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**Red Butte Creek
Risk Characterization Report:
Data Summary and Comparison to the 2011 Human Health
Risk Assessment (HHRA) and 2012 Screening Level
Ecological Risk Assessment (SLERA)**

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For Chevron Pipe Line Company
June 7, 2016**

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1 Purpose and Objectives

On April 18, 2016, Chevron Pipe Line (CPL) submitted the interim “Request to Suspend Red Butte Creek Sampling and Analysis” as required by NOV I10-01. Per this interim request, a request for permanent cessation of sampling and analysis is contingent upon demonstration that the current condition of Red Butte Creek (RBC) does not present an unacceptable risk to human health or ecological receptors. This Risk Characterization Report presents a qualitative characterization of current human health and ecological risks based on an evaluation and comparison of sediment and macroinvertebrate data collected from 2011-2015. If results of this Risk Characterization indicate that the existing data do not demonstrate unacceptable risks, CPL will request permanent cessation of sampling, after Utah Division of Water Quality (DWQ) has reviewed the latest reports and concurred with this conclusion.

2 Data Summary and Qualitative Risk Characterization Methodology

2.1 Sediment Data Summary

Following spill cleanup activities in RBC, CPL has conducted semi-annual creek surface water, sediment and bank soil sampling from 2011 to 2015. Sample sites in RBC along with four “background” creeks were defined in the the 2011 Human Health Risk Assessment¹ conducted by McDaniel Lambert, Inc. Background samples were taken from City Creek, Emigration Creek, Mill Creek, and Parleys Creek. RBC samples were taken downstream of the spill with the exception of the sample location defined as “Above Amphitheater”. During the October 2014 sampling event, the HHRA locations sampled were re-sampled while all other sampling events targeted a subset of those locations. **Table 1** provides a historical sampling summary by location and date.

Samples were analyzed for petroleum-associated hydrocarbons by AWAL and Lancaster Laboratories based on the 2011 CPL Sampling and Analysis Plan. In April 2016, summary sample chemical results were provided by Utah Department of Environmental Quality (Scott Daly) for 2011 and 2012 samples and by EarthFax Engineering, LLC (Galen Williams) for 2013-2015 samples in Excel spreadsheet format. All data have been submitted previously to Utah DWQ as laboratory datasets from analytical vendors.

In preparation for statistical evaluation of the sediment datasets, Integral Consulting, on behalf of CPL, reviewed the August 2011 HHRA dataset and all 2014 and 2015 datasets for completeness. In the August 2011 dataset, zero was input for non-detected chemical concentrations. Per the HHRA statistical methods, the practical quantification limit (PQL) was selected to represent non-detected chemical concentration in the statistical analyses. Similarly, the 2014 and 2015 datasets only reflected chemical concentrations for a specific sampling site and date if the chemical was detected (either the parent sample or the duplicate). If the chemical was not detected at a specific sampling location and date, that chemical was not included in the dataset. Chevron provided Integral Consulting with Electronic Data Deliverables

¹ McDaniel Lambert, Inc. Human Health Risk Assessment, Red Butte Creek, Salt Lake City, Utah. Final Draft dated November 2012, <http://www.deq.utah.gov/locations/R/redbutte/docs/2012/11Nov/Final%20HHRARedButteCreek110512.PDF>.

for 2011, 2014 and 2015 from which Integral Consulting populated the datasets to reflect all analyzed chemicals regardless of detection limits and entered the appropriate PQLs for all applicable chemicals. A comprehensive technical report detailing the data evaluation and subsequent development of the complete dataset is provided in **Appendix A**. The 2011 and 2014/15 sediment and soil datasets evaluated herein are provided in **Appendix B**.

2.2 Water Data Summary

Water samples were collected from select RBC and background locations in 2014 and 2015. **Table 2** provides a summary of samples locations by sample date. Samples were analyzed for petroleum-associated hydrocarbons by AWAL and Lancaster Laboratories. A summary of water sample hydrocarbon detections is provided in **Appendix B**.

2.3 Macroinvertebrate Data Summary

Macroinvertebrate sampling was conducted by BIO-WEST Inc. and macroinvertebrate analysis was conducted by BLM/USU National Aquatic Monitoring Center (NAMC) Department of Watershed Sciences (WATS) in accordance with the methods described in the 2012 Screening Level Ecological Risk Assessment (SLERA)² conducted by ERM. Compiled macroinvertebrate data from 2013-2015 sampling events were provided to Chevron by EarthFax Engineering, LLC in April 2016. Macroinvertebrate samples were collected in April and August from 2013-2015. Macroinvertebrate sample locations were paired with the corresponding HHRA/ERA sediment sample locations. **Table 3** provides a summary of samples locations by sample date. All data have been submitted previously to Utah DWQ.

2.4 Qualitative Human Health Risk Characterization Methodology

As stated in NOV I10-01, the 2011 HHRA concluded the following:

- RBC surface waters were below detection limits for petroleum-related hydrocarbons
- RBC sediment and bank soils had petroleum-related chemical concentrations greater than “no further action” screening levels in some locations but were lower than those concentrations that typically require remediation
- RBC sediment and bank soil hydrocarbon concentrations were statistically similar to background concentrations in Salt Lake creeks not impacted by the CPL spills.
- Human health risks in RBC were similar to those calculated for background creeks

Utah DWQ concluded that additional physical removal of sediments or soils was not warranted by the data available at that time; however, continued monitoring of the creek in April and August until 2015 was required in order to: 1) ensure that appropriate actions can be taken if any remaining spill contamination is identified in

² Screening Level Ecological Risk Assessment – Final, Chevron Pipeline June 2010 Crude Oil Spill, Lower Red Butte Creek, Salt Lake City, Utah. Date November 2012.
http://www.deq.utah.gov/locations/R/redbutte/docs/2012/11Nov/RBC_SLERAFinal110712.PDF.

areas where people can be exposed, and 2) verify the assumption that Red Butte Creek is similar to un-impacted creeks with respect to hydrocarbon contamination.

Based on the 2011 HHRA conclusions and the Utah DWQ monitoring objectives, the objectives of this risk characterization are to:

- Determine if hydrocarbons concentrations representative of current conditions in RBC are greater than those identified in 2011, and
- Determine if hydrocarbon concentrations representative of current conditions in RBC are similar to hydrocarbon concentrations representative of current conditions in background streams.

To meet these objectives, recent (2014/15) sediment and soil data from sampling locations defined in the HHRA were compiled and compared to August 2011 RBC data (presented in the 2011 HHRA) and current (2014/15) background creek data using the statistical methods outlined in the approved 2011 HHRA Final Report. Data compilation and statistical analyses were performed by experienced statisticians from Integral Consulting on behalf of CPL. A comprehensive technical report detailing data compilation, statistical methods, statistical results and interpretation of results by Integral Consulting is included in **Appendix A**.

2.5 Qualitative Ecological Risk Characterization Methodology

The 2012 SLERA reached similar conclusions as the HHRA. In summary, the SLERA concluded the following:

- RBC surface waters are not a threat to ecological receptors because hydrocarbon contaminants are consistently not detected in the water
- RBC sediment hydrocarbon concentrations did not pose a risk to benthic macroinvertebrates
- RBC and background sediment and bank soil hydrocarbon concentrations posed similar potential health risk to mammals and birds
- Macroinvertebrate community metrics in RBC were similar to background (un-impacted) creeks
- Impacts to macroinvertebrates increased with distance from the spill site and are correlated with urban sources of hydrocarbons

Utah DWQ concluded that additional physical removal of sediments or soils was not warranted by the data available at that time; however, continued monitoring of the creek in August until 2015 was required in order to evaluate potential recovery of macroinvertebrates in RBC compared to background creeks.

Based on the 2011 SLERA conclusions and the Utah DWQ macroinvertebrate monitoring objectives, the objectives of this risk characterization are to:

- Determine if macroinvertebrate community metrics downstream of the spill site are qualitatively similar to the sample location upstream of the spill site
- Determine if the distribution of macroinvertebrate community metrics from 2013-2015 in RBC are qualitatively similar to background creeks

To meet these objectives, 2013-2015 macroinvertebrate metrics were qualitatively compared within RBC based on distance from the spill location and between RBC and background creeks. Macroinvertebrate metrics of interest were defined in the 2012 SLERA as Taxa Richness, Evenness, Shannon Diversity Index, Hilsenhoff Biotic Index, Percent Chironomidae, and Percent EPT.

3 Qualitative Risk Characterization Findings

3.1 Human Health Risk Characterization

The objectives of the human health risk characterization are to:

- Determine if hydrocarbons concentrations representative of current conditions in RBC are greater than those identified in 2011, and
- Determine if hydrocarbon concentrations representative of current conditions in RBC are similar to hydrocarbon concentrations representative of current conditions in background creeks.

Using the statistical methodology used by McDaniel Lambert, Inc. in the 2011 HHRA, Integral Consulting compared current RBC sediment and bank soil data to August 2011 levels and current sediment and soil data for background creeks. **A comprehensive report of the statistical results and conclusions can be found in Appendix A.** Section 4 of Appendix A provides a summary of the conclusions of the statistical analyses.

In summary, the statistical analyses concluded that:

- Current (2014/15) hydrocarbon concentrations in RBC are statistically similar to 2011 RBC hydrocarbon concentrations (Appendix A, Section 3.1).
- Background median hydrocarbon concentrations are greater than RBC median hydrocarbon concentrations for 2014/15 (Appendix A, Table 1).
- Using the hypothesis testing methodology defined in the HHRA, current RBC hydrocarbon concentrations for all but one hydrocarbon (i.e. Indeno(1,2,3-cd)pyrene) are statistically similar to current hydrocarbon concentrations in background creeks; however, indeno(1,2,3-cd)pyrene concentrations in 2014/15 RBC samples are below the “no further action” level for human health risks. Additionally, the median and maximum background concentration for indeno(1,2,3-cd)pyrene are higher than RBC (Appendix A, Section 3.2).
- A limited number of surface water sample locations had minimal hydrocarbons detections in surface waters of background creeks (1 sample out of 50), upstream of the spill site (1 sample out of 4), and within RBC (3 samples out of 19). At RBC, 6 of 8 PAHs detected in RBC samples were detected at one site, RBC at above 1500 E, sampled in August 2015. PAHs were not detected at any other RBC locations sampled in August 2015 located between the spill site and RBC at above 1500E (Appendix A, Figure E-1 through E-18). This finding suggests the source of hydrocarbons in this sample on this date is likely downstream of the spill site (e.g., urban runoff).

To further evaluate a potential increase in risk to human health since 2011, CPL compared current RBC sediment and soil hydrocarbon concentrations to the Utah DWQ “no further action” screening levels. Consistent with the findings of the 2011 HHRA, most hydrocarbon concentrations were below the no further action levels. Four hydrocarbons (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenzo(a,h)anthracene) were above the no further action levels; however, these occurrences were observed at background creek sampling locations and within the RBC above and below the 2010 spill site. This consistent pattern of detections of these four hydrocarbons is likely a result of contamination from urban runoff which would also counteract and negate the benefits of any further sediment remediation efforts in RBC. All hydrocarbon concentrations were below expedited action levels in both background and RBC sampling locations. **Table 4** provides a summary of results that exceed the no further action levels for samples collected in 2014 and 2015 at all locations.

3.2 Ecological Risk Characterization

The objectives of the ecological risk characterization are to:

- Determine if macroinvertebrate community metrics in RBC are similar to background creeks
- Determine if macroinvertebrate community metrics downstream of the spill site are qualitatively similar to the sample location upstream of the spill site

Comparison of macroinvertebrate community metrics concluded that conditions for biota in RBC are the same or more favorable than that of background. Box-plots for each macroinvertebrate community metric are shown in **Appendix A, Figures F-1 through F-7** for each background creek in comparison to RBC. The distribution for each metric for RBC generally overlaps with the combined background distribution. Additionally, the median for RBC is slightly greater for Taxa Richness, Shannon Diversity Index, and Percent EPT, and lower for Percent Chironomidae.

For the Hilsenhoff Biotic Index, 11 of 21 (52%) sampling events in RBC yielded index values classified as *very good or excellent* water quality, 5 of 21 (24%) are classified as *good*, and the remaining 5 of 21 (24%) are classified as *fair*. This distribution matches almost exactly the classifications for the combined background creek dataset (n= 38): very good or excellent (55%), good (23%), fair (15%), and fairly poor (7%).

In the SLERA (ERM, 2012), community metrics were progressively impacted within RBC with distance from the spill site which was attributed to urban runoff sources downstream of the spill site. As requested in the NOV I10-01, all RBC sites were re-samples in August 2014. A qualitative comparison of macroinvertebrate community metrics with distance from the spill site suggests no consistent positive or negative trends with distance from the spill site (**Figures 1 through Figure 6**).

Collectively, these findings support the conclusion that the communities are similar across RBC and background creeks, which is consistent with the findings of similar water and sediment conditions across RBC and background creeks.

4 Conclusions

Based on the results presented above and in Appendix A, current concentrations of hydrocarbons in RBC are similar to those found in background creeks sampled for this report and data presented in the 2011 HHRA. Similarly, macroinvertebrate communities based on six community metrics are qualitatively similar in distribution within RBC and compared to background creeks. These results support the conclusion that current hydrocarbon conditions do not pose an unacceptable risk to human health or ecological health and are consistent to risk found in background creeks sampled in this report. The conclusions of this report are also consistent with the findings and conclusions of the 2011 HHRA and 2012 SLERA.

Tables

Table 1. Sediment sample locations from 2012-2015

Site Locations	2/2012	5/2012	4/2013	8/2013	4/2014	10/2014	4/2015	8/2015
CC Below N Canyon loop	X	X	X	X	X	X	X	X
CC Canyon Entrance Gate	X	X	X	X	X	X	X	X
CC Lower Natural Channel	X	X	X	X	X	X	X	X
CC N. Cyn Rd Footbridge						X		
EC Above 1300 E	X	X	X	X	X	X	X	X
EC Above 1900 E	X	X	X	X	X	X	X	X
EC Above 2100 E						X		
EC Donner Hill	X	X	X	X	X	X	X	X
MC Above Gage Station	X	X	X	X	X	X	X	X
MC Below 2300E	X	X	X	X	X	X	X	X
MC Below 700E	X	X	X	X	X	X	X	X
MC Below Highland Dr						X		
PC Above 2000 E						X		
PC Above I-80		X	X	X	X	X	X	X
PC Below 1300 E	X	X	X	X	X	X	X	X
PC Below 1700 E			X	X	X	X	X	X
PC Sugar House Park*		X						
RBC 1731 E 900 S						X		
RBC Above 1500 E	X	X	X	X	X	X	X	X
RBC Above Amphitheater**	X	X	X	X	X	X	X	X
RBC Above Foothills Dr	X	X	X	X	X	X	X	X
RBC Above Sunnyside						X		
RBC Below 1100 E	X	X	X	X	X	X	X	X
RBC Below 1300 E						X		
RBC Below 900 E						X		
RBC Below Chipeta Way						X		
RBC County Gage						X		
RBC Former Lower Dam						X		
RBC Mt Olivet Diversion						X		
RBC University Marriott						X		
*PC Sugar House Park not included in HHRA locations								
**RBC Above Amphitheater is located upstream of the spill								

Table 2. Water sample locations in 2014 and 2015

Sample Locations	4/22/2014	10/15/2014	4/1/2015	8/1/2015
CC Below N Canyon loop	X	X	X	X
CC Canyon Entrance Gate	X	X	X	X
CC Lower Natural Channel	X	X	X	X
CC N. Cyn Rd Footbridge		X		
EC Above 1300 E	X	X	X	X
EC Above 1900 E	X	X	X	
EC Above 2100 E		X		
EC Donner Hill	X	X	X	
Jordan River 800 S	X	X	X	X
Jordan River Above 1700 S	X	X	X	X
MC Above Gage Station	X	X	X	X
MC Below 2300E	X	X	X	X
MC Below 700E	X	X	X	X
MC Below Highland Dr		X		
PC Above 2000 E		X		
PC Above I-80	X	X	X	X
PC Below 1300 E	X	X	X	X
PC Below 1700 E	X	X	X	X
RBC 1731 E 900 S		X		
RBC Above 1500 E	X		X	X
RBC Above Amphitheater	X	X	X	X
RBC Above Foothills Drive	X	X	X	X
RBC Above Sunnyside		X		
RBC Below 1100 E	X	X	X	X
RBC Below 1300 E		X		
RBC Below 900 E		X		
RBC Below Chipeta Way		X		
RBC Former Lower Dam		X		
RBC Mt Olivet Diversion		X		
RBC University Marriott		X		

Table 3. Macroinvertebrate sample locations in 2013-2015

Sample Locations¹	4/17/2013	8/20/2013	4/21/2014	8/25/2014	4/20/2015	8/24/2015
CC Canyon Entrance Gate	X	X	X	X	X	X
CC Lower Natural Channel	X	X	X	X	X	X
CC N. Cyn Rd Footbridge				X		
EC Above 1300 East				X		
EC Above 1900 East	X	X	X	X	X	X
EC Donner Hill	X		X		X	
MC Above Gage Station	X	X	X	X	X	X
MC Below 2300E	X	X	X	X	X	X
MC Below Highland Dr				X		
PC Above I-80				X		
PC Below 1700 E				X		
RBC Above 1500 E	X		X		X	X
RBC Above Foothills Dr				X		
RBC Above Garden	X	X	X	X	X	X
RBC Above Sunnyside				X		
RBC Below 1100 E				X		
RBC Below 1300 E				X		
RBC Below Gardens	X	X	X	X	X	X
RBC Mt Olivet Diversion				X		

1. Sample locations in this table represent the closest ERA/HHRA sediment sample location to the macroinvertebrate sample location.

Table 4. Sediment sample exceedances of human health screening levels in 2014-15
(yellow = exceeds No Further Action Level; red = exceeds Expedited Action Level)

Collection Date	Site Description	Watershed	Location	Chemical	sample type	Detected	Result	Rslt Units	No Action Level (mg/kg)	Expedited Action Level (mg/kg)	Duplicate?
4/22/2014	RBC Above Amphitheater	Red Butte Creek	RBC Upstream	Benzo(a)anthracene	bank	Yes	0.295	mg/kg	0.15	15	N
4/22/2014	RBC Above 1500 E	Red Butte Creek	Red Butte Creek	Benzo(a)anthracene	bank	Yes	0.216	mg/kg	0.15	15	N
4/1/2015	PC Below 1300 E	Parleys Creek	Background	Benzo(a)anthracene	bed	Yes	0.342	mg/kg	0.15	15	N
4/22/2014	PC Above I-80	Parleys Creek	Background	Benzo(a)anthracene	bank	Yes	0.155	mg/kg	0.15	15	N
10/15/2014	MC Below Highland Dr	Mill Creek	Background	Benzo(a)anthracene	bed	Yes	0.183	mg/kg	0.15	15	N
4/22/2014	CC Lower Natural Channel	City Creek	Background	Benzo(a)anthracene	Bed	Yes	0.16	mg/kg	0.15	15	Y
10/15/2014	RBC Mt Olivet Diversion	Red Butte Creek	Red Butte Creek	Benzo(a)pyrene	bank	Yes	0.0658	mg/kg	0.015	1.5	N
10/15/2014	RBC Mt Olivet Diversion	Red Butte Creek	Red Butte Creek	Benzo(a)pyrene	bed	Yes	0.0938	mg/kg	0.015	1.5	N
10/15/2014	RBC County Gage	Red Butte Creek	Red Butte Creek	Benzo(a)pyrene	bank	Yes	0.0554	mg/kg	0.015	1.5	N
10/15/2014	RBC Below 900 E	Red Butte Creek	Red Butte Creek	Benzo(a)pyrene	bank	Yes	0.0729	mg/kg	0.015	1.5	N
4/22/2014	RBC Below 1100 E	Red Butte Creek	Red Butte Creek	Benzo(a)pyrene	bank	Yes	0.0456	mg/kg	0.015	1.5	N
10/15/2014	RBC Below 1100 E	Red Butte Creek	Red Butte Creek	Benzo(a)pyrene	bed	Yes	0.035	mg/kg	0.015	1.5	N
10/15/2014	RBC Below 1100 E	Red Butte Creek	Red Butte Creek	Benzo(a)pyrene	bank	Yes	0.0876	mg/kg	0.015	1.5	N
4/1/2015	RBC Below 1100 E	Red Butte Creek	Red Butte Creek	Benzo(a)pyrene	bank	Yes	0.0446	mg/kg	0.015	1.5	N
8/1/2015	RBC Below 1100 E	Red Butte Creek	Red Butte Creek	Benzo(a)pyrene	bank	Yes	0.0673	mg/kg	0.015	1.5	N
8/1/2015	RBC Below 1100 E	Red Butte Creek	Red Butte Creek	Benzo(a)pyrene	bed	Yes	0.1	mg/kg	0.015	1.5	N
10/15/2014	RBC Above Sunnyside	Red Butte Creek	Red Butte Creek	Benzo(a)pyrene	bank	Yes	0.102	mg/kg	0.015	1.5	Y

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10/15/2014	RBC Above Sunnyside	Red Butte Creek	Red Butte Creek	Benzo(a)pyrene	bed	Yes	0.0603	mg/kg	0.015	1.5	Y
10/15/2014	RBC Above Foothills Dr	Red Butte Creek	Red Butte Creek	Benzo(a)pyrene	bank	Yes	0.0472	mg/kg	0.015	1.5	N
8/1/2015	RBC Above Foothills Dr	Red Butte Creek	Red Butte Creek	Benzo(a)pyrene	bank	Yes	0.0475	mg/kg	0.015	1.5	N
4/22/2014	RBC Above Amphitheater	Red Butte Creek	RBC Upstream	Benzo(a)pyrene	bank	Yes	0.289	mg/kg	0.015	1.5	N
4/1/2015	RBC Above Amphitheater	Red Butte Creek	RBC Upstream	Benzo(a)pyrene	bank	Yes	0.0668	mg/kg	0.015	1.5	N
4/22/2014	RBC Above 1500 E	Red Butte Creek	Red Butte Creek	Benzo(a)pyrene	bank	Yes	0.166	mg/kg	0.015	1.5	N
10/15/2014	RBC Above 1500 E	Red Butte Creek	Red Butte Creek	Benzo(a)pyrene	bank	Yes	0.131	mg/kg	0.015	1.5	N
8/1/2015	RBC Above 1500 E	Red Butte Creek	Red Butte Creek	Benzo(a)pyrene	bank	Yes	0.0673	mg/kg	0.015	1.5	N
10/15/2014	RBC 1731 E 900 S	Red Butte Creek	Red Butte Creek	Benzo(a)pyrene	bank	Yes	0.0871	mg/kg	0.015	1.5	N
10/15/2014	PC Below 1300 E	Parleys Creek	Background	Benzo(a)pyrene	bank	Yes	0.111	mg/kg	0.015	1.5	N
4/1/2015	PC Below 1300 E	Parleys Creek	Background	Benzo(a)pyrene	bed	Yes	0.31	mg/kg	0.015	1.5	N
8/1/2015	PC Below 1300 E	Parleys Creek	Background	Benzo(a)pyrene	bank	Yes	0.0552	mg/kg	0.015	1.5	N
8/1/2015	PC Below 1300 E	Parleys Creek	Background	Benzo(a)pyrene	bed	Yes	0.1	mg/kg	0.015	1.5	N
10/15/2014	PC Above I-80	Parleys Creek	Background	Benzo(a)pyrene	Bed	Yes	0.059	mg/kg	0.015	1.5	N
10/15/2014	PC Above I-80	Parleys Creek	Background	Benzo(a)pyrene	bank	Yes	0.0702	mg/kg	0.015	1.5	N
4/1/2015	PC Above I-80	Parleys Creek	Background	Benzo(a)pyrene	Bank	Yes	0.0337	mg/kg	0.015	1.5	N
8/1/2015	PC Above I-80	Parleys Creek	Background	Benzo(a)pyrene	Bed	Yes	0.061	mg/kg	0.015	1.5	N
8/1/2015	PC Above I-80	Parleys Creek	Background	Benzo(a)pyrene	Bank	Yes	0.0806	mg/kg	0.015	1.5	N
10/15/2014	MC Below Highland Dr	Mill Creek	Background	Benzo(a)pyrene	bank	Yes	0.132	mg/kg	0.015	1.5	N
10/15/2014	MC Below Highland Dr	Mill Creek	Background	Benzo(a)pyrene	bed	Yes	0.238	mg/kg	0.015	1.5	N
4/1/2015	MC Below 700E	Mill Creek	Background	Benzo(a)pyrene	bank	Yes	0.0732	mg/kg	0.015	1.5	N
10/15/2014	MC Below 2300E	Mill Creek	Background	Benzo(a)pyrene	bed	Yes	0.0826	mg/kg	0.015	1.5	N
10/15/2014	MC Below 2300E	Mill Creek	Background	Benzo(a)pyrene	bank	Yes	0.138	mg/kg	0.015	1.5	N
4/1/2015	MC Below 2300E	Mill Creek	Background	Benzo(a)pyrene	bed	Yes	0.0318	mg/kg	0.015	1.5	N
4/1/2015	MC Below 2300E	Mill Creek	Background	Benzo(a)pyrene	bank	Yes	0.0701	mg/kg	0.015	1.5	N
8/1/2015	MC Below 2300E	Mill Creek	Background	Benzo(a)pyrene	bed	Yes	0.0603	mg/kg	0.015	1.5	N

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10/15/2014	EC Donner Hill	Emigration Creek	Background	Benzo(a)pyrene	bank	Yes	0.163	mg/kg	0.015	1.5	N
10/15/2014	EC Above 2100 E	Emigration Creek	Background	Benzo(a)pyrene	bank	Yes	0.128	mg/kg	0.015	1.5	N
4/22/2014	EC Above 1900 E	Emigration Creek	Background	Benzo(a)pyrene	bank	Yes	0.0622	mg/kg	0.015	1.5	N
10/15/2014	EC Above 1900 E	Emigration Creek	Background	Benzo(a)pyrene	bank	Yes	0.0952	mg/kg	0.015	1.5	N
4/1/2015	EC Above 1900 E	Emigration Creek	Background	Benzo(a)pyrene	bank	Yes	0.0341	mg/kg	0.015	1.5	N
8/1/2015	EC Above 1900 E	Emigration Creek	Background	Benzo(a)pyrene	bank	Yes	0.0349	mg/kg	0.015	1.5	N
8/1/2015	EC Above 1900 E	Emigration Creek	Background	Benzo(a)pyrene	bed	Yes	0.0601	mg/kg	0.015	1.5	N
10/15/2014	EC Above 1300 E	Emigration Creek	Background	Benzo(a)pyrene	bank	Yes	0.045	mg/kg	0.015	1.5	N
4/1/2015	EC Above 1300 E	Emigration Creek	Background	Benzo(a)pyrene	bank	Yes	0.0374	mg/kg	0.015	1.5	N
4/1/2015	EC Above 1300 E	Emigration Creek	Background	Benzo(a)pyrene	bed	Yes	0.0513	mg/kg	0.015	1.5	N
10/15/2014	CC N. Cyn Rd Footbridge	City Creek	Background	Benzo(a)pyrene	Bank	Yes	0.0368	mg/kg	0.015	1.5	N
10/15/2014	CC N. Cyn Rd Footbridge	City Creek	Background	Benzo(a)pyrene	Bed	Yes	0.0521	mg/kg	0.015	1.5	N
4/22/2014	CC Lower Natural Channel	City Creek	Background	Benzo(a)pyrene	Bed	Yes	0.031	mg/kg	0.015	1.5	N
4/22/2014	CC Lower Natural Channel	City Creek	Background	Benzo(a)pyrene	Bank	Yes	0.066	mg/kg	0.015	1.5	N
10/15/2014	CC Lower Natural Channel	City Creek	Background	Benzo(a)pyrene	Bank	Yes	0.0749	mg/kg	0.015	1.5	N
4/1/2015	CC Lower Natural Channel	City Creek	Background	Benzo(a)pyrene	Bank	Yes	0.0304	mg/kg	0.015	1.5	N
8/1/2015	CC Lower Natural Channel	City Creek	Background	Benzo(a)pyrene	Bank	Yes	0.0634	mg/kg	0.015	1.5	N
10/15/2014	CC Canyon Entrance Gate	City Creek	Background	Benzo(a)pyrene	Bank	Yes	0.0359	mg/kg	0.015	1.5	Y
8/1/2015	CC Canyon Entrance Gate	City Creek	Background	Benzo(a)pyrene	Bank	Yes	0.0318	mg/kg	0.015	1.5	N
10/15/2014	CC Below N Canyon loop	City Creek	Background	Benzo(a)pyrene	Bank	Yes	0.0322	mg/kg	0.015	1.5	N
4/22/2014	RBC Above Amphitheater	Red Butte Creek	RBC Upstream	Benzo(b)fluoranthene	bank	Yes	0.335	mg/kg	0.15	15	N
4/22/2014	RBC Above 1500 E	Red Butte Creek	Red Butte Creek	Benzo(b)fluoranthene	bank	Yes	0.263	mg/kg	0.15	15	N

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4/1/2015	PC Below 1300 E	Parleys Creek	Background	Benzo(b)fluoranthene	bed	Yes	0.322	mg/kg	0.15	15	N
10/15/2014	MC Below Highland Dr	Mill Creek	Background	Benzo(b)fluoranthene	bed	Yes	0.206	mg/kg	0.15	15	N
10/15/2014	MC Below 2300E	Mill Creek	Background	Benzo(b)fluoranthene	bank	Yes	0.239	mg/kg	0.15	15	N
4/1/2015	MC Below 2300E	Mill Creek	Background	Benzo(b)fluoranthene	bank	Yes	0.174	mg/kg	0.15	15	N
10/15/2014	RBC Above Sunnyside	Red Butte Creek	Red Butte Creek	Dibenz(a,h)anthracene	bank	Yes	0.039	mg/kg	0.015	1.5	Y
4/1/2015	RBC Above Amphitheater	Red Butte Creek	RBC Upstream	Dibenz(a,h)anthracene	bank	Yes	0.0539	mg/kg	0.015	1.5	N
8/1/2015	PC Above I-80	Parleys Creek	Background	Dibenz(a,h)anthracene	Bed	Yes	0.0324	mg/kg	0.015	1.5	N
4/22/2014	CC Lower Natural Channel	City Creek	Background	Dibenz(a,h)anthracene	Bank	Yes	0.016	mg/kg	0.015	1.5	N

Figures

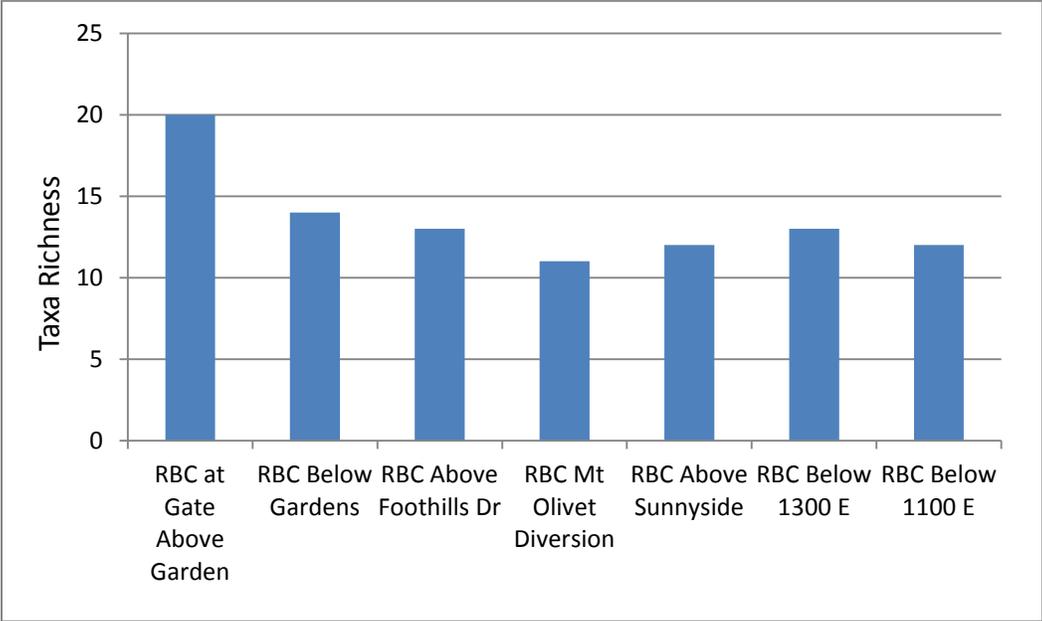


Figure 1. Taxa Richness at RBC sites based on August 2014 macroinvertebrate samples. Sample sites are ordered from upstream to downstream. Spill site located between RBC Above Garden and RBC Below Garden.

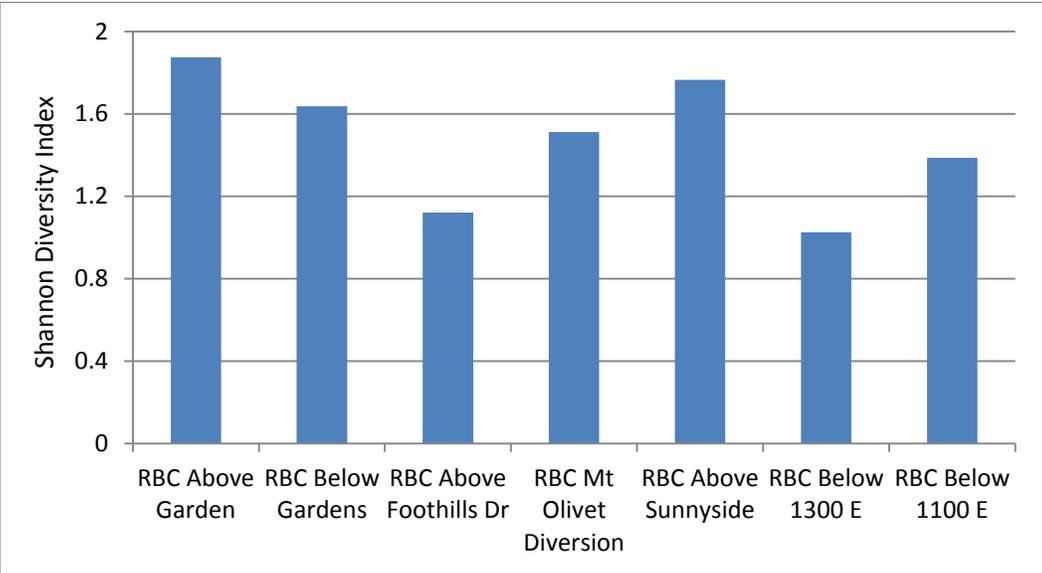


Figure 2. Shannon Diversity Index at RBC sites based on August 2014 macroinvertebrate samples. Sample sites are ordered from upstream to downstream. Spill site located between RBC Above Garden and RBC Below Garden.

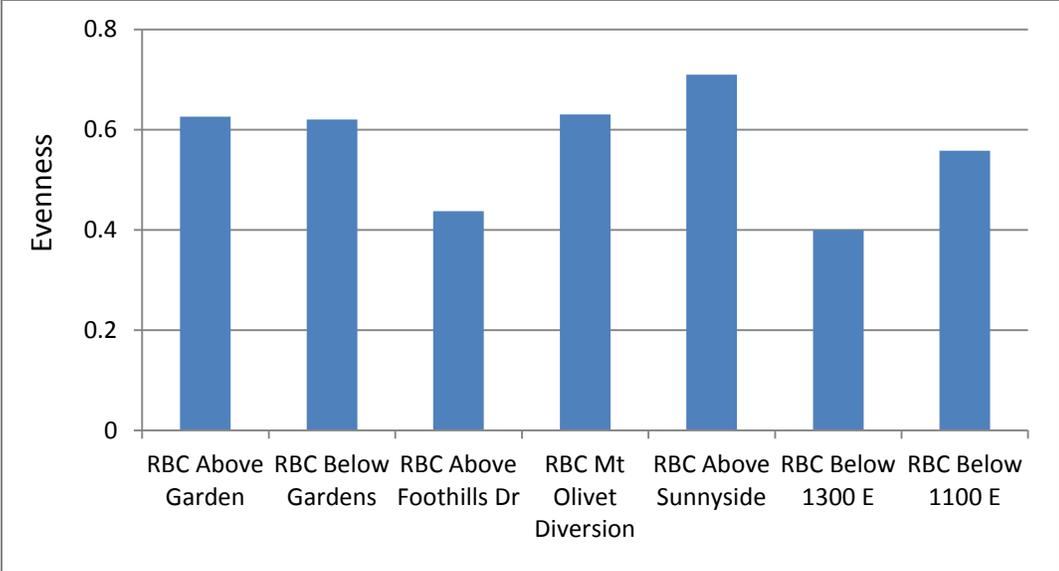


Figure 3. Evenness at RBC sites based on August 2014 macroinvertebrate samples. Sample sites are ordered from upstream to downstream. Spill site located between RBC Above Garden and RBC Below Garden.

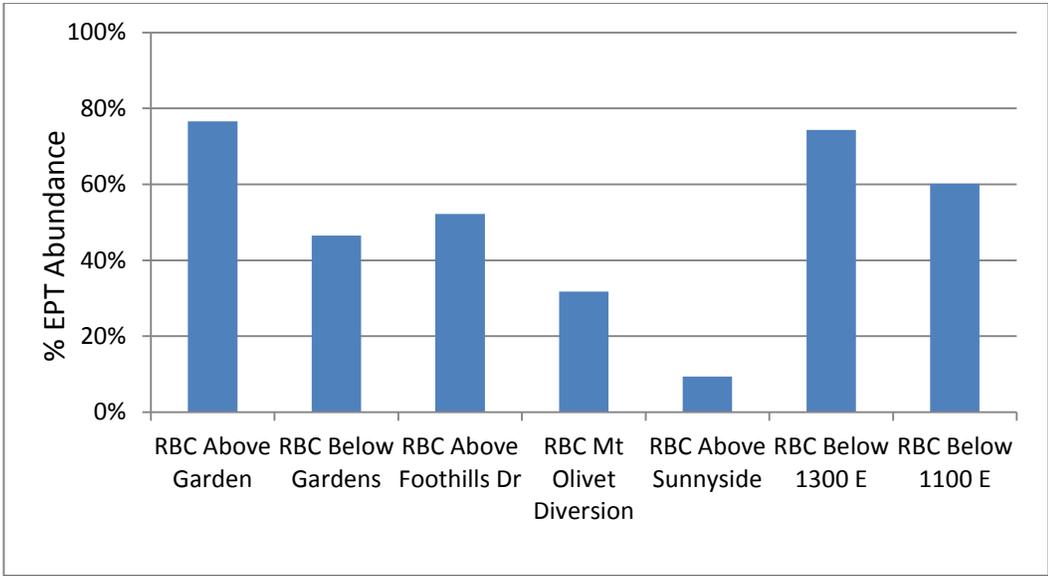


Figure 4. Percent EPT Abundance at RBC sites based on August 2014 macroinvertebrate samples. Sample sites are ordered from upstream to downstream. Spill site located between RBC Above Garden and RBC Below Garden.

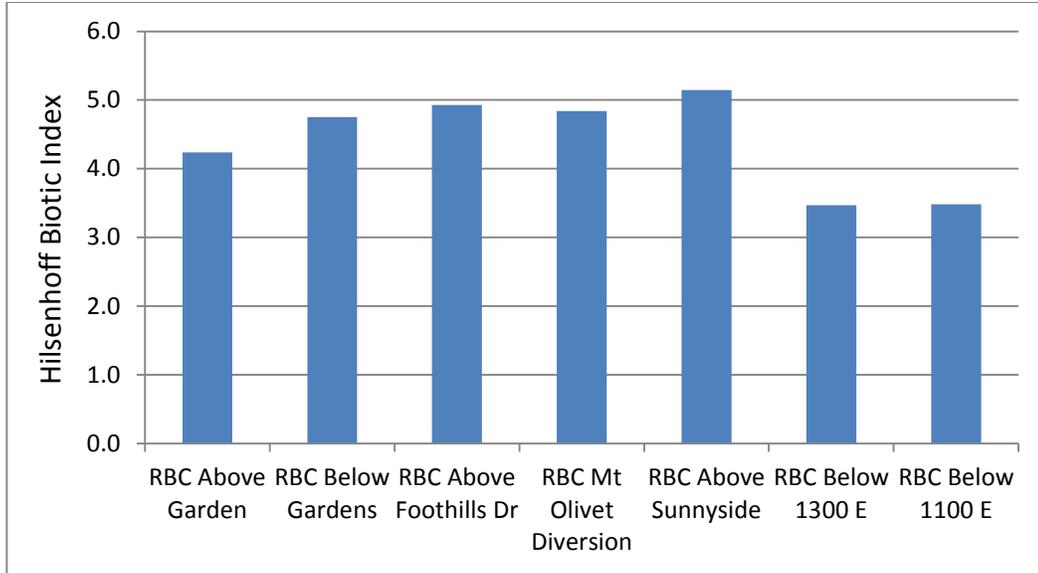


Figure 5. Hilsenhoff Biotic Index at RBC sites based on August 2014 macroinvertebrate samples. Sample sites are ordered from upstream to downstream. Spill site located between RBC Above Garden and RBC Below Garden.

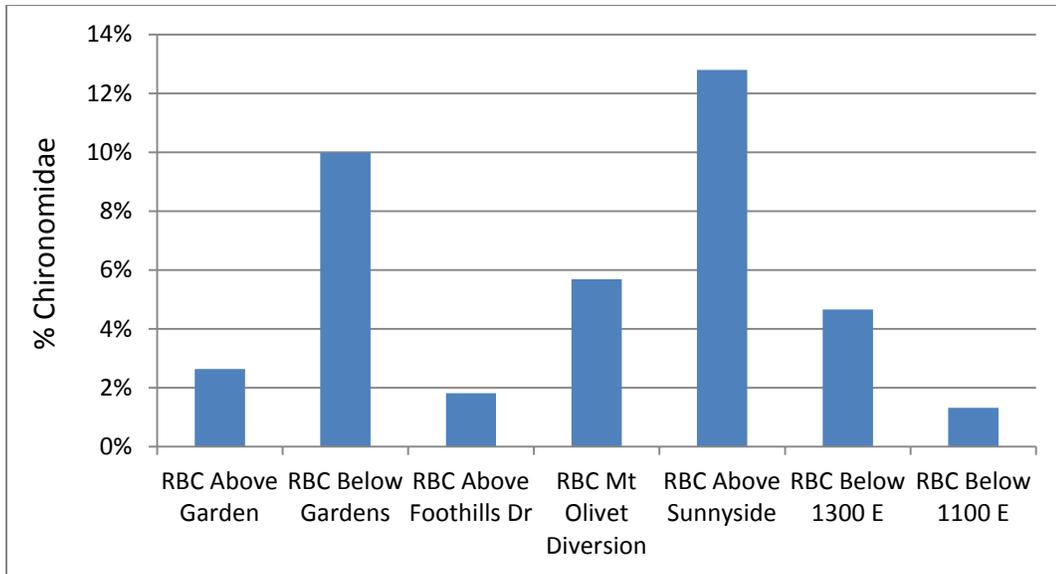


Figure 6. Percent chironomidae at RBC sites based on August 2014 macroinvertebrate samples. Sample sites are ordered from upstream to downstream. Spill site located between RBC Above Garden and RBC Below Garden.

**appendix a: Report for Red Butte Creek Human Health Risk
Characterization: PAHs in Sediment/Soil and Water and
Macroinvertebrate Metrics, 2014 and 2015**