297	-0.409	-0.189	-0.238
skew statistic	0.453	1.025	0.904	-0.285	-0.132	-0.166
kurtosis	-0.549	1.271	0.703	-0.897	-1.678	-1.747
kurtosis statistic	-0.196	0.454	0.251	-0.320	-0.599	-0.624
Shap.Wilk W stat	0.941	0.746	0.805	0.955	0.934	0.893
P-val, Shapiro Wilk Test	0.589	0.005	0.023	0.744	0.517	0.212

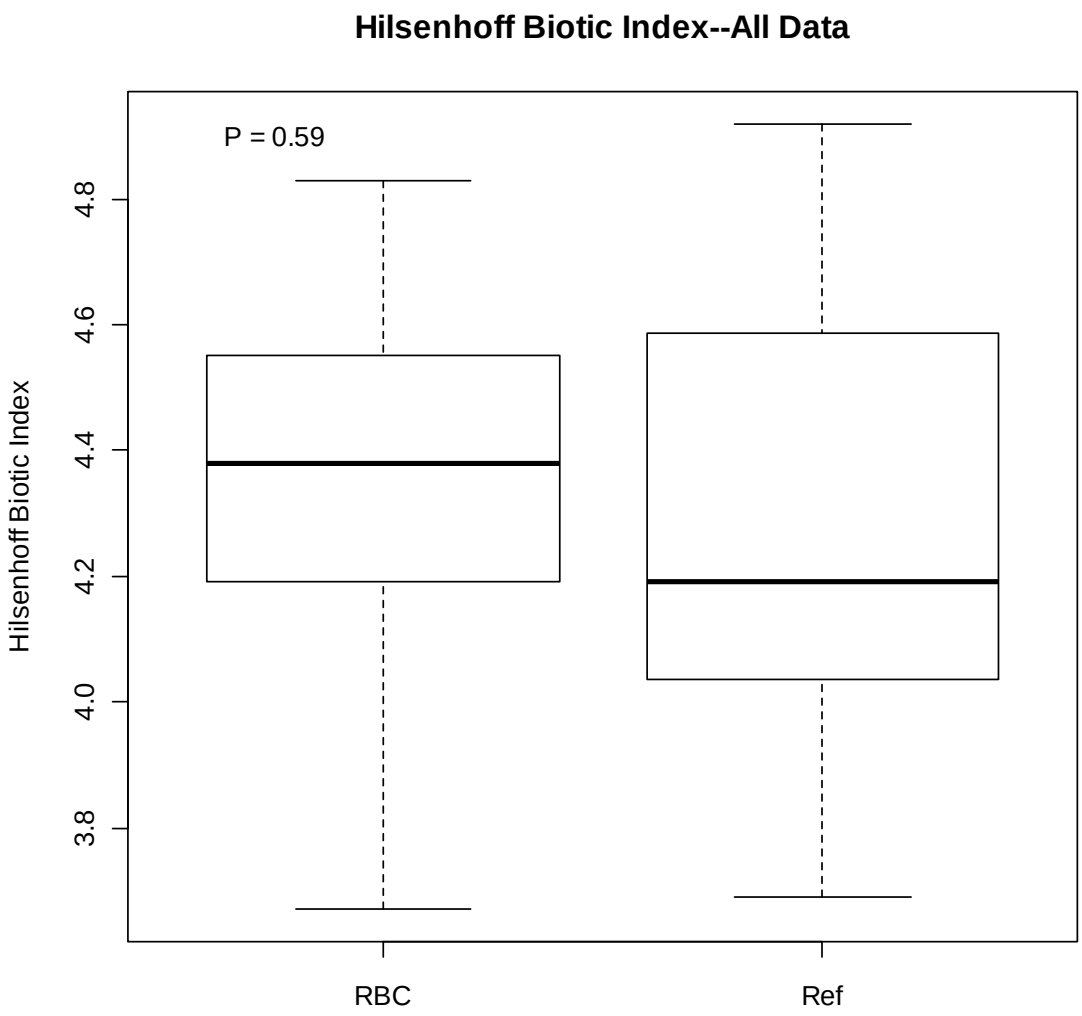
Reference Creeks, All data included

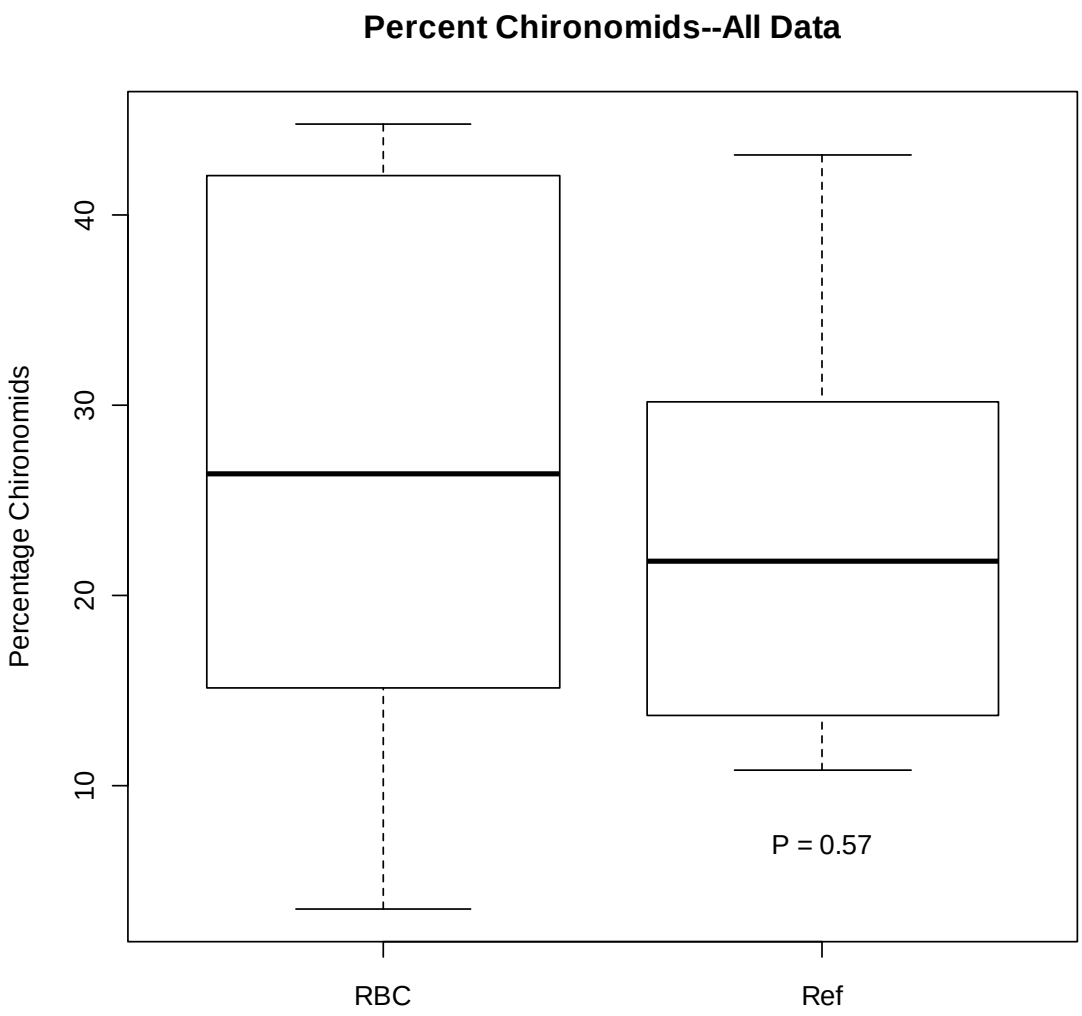
	richness	shannon	even	HBI	%EPT	%chironomid
n	11	11	11	11	11	11
min	13	0.73	0.28	3.69	35.506	10.745
max	38	2.56	0.74	4.92	83.578	43.146
range	25	1.83	0.46	1.23	48.072	32.401
sum	287	21.25	6.53	47.1	588.930	260.454
median	26	2	0.62	4.19	50.777	21.799
mean	26.091	1.932	0.594	4.282	53.539	23.678
SE on mean	2.376	0.170	0.044	0.130	4.458	3.515
CI on mean (0.95)	5.294	0.380	0.099	0.290	9.934	7.832
variance	62.091	0.319	0.022	0.187	218.640	135.924
SD	7.880	0.565	0.147	0.432	14.786	11.659
COV	0.302	0.292	0.247	0.101	0.276	0.492
skewness	-0.107	-0.636	-0.711	0.159	0.582	0.317
skew statistic	-0.081	-0.481	-0.538	0.120	0.440	0.240
kurtosis	-1.355	-0.705	-0.736	-1.469	-0.946	-1.521
kurtosis statistic	-0.530	-0.275	-0.288	-0.574	-0.370	-0.594
Shap.Wilk W stat	0.965	0.921	0.874	0.926	0.932	0.900
P-val, Shapiro Wilk Test	0.829	0.327	0.087	0.373	0.436	0.183

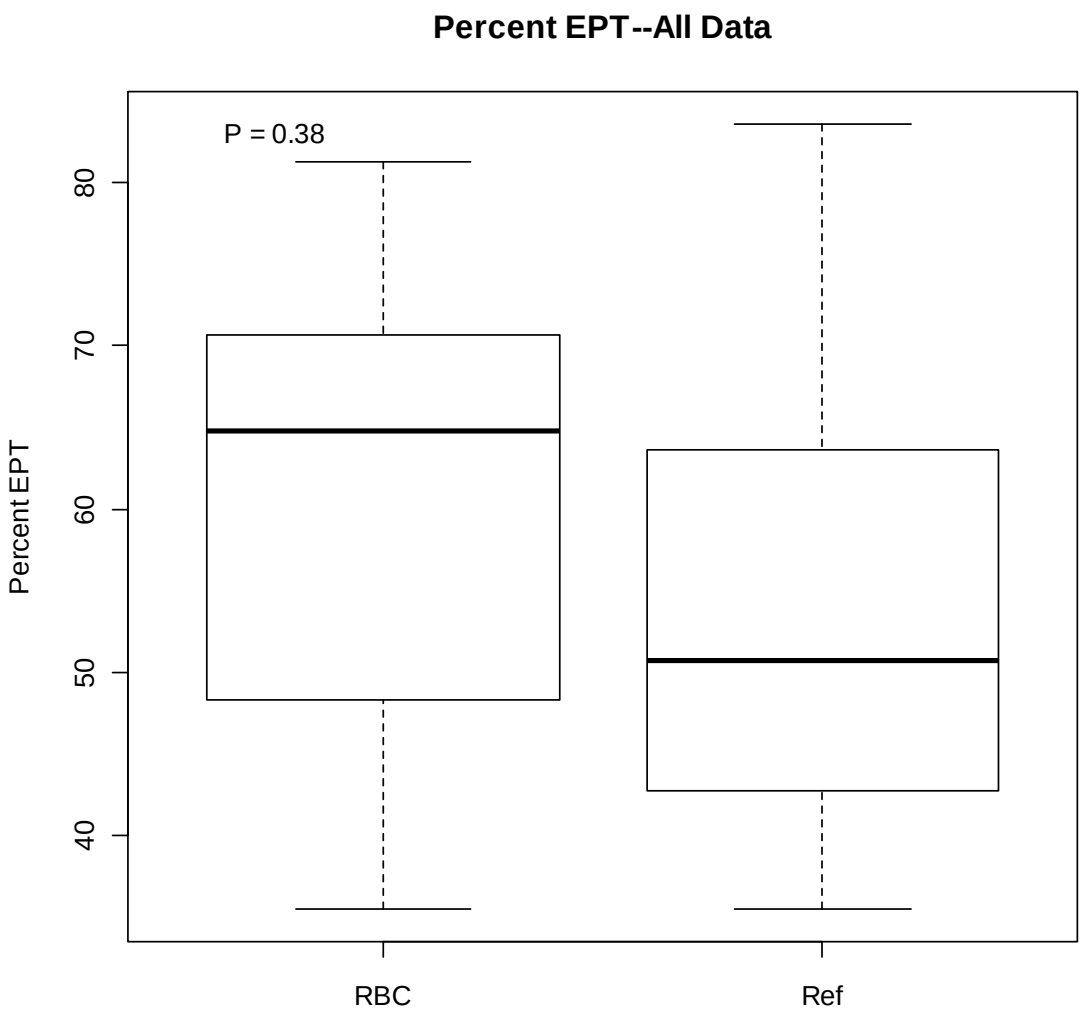

Richness--All Data
P = 0.14
Number of taxa
15
20
25
30
35
RBC
Ref


Evenness--All Data
P = 0.42
Evenness
0.3
0.4
0.5
0.6
0.7
0.8
RBC
Ref


Shannon-Weiner Diversity--All Data
Shannon-Weiner Diversity Index
2.5
2.0
1.5
1.0
P = 0.25
RBC
Ref


Hilsenhoff Biotic Index--All Data
P = 0.59
Hilsenhoff Biotic Index
3.8
4.0
4.2
4.4
4.6
4.8
RBC
Ref


Percent Chironomids--All Data
Percentage Chironomids
10
20
30
40
P = 0.57
RBC
Ref


Percent EPT--All Data
P = 0.38
Percent EPT
40
50
60
70
80
RBC
Ref

Spatial trend analysis over space for benthic macroinvertebrate communities in Red Butte Creek

APPROACH

Benthic macroinvertebrates were identified and quantified in Red Butte Creek at nine locations (Table 1). These locations represent one natural (non-urban) site upstream of the spill (in RB Gardens). The remaining sites range from immediately downstream of the spill (below Chipeta Drive) to a 2.3 miles downstream (Below 1100 East). For these analyses, the one natural site in RB Gardens was excluded so a change in the benthic macroinvertebrate community could be described below the spill site.

Table 1. Sampling locations along Red Butte Creek

Sampling site	Description	Distance (Miles)
In RB Gardens	Natural	0
Below Chipeta Way,	Urban	0.305
Above Foothill Dr	Urban	0.848
At Mt Olivet Diversion	Urban	1.209
Above Sunnyside Ave.	Urban	1.326
At County Stream Gauging Station	Urban	1.726
Above 1500 East	Urban	1.89
Below 1300 East	Urban	2.298
Below 1100 East	Urban	2.557

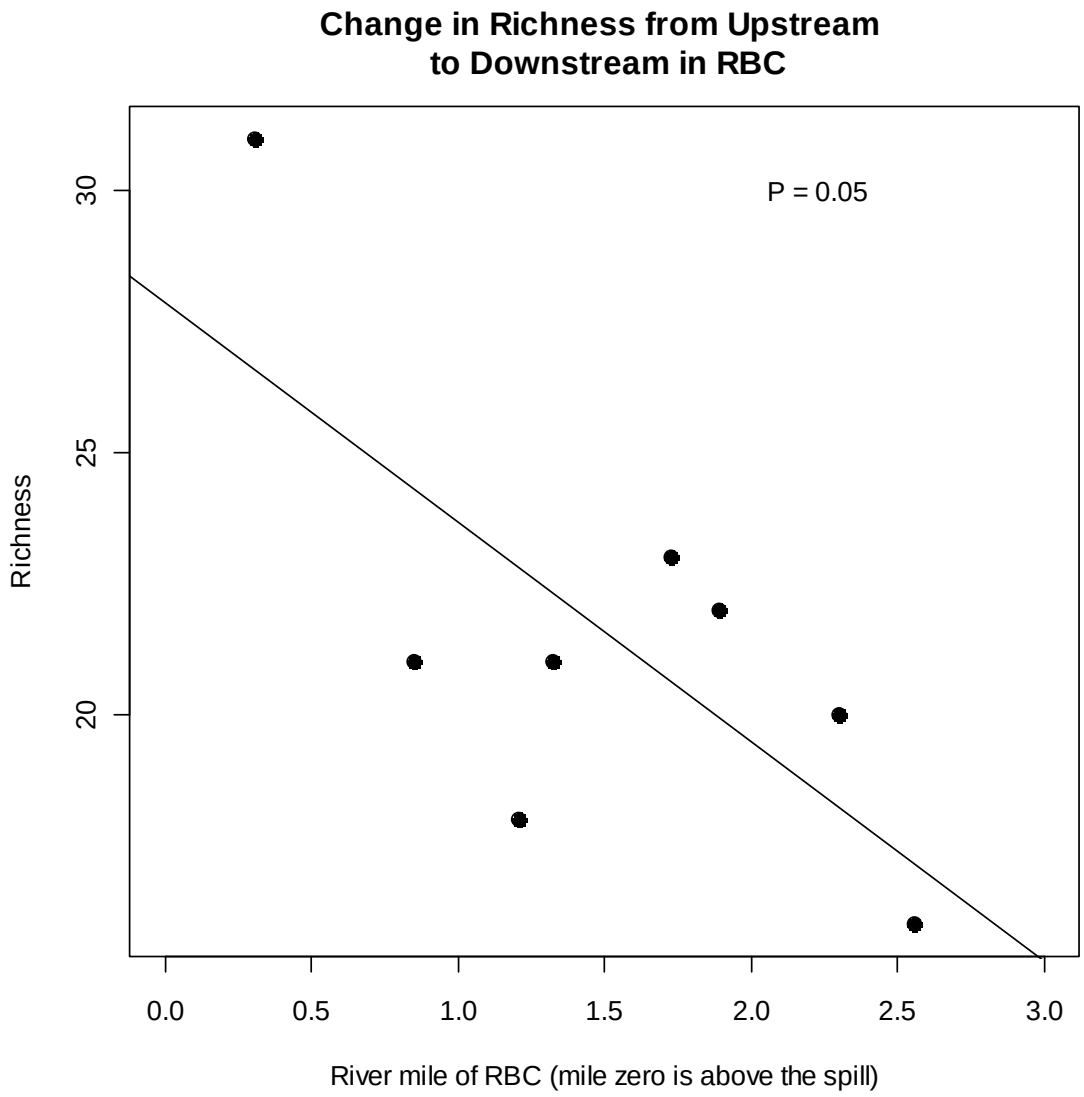
The following biotic indices were tested for trends over horizontal distance and elevation distances below the spill site:

- Richness
- Evenness
- Total Macroinvertebrate Abundance
- Shannon-Weiner Diversity Index
- Hilsenhoff Biotic Index
- Percent EPT
- Percent Chironomids
- Abundance of EPT taxa
- Abundance of intolerant taxa

All data were tested for normality using a Shapiro Wilks test. No index was found to deviate from the normal distribution with the exception of the abundance of intolerant taxa which was borderline ($p = 0.054$). All data were then tested in a linear model as a function of distance or elevation:

Biotic index = distance * x + a

Residuals were examined to assure there was no additional underlying trend in the data.



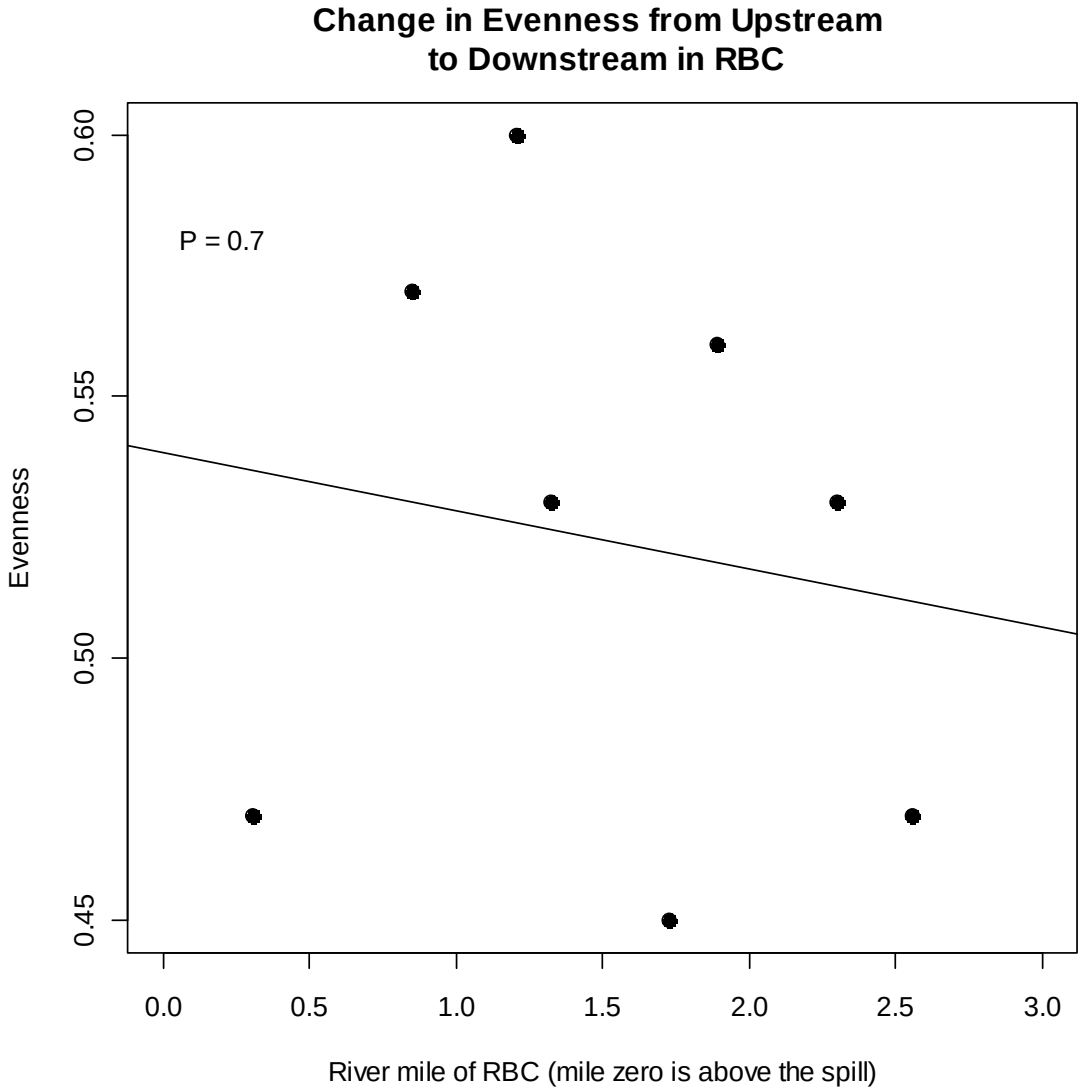
Richness as a function of horizontal distance

```
lm(formula = x$richness ~ x$cum.mi)

Residuals:
    Min      1Q  Median      3Q     Max
-4.7997 -1.8101  0.2945  2.1260  4.4209

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)   27.854      2.875   9.690 6.93e-05 ***
x$cum.mi      -4.181      1.718  -2.434   0.0509 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 3.402 on 6 degrees of freedom
Multiple R-squared: 0.4968,     Adjusted R-squared: 0.4129
F-statistic: 5.923 on 1 and 6 DF,  p-value: 0.0509
```



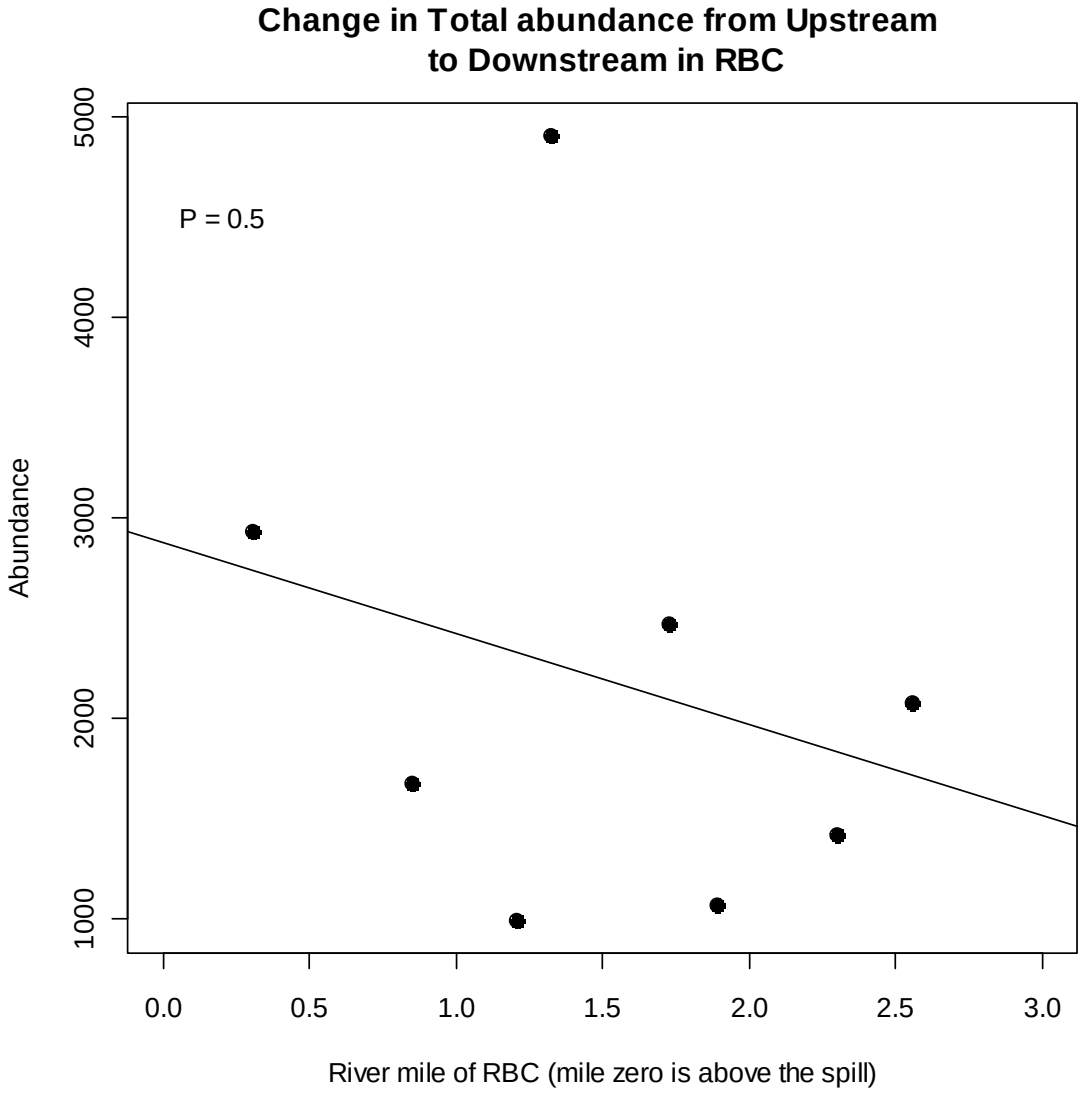
Evenness as a function of horizontal distance

```
lm(formula = x$even ~ x$cum.mi)

Residuals:
     Min       1Q   Median       3Q      Max
-0.07022 -0.04726  0.01073  0.04045  0.07406

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.53930    0.04887  11.035 3.29e-05 ***
x$cum.mi    -0.01105    0.02920  -0.379    0.718
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.05784 on 6 degrees of freedom
Multiple R-squared: 0.02332,    Adjusted R-squared: -0.1395
F-statistic: 0.1433 on 1 and 6 DF,  p-value: 0.7181
```



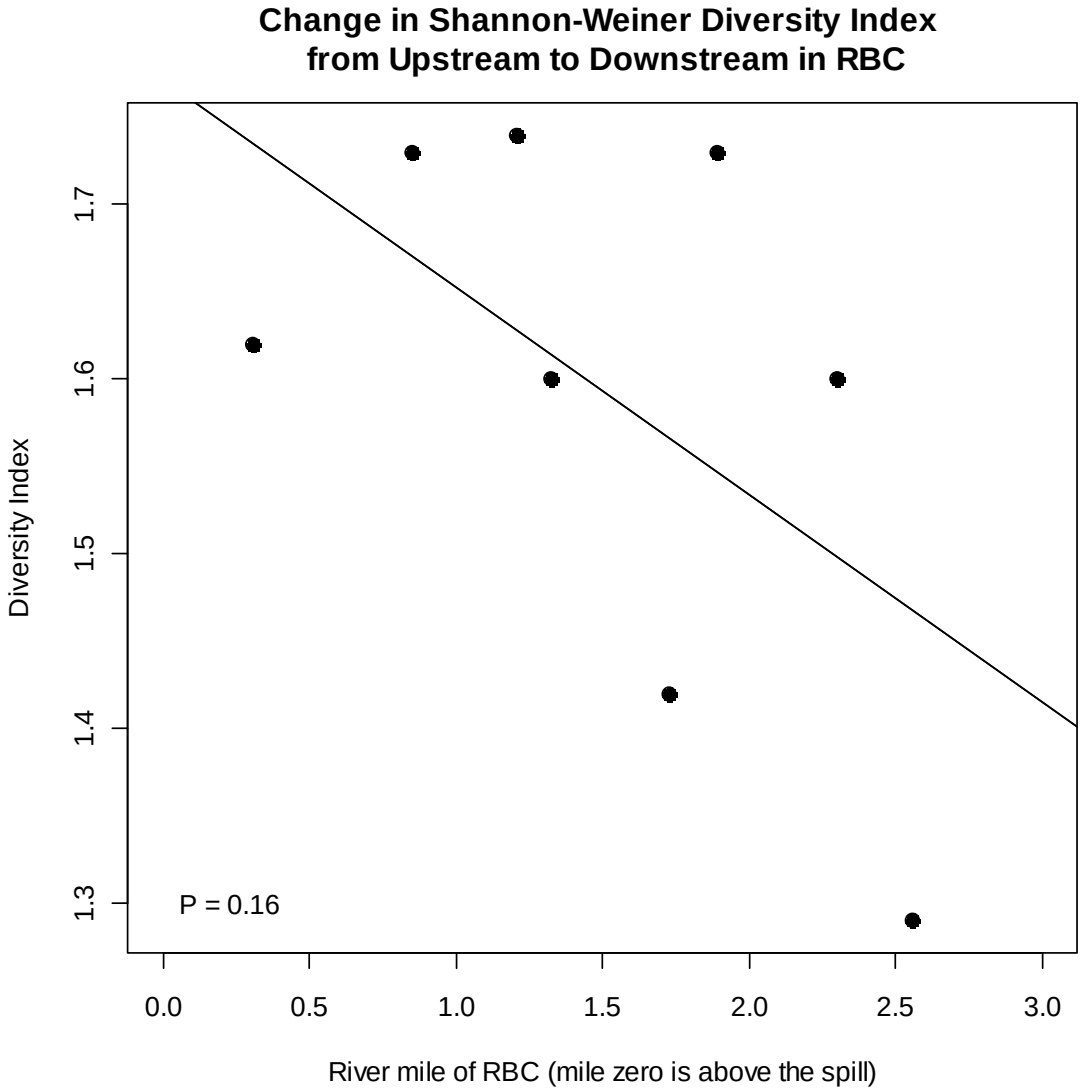
Total aquatic organism abundance as a function of horizontal distance

```
lm(formula = x$tot.abund ~ x$cum.mi)

Residuals:
    Min      1Q  Median      3Q     Max
-1342.5  -856.6  -115.5   357.6  2628.6

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)   2882.8     1132.1   2.546   0.0437 *
x$cum.mi      -453.5      676.5  -0.670   0.5276
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1340 on 6 degrees of freedom
Multiple R-squared: 0.06968,    Adjusted R-squared: -0.08538
F-statistic: 0.4494 on 1 and 6 DF,  p-value: 0.5276
```



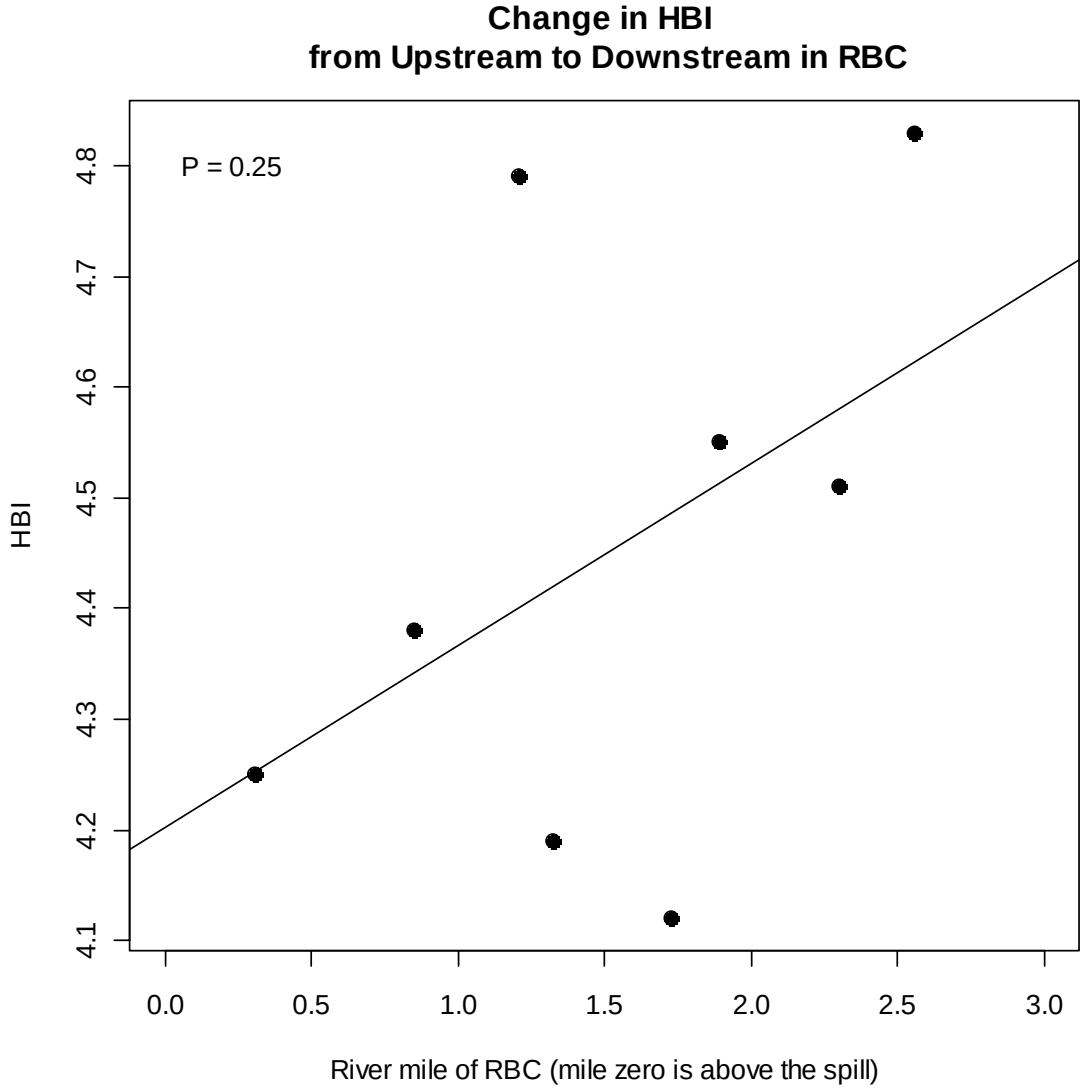
Shannon-Weiner Diversity Index as a function of horizontal distance

```
lm(formula = x$shannon ~ x$cum.mi)

Residuals:
     Min       1Q   Median       3Q      Max
-0.17812 -0.12331  0.02236  0.10381  0.18269

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  1.77170    0.12264   14.45 6.89e-06 ***
x$cum.mi    -0.11873    0.07329   -1.62    0.156
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.1451 on 6 degrees of freedom
Multiple R-squared: 0.3043,     Adjusted R-squared: 0.1883
F-statistic: 2.624 on 1 and 6 DF,  p-value: 0.1564
```



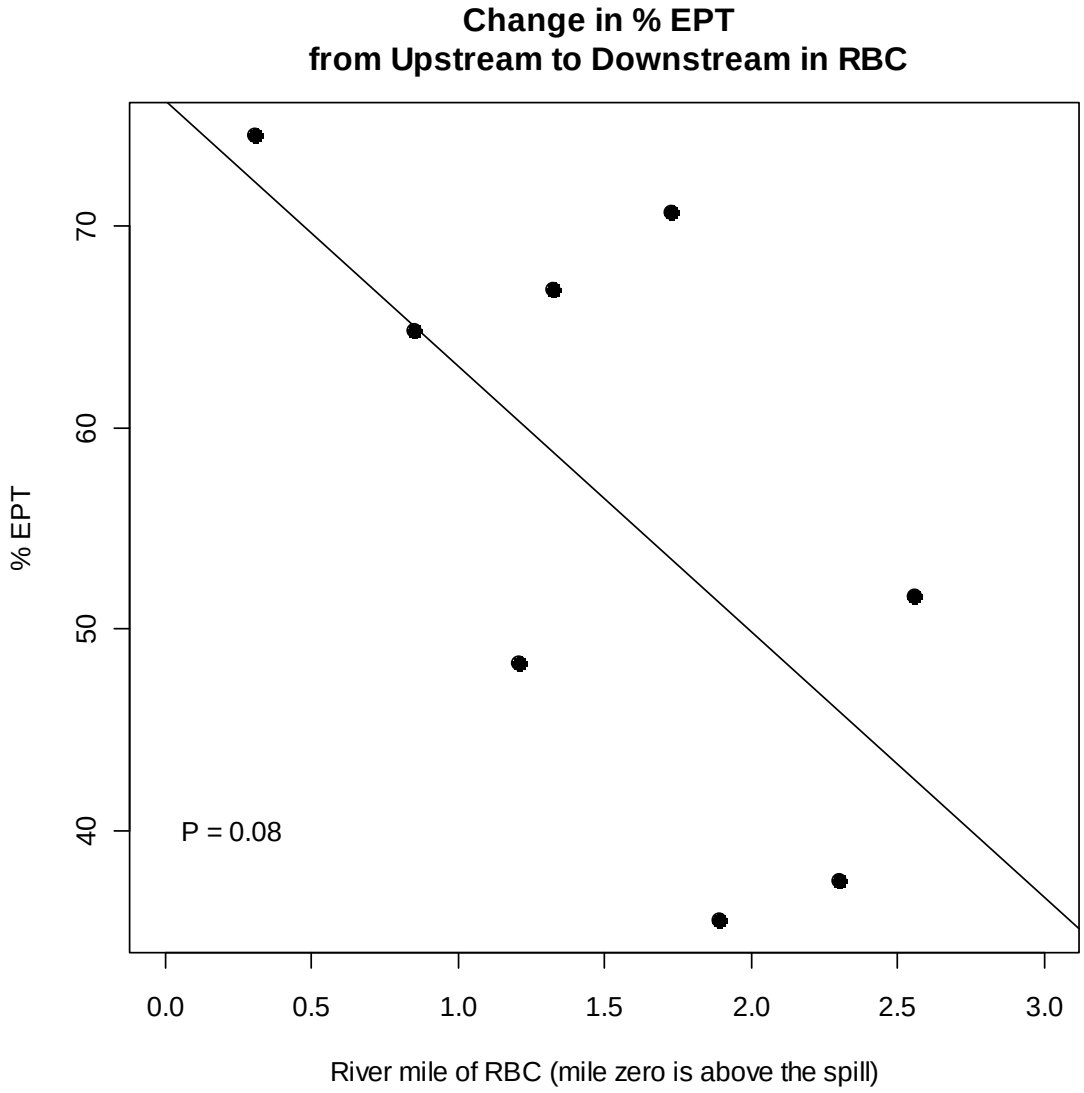
HBI as a function of horizontal distance

```
lm(formula = x$HBI ~ x$cum.mi)

Residuals:
     Min       1Q   Median       3Q      Max
-0.36637 -0.11043  0.01691  0.08020  0.38858

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)   4.2027     0.2152  19.533 1.17e-06 ***
x$cum.mi      0.1643     0.1286   1.278    0.248
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.2546 on 6 degrees of freedom
Multiple R-squared: 0.214,      Adjusted R-squared: 0.08297
F-statistic: 1.633 on 1 and 6 DF,  p-value: 0.2485
```



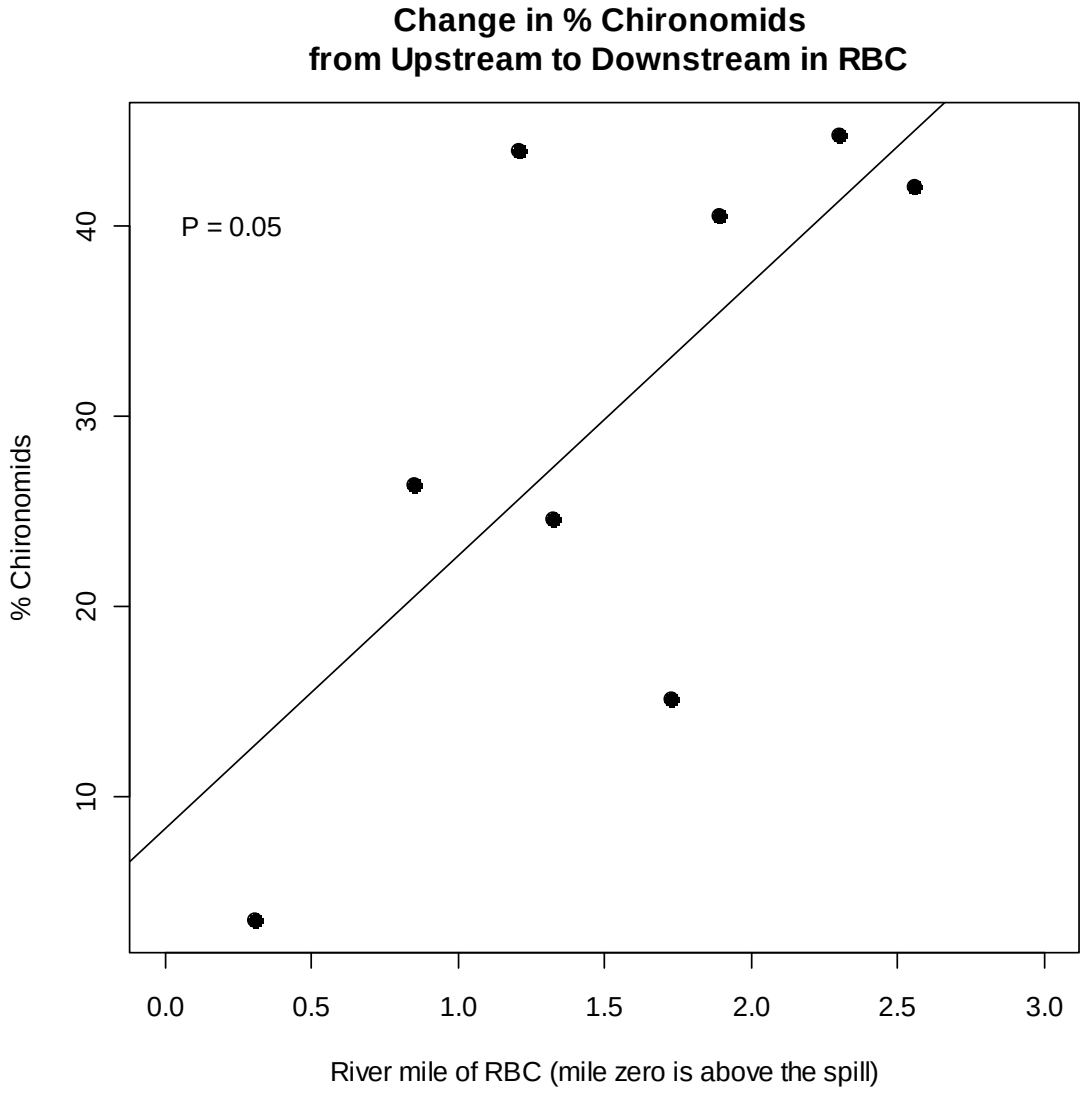
Percent EPT as a function of horizontal distance

```
lm(formula = x$per.EPT ~ x$cum.mi)

Residuals:
    Min      1Q  Median      3Q     Max
-15.820  -9.357   1.028   8.316  17.156

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)    76.24      10.43   7.313 0.000334 ***
x$cum.mi      -13.16       6.23  -2.113 0.079037 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 12.34 on 6 degrees of freedom
Multiple R-squared: 0.4267,     Adjusted R-squared: 0.3311
F-statistic: 4.465 on 1 and 6 DF,  p-value: 0.07904
```



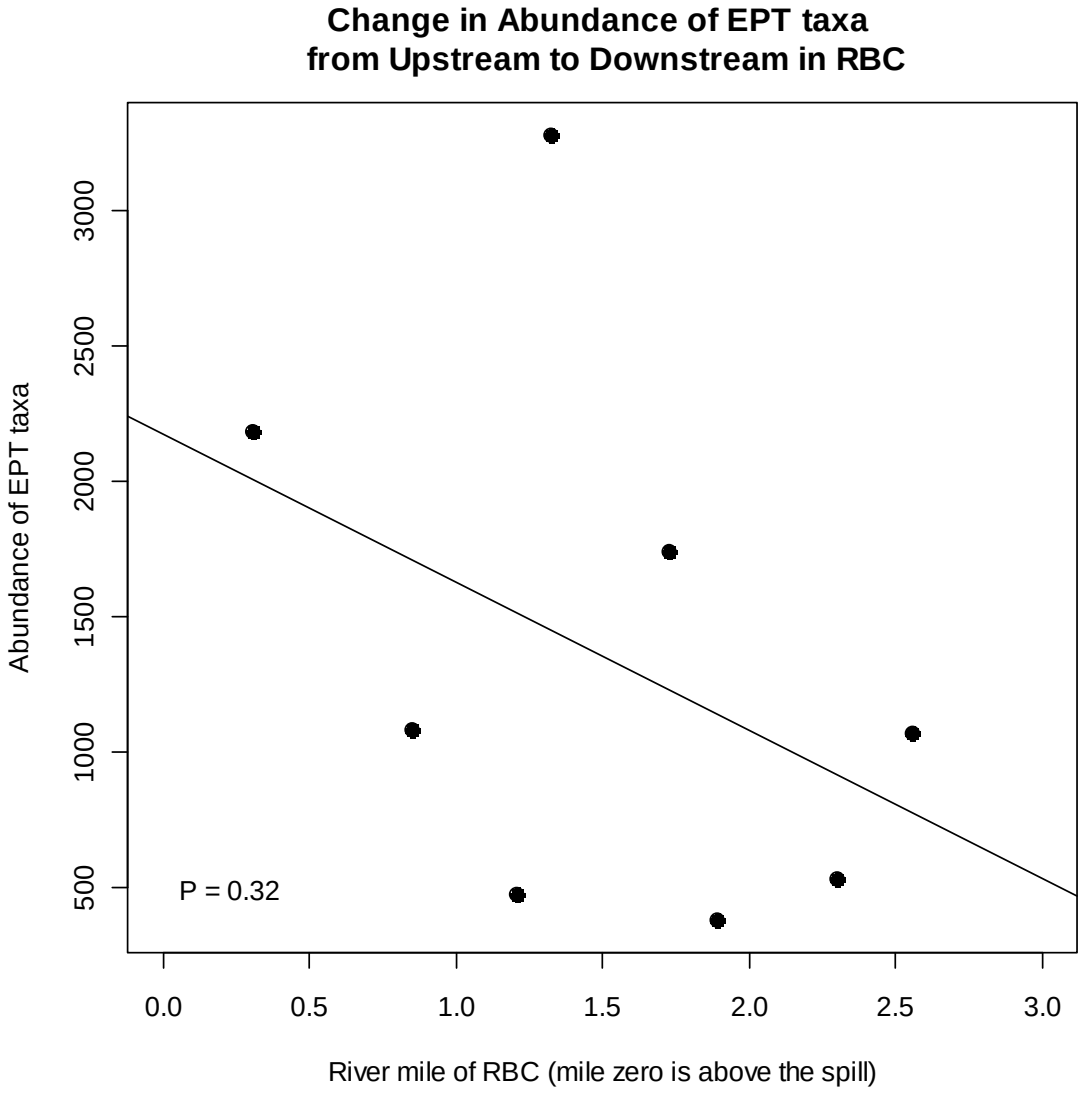
Percent Chironomids as a function of horizontal distance

```
lm(formula = x$per.chironomid ~ x$cum.mi)

Residuals:
     Min       1Q   Median       3Q      Max
-17.9455  -4.4896   0.3889   5.3142  18.2928

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)    8.273      9.942   0.832   0.4372
x$cum.mi      14.380      5.941   2.420   0.0518 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 11.77 on 6 degrees of freedom
Multiple R-squared: 0.494,      Adjusted R-squared: 0.4097
F-statistic: 5.858 on 1 and 6 DF,  p-value: 0.05184
```



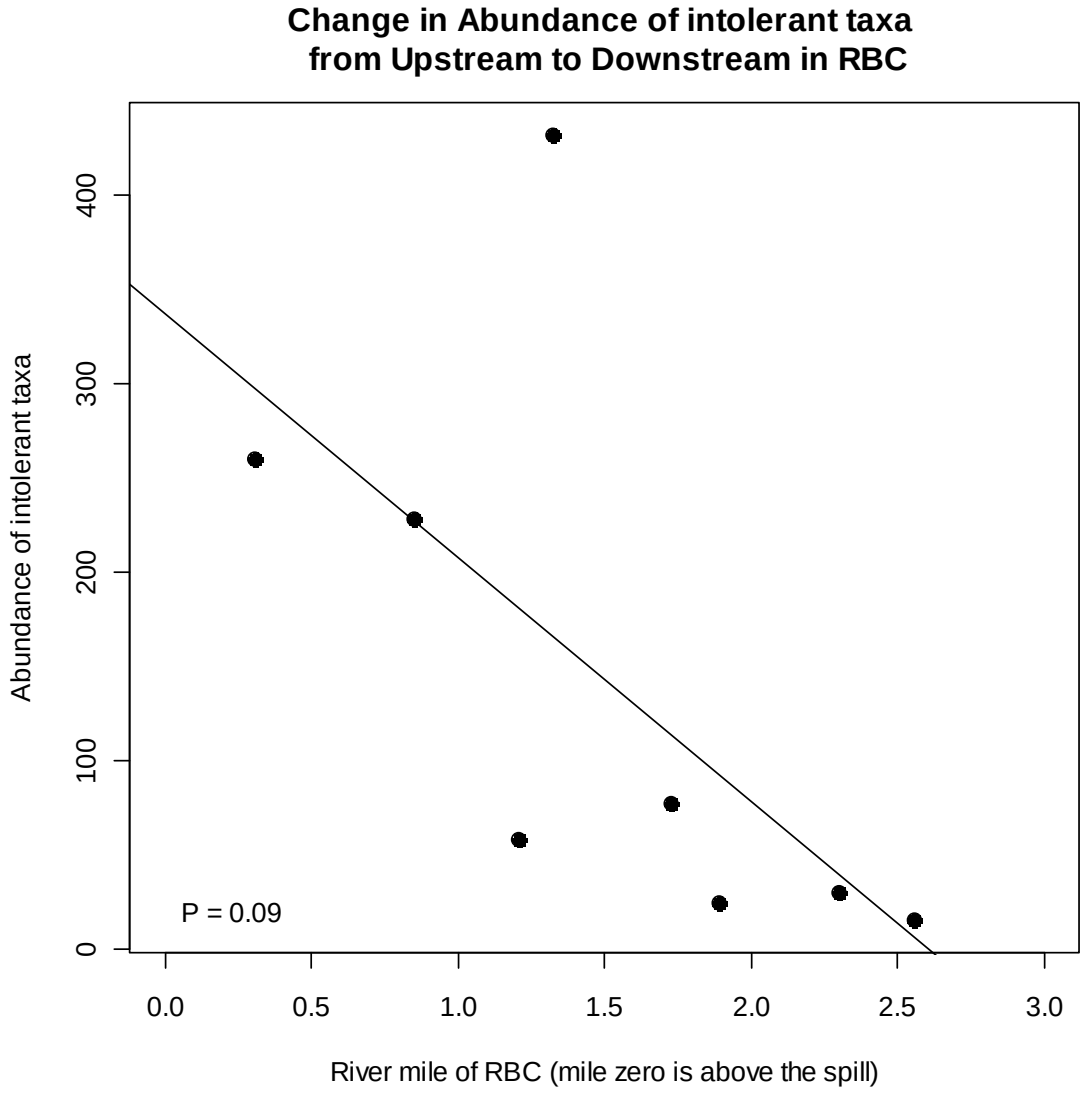
Abundance of EPT Taxa as a function of horizontal distance

```
lm(formula = x$abund.EPT.taxa ~ x$cum.mi)

Residuals:
    Min      1Q  Median      3Q     Max
-1036.2  -661.0  -105.2   347.5  1831.7

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)   2175.1      840.2   2.589   0.0413 *
x$cum.mi      -545.8      502.1  -1.087   0.3187
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 994.3 on 6 degrees of freedom
Multiple R-squared: 0.1646,     Adjusted R-squared: 0.02534
F-statistic: 1.182 on 1 and 6 DF,  p-value: 0.3187
```



Abundance of intolerant taxa as a function of horizontal distance

```
lm(formula = x$abund.intol.taxa ~ x$cum.mi)

Residuals:
     Min       1Q   Median       3Q      Max
-122.700  -45.359  -23.362    2.617  266.429

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)    337.0      105.6   3.192   0.0188 *
x$cum.mi      -129.3       63.1  -2.049   0.0863 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 125 on 6 degrees of freedom
Multiple R-squared: 0.4118,     Adjusted R-squared: 0.3137
F-statistic:   4.2 on 1 and 6 DF,  p-value: 0.08632
```

Appendix G

Data Used in Risk Assessment

(provided by McDaniel-Lambert)
[see attached CD]

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