2019 ANNUAL REPORT

Submit the completed document and any additional information identified to the Division by March 31, 2020.

GENERAL INFORMATION

Company Name	Canyon Fuel Company, LLC	Mine Name	Skyline Mine
Permit Number	C/007/0005	Permit Expiration Date	April 30, 2022
Operator Name	Gregg A. Galecki	Phone Number	+1 (435) 448-2636
Mailing Address	HC 35 Box 380	Email	ggalecki@wolverinefuels.com
City	Helper		
State	UT	Zip Code	84526

		DOGM File Location or Annual Report Location
Excess Spoil Piles	☐ Required ☒ Not Required	
Refuse Piles	☒ Required ☐ Not Required	Quarterly Certified Refuse Pile Inspection reports were submitted electronically to the Division on 4/12/19, 7/30/19, 10/24/19, and 3/3/20 for the 1st through 4th quarters, respectively.
Impoundments	☒ Required ☐ Not Required	Quarterly Certified Pond Inspection reports were submitted electronically to the Division on 4/12/19, 7/30/19, 10/24/19, and 3/3/20 for the 1st through 4th quarters, respectively.
Other:		

OPERATOR COMMENTS

REVIEWER COMMENTS ☐ Met Requirements ☐ Did Not Meet Requirements

COMMITMENTS AND CONDITIONS

The Permittee is responsible for ensuring annual technical commitments in the Mining and Reclamation Plan and conditions accepted with the permit are completed throughout the year. The Division has identified these commitments below and has provided space for you to report what you have done during the past year for each commitment. If additional written response is required, it should be filed as an attachment to this report.

Title: WASTE ROCK SAMPLING

Objective: To document chemical characteristics and support reclamation plan using less than four feet of cover and to protect surface and groundwater.
Frequency: During periods of deposition at the waste rock site.
Status: Quarterly sampling, one sample per 2000 tons hauled to the disposal site.
Reports: Annual report
Citation: Chapter 4, Section 4.4, page 4-30 and 1988 Soils Guidelines Table 6

OPERATOR COMMENTS

Lab Analysis report S2002097 for the two (2) samples collected (WRS2019-1 and WRS2019-2) during 2019 are attached to this report.

REVIEWER COMMENTS ☐ Met Requirements ☐ Did Not Meet Requirements

Title: RAPTOR SURVEYS

Objective: To monitor known nest locations and identify new raptor nests that could be impacted from subsidence or new surface facilities. Damaged nests will be replaced immediately with an artificial structure in consultation with DWR.
Frequency: Annually and according to the Division's Raptor Survey Guidelines
Status: Ongoing
Reports: As Available
Citation: Chapter 4, Section 4.18, page 4-103

OPERATOR COMMENTS

The 2019 Northern Goshawk, other Raptors, and General Wildlife surveys for subsidence titled, "2019AreaofPotentialSubsidenceWildlife.pdf" is attached to this report.

REVIEWER COMMENTS ☐ Met Requirements ☐ Did Not Meet Requirements

Title: MACROINVERTEBRATE SURVEYS
Objective: To determine if mining and mining related activities are impacting Eccles Creek.
Frequency: Conduct studies in the fall for two consecutive years then two years off.
Status: Surveys due 2019/2020
Reports: Annual
Citation: Appendix A-3, Volume 2, Volume 1A, Section 2.8, pages 2-70-2-71C Section 2.8, Table 2.8-1a

OPERATOR COMMENTS

Macroinvertebrate studies were conducted in 2019. The report titled, "Fish and Macroinvertebrate Assessment on Eccles and Boulger Creeks, 2019" is attached to this report.

REVIEWER COMMENTS ☐ Met Requirements ☐ Did Not Meet Requirements

Title: FISH SURVEY
Objective: To determine if mining and mining related activities are impacting fish in Eccles Creek.
Frequency: In the fall every three years.
Status: Survey due 2019
Reports: Every three years
Citation: MRP, Volume 1A, Section 2.8, page 2-71d

OPERATOR COMMENTS

Fish studies were conducted in 2019. The report titled, "Fish and Macroinvertebrate Assessment on Eccles and Boulger Creeks, 2019" is attached to this report.

REVIEWER COMMENTS ☐ Met Requirements ☐ Did Not Meet Requirements

Title: SUBSIDENCE MONITORING
Objective: To document the amount of subsidence that has occurred.
Frequency: Annually
Status: Ongoing
Reports: Annual Update of Drawing 4.17.3-1 and digitized area survey information and results of on the ground visual inspection.
Citation: Chapter 4, page 4-97 thru 4-99a

OPERATOR COMMENTS

The Cumulative Subsidence 1982 - 2019 map is attached. Note that since aerial flights are conducted in the summer not all of the 2019 potential subsidence is documented. Visual ground inspections of the 2019 full extraction mining areas was done in September-October in conjunction with water monitoring and seismic station maintenance. No hazardous conditions were observed during the inspections.

REVIEWER COMMENTS ☐ Met Requirements ☐ Did Not Meet Requirements

Title: SUBSOIL SAMPLING AT WASTE ROCK SITE

Objective: To provide chemical characteristics of purchased subsoil.
Frequency: Once. Sample purchased subsoil for parameters in Table 1 of the Utah 1988 Guidelines.
Status: Ongoing with contemporaneous reclamation at the waste rock site.
Reports: None specified. Suggest verbal communication with Division and lab analysis to be included in bond release application.
Citation: Volume 3, Section 4.6.4.1, page 4-38a and page 4-38b

OPERATOR COMMENTS

No contemporaneous reclamation was conducted at the Waste Rock site in 2019 and no subsoil was purchased.

REVIEWER COMMENTS ☐ Met Requirements ☐ Did Not Meet Requirements

Title: AGE-MONITORING OF WATER

Objective: To understand the possible sources of groundwater inflows.
Frequency: When inflows of 800 gpm are encountered.
Status: No significant inflows in the North Lease.
Reports: Immediately notify Division
Citation: Volume 1, page 2-35b

OPERATOR COMMENTS

REVIEWER COMMENTS ☐ Met Requirements ☐ Did Not Meet Requirements

Title: SAMPLING PRIOR TO SLURRY PLACEMENT IN ABANDONED UNDERGROUND WORKINGS

Objective: Protection of groundwater
Frequency: Every 450 feet of advance
Status: Report if placed slurry in abandoned underground workings.
Reports: Notification if parameters are out of compliance with Guidelines for Topsoil and Overburden.
Citation: Volume 2, Incorporation of 97K-1 and Section 1.2 (at the end of section 3.2)

OPERATOR COMMENTS

No slurry was placed in abandoned underground workings in 2018.

REVIEWER COMMENTS ☐ Met Requirements ☐ Did Not Meet Requirements

Title: SAMPLING OF WASTE ROCK IN TEMPORARY STOCKPILES

Objective: Protection of surface and groundwater
Frequency: one sample per 2000 tons of temporary stockpiled material if remains in temporary location longer than three months.
Status: Ongoing
Reports: Not specified. Assumed to be the same as disposal site sampling (previous paragraph on same page.)
Citation: Volume 3, page 4-30 and 1988 Soils Guidelines, Table 6

OPERATOR COMMENTS

No waste rock was stored in excess of three months in a temporary location. No samples were collected.

REVIEWER COMMENTS ☐ Met Requirements ☐ Did Not Meet Requirements

FUTURE COMMITMENTS AND CONDITIONS

The following commitments are not required for the current annual report year, but will be required by the permittee in the future as indicated by the "status" field. These commitments are included for information only, and do not currently require action. If you feel that the commitment is no longer relevant or needs to be revised, please contact the Division.

Title: TOPSOIL SAMPLING

Objective: To determine fertilizer application rate.
Frequency: At final reclamation sample redistributed topsoil for N, P, K, Fe, Mg, Mn, Zn, Ca and pH.
Status: At final reclamation
Reports: None specified. Suggest verbal communication with Division and lab analyses to be included in bond release application.
Citation: Section 4.5, page 4-32

Title: MONITORING OF REFERENCE AREAS

Objective: Determine condition class of reference site to ensure the site is still appropriate for "reference"
Frequency: During last 2 years of mining leading up to reclamation
Status: Ongoing
Reports: Submit evaluation of all reference areas with determination of condition class as established by the NRCS.
Citation: Chapter 4, Page 4-47

REPORTING OF OTHER TECHNICAL DATA

Please list other technical data or information that was not included in the form above, but is required under the approved plan, which must be periodically submitted to the Division.

Please list attachments:

Lab Analysis report S2002097; "Fish and Macroinvertebrate Assessment on Eccles and Boulger Creeks, 2019";

REVIEWER COMMENTS ☐ Met Requirements ☐ Did Not Meet Requirements

MAPS

Copies of mine maps, current and up-to-date, are to be provided to the Division as an attachment to this report in accordance with the requirements of R645-301-525.240. The map copies shall be made in accordance with 30 CFR 75.1200 as required by MSHA. Mine maps are not considered confidential.

Map Name	Map Number	Included		Confidential	
		Yes	No	Yes	No
Cumulative Subsidence 1982 - 2019		☐	☐	☐	☒
As-Mined Map		☐	☐	☐	☒
5-year Plan		☐	☐	☒	☐
		☐	☐	☐	☐
		☐	☐	☐	☐

REVIEWER COMMENTS ☐ Met Requirements ☐ Did Not Meet Requirements

Pace Analytical® Formerly Inter-Mountain Laboratories
1673 Terra Avenue Sheridan, WY 82801 ph: (307) 672-8945

Date: 3/25/2020

CLIENT: Canyon Fuel Company
Project: Skyline Mine Utah Table 3
Lab Order: S2002097

CASE NARRATIVE

Report ID: S2002097001

Samples WRS2019-1 and WRS2019-2 were received on February 11, 2020.

Samples were analyzed using the methods outlined in the following references:

U.S.E.P.A. 600/2-78-054 "Field and Laboratory Methods Applicable to Overburden and Mining Soils", 1978
American Society of Agronomy, Number 9, Part 2, 1982
USDA Handbook 60 "Diagnosis and Improvement of Saline and Alkali Soils", 1969
Wyoming Department of Environmental Quality, Land Quality Division, Guideline No. 1, 1984
New Mexico Overburden and Soils Inventory and Handling Guideline, March 1987
State of Utah, Division of Oil, Gas, and Mining: Guidelines for Management of Topsoil and Overburden for Underground and Surface Coal Mining, April 1988
Montana Department of State Lands, Reclamation Division: Soil, Overburden, and Regraded Spoil Guidelines, December 1994
State of Nevada Modified Sobek Procedure
Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW846, 3rd Edition

All Quality Control parameters met the acceptance criteria defined by EPA and Pace Analytical (Formerly Inter-Mountain Laboratories) except as indicated in this case narrative.

Reviewed by: Karen A Secor
Karen Secor, Soil Lab Supervisor

Pace Analytical®
Formerly Inter-Mountain Laboratories
1673 Terra Avenue Sheridan, WY 82801 ph: (307) 672-8945

Soil Analysis Report

Canyon Fuel Company
HC 35 Box 380
Helper, UT 84526

Report ID: S2002097001

Project: Skyline Mine Utah Table 3
Date Received: 2/11/2020

Date Reported: 3/25/2020
Work Order: S2002097

Lab ID	Sample ID	pH	Saturation	Electrical Conductivity	Organic Matter LOI	CaCO3	Calcium PE	Magnesium PE	Potassium PE	Sodium PE	SAR
		s.u.	%	dS/m	%	%	meq/L	meq/L	meq/L	meq/L	
S2002097-001	WRS2019-1	7.7	34.2	1.74	27.5	5.7	9.30	3.39	0.35	1.02	0.41
S2002097-002	WRS2019-2	9.2	38.5	1.45	60.6	7.0	11.5	3.11	0.26	1.04	0.38

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential
Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage, TOC=Total Organic Carbon

Reviewed by: Karen A Secor
Karen Secor, Soil Lab Supervisor

Pace Analytical®
Formerly Inter-Mountain Laboratories
1673 Terra Avenue Sheridan, WY 82801 ph: (307) 672-8945

Soil Analysis Report

Canyon Fuel Company
HC 35 Box 380
Helper, UT 84526

Report ID: S2002097001

Project: Skyline Mine Utah Table 3
Date Received: 2/11/2020

Date Reported: 3/25/2020
Work Order: S2002097

Lab ID	Sample ID	Sand %	Silt %	Clay %	Texture	Very Fine Sand %	Phosphorus ppm	Nitrate(as N) ppm	Available Potassium meq/100g
S2002097-001	WRS2019-1	71.3	18.8	10.0	Sandy Loam	3.2	15	7.3	0.23
S2002097-002	WRS2019-2	77.5	17.5	5.0	Loamy Sand	10.2	6	<0.1	0.11

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential
Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage, TOC=Total Organic Carbon

Reviewed by: Karen A Secor
Karen Secor, Soil Lab Supervisor

Canyon Fuel Company, LLC
A Subsidiary of Wolverine Fuels, LLC

Skyline Mine
Gregg A. Galecki, Sr. Environmental Engineer
HC35, Box 380
Helper, Utah 84526
(435) 448-2636
Fax (435) 448-2632

February 7, 2020

Ms. Karen Secor
Inter-Mountain Laboratories, Inc.
1633 Terra Avenue
Sheridan, Wyoming 82801

RE: Two (2) Sample for Analysis According to the Parameters Listed in Table 3 of the Utah Division of Oil, Gas and Mining 2008 Guidelines for Topsoil and Overburden

Dear Ms. Secor:

Please find enclosed in one (1) box a total of two (2) sample (WRS2019-1 and WRS2019-2) for analysis in accordance with the parameters listed in Table 3 of the Utah Division of Oil, Gas and Mining 2008 Guidelines for Topsoil and Overburden. Let me know if you need a copy of Table 3.

I'll forward a purchase order number ASAP.

If you have any questions regarding these samples, please give me a call at (435) 448-2636.

Sincerely,

Gregg A. Galecki

Gregg A. Galecki
Sr. Environmental Engineer – Skyline Mines
Canyon Fuel Company, LLC.
(435) 448-2636
ggalecki@wolverinefuels.com

Rec'd 2/11/20
Karen Secor
S2002097

2019 Wildlife Survey Report

Areas of Potential Subsidence,

Northern Goshawk, other Raptors, and
General Wildlife Surveys

Prepared for:

Skyline Mine
Gregg Galecki
Sr. Environmental Engineer
Wolverine Fuel Company, LLC

Prepared By:
Alpine Ecological
HC 80 Box 570
Greenwich, UT 84732

08.04.2019

1.0 Introduction

The following narrative is submitted pursuant to requirements regulating potential impacts to threatened, endangered, candidate and sensitive species and their associated habitats. This report details the results of the northern goshawk (*Accipiter gentilis*), American three-toed woodpecker (*Picoides dorsalis*), general raptor, and general wildlife surveys conducted for the 2019 Areas of Potential Subsidence. Areas of potential subsidence included the surface above panels which are scheduled to be mined in 2019, 2020, and 2021. No other special status species were identified to have suitable habitat within these project areas. The areas surveyed are displayed on the attached maps.

Pre-field research was completed by Alpine wildlife biologists who utilized GIS data from the Utah Division of Wildlife Resources' (UDWR) Utah Threatened, Endangered, and Sensitive Species Occurrences shapefiles and mapping services and the US Fish and Wildlife Services' Information, Planning and Consultation System (IPaC). Research included species occurrences, historic records, species ecology, life histories, known distributions, and habitat requirements. Coordination with UDOGM and Forest Service Wildlife Biologists was conducted prior to survey initiation. Survey requirements were discussed and are in accordance with the Northern Goshawk Technical Guide. American three-toed woodpecker surveys were conducted using the same methodology as the Forest Service; conducted along northern goshawk transects in suitable habitat. Northern goshawk protocol surveys, nesting raptor surveys, American three-toed woodpecker, and general wildlife surveys have been conducted in or near the project area by both professional and federal biologists over the past several years.

There are no threatened, endangered, or candidate species known to occur within the project areas. State or Federally listed sensitive species which were identified as species of concern included raptors, with emphasis on northern goshawk, golden eagle, and American three-toed woodpecker. The remaining special status species were dismissed from further consideration, as a result of the multiple agency review, as there is no suitable habitat or the project is outside of the species known distribution.

2.0 Project Description

The 2019 wildlife survey area included the surface areas above the mine panels scheduled to be mined in 2019, 2020, and 2021. Northern goshawk protocol surveys, general raptor surveys, American three-toed woodpecker, and general wildlife surveys were conducted in and around the areas as displayed on the attached map.

3.0 General Habitat Overview

The vegetation across the survey area is very diverse and yet somewhat consistent throughout the survey area. Vegetation is dependent on elevation, slope, and available water resources. Riparian areas are dominated by typical high elevation riparian species. The bottoms of the valleys that are drier are dominated by mountain big sagebrush and silver sagebrush communities. South and East facing slopes, at higher elevations are dominated by quaking aspen communities. However, there are some areas that are open on South and East facing slopes. These open areas are typically grass and tall forb communities. However, a significant number of the open areas are dominated by false

hellebore. The North and West facing slopes are dominated by conifer communities. The tree species within the conifer community are mostly dead or dying, and most areas have an abundance of deadfall due to beetle infestations. Because of the deadfall and dead trees the forbs and grasses within the conifer communities are very diverse and most areas have a solid understory. The tops of the ridges in the survey area vary with some being dominated by shrub communities such as mountain big sagebrush, elderberry or chokecherry while others are dominated by grass and tall forb communities. Some of the ridge tops are dominated by cluster tarweed.

4.0 Methodology

Northern Goshawk broadcast acoustical surveys were conducted following U.S. Department of Agriculture (USDA) Forest Service, 2006, Northern Goshawk Inventory and Monitoring Technical Guide pp.3.13-15. Using GIS, survey transects were established 250 meters apart throughout the survey area which extended 0.5 miles beyond the project footprint. Broadcast calling stations were then established every 200 meters along each transect. Calling stations were then overlaid on aerial imagery in a GIS and call stations not located in suitable habitat were removed from the survey. Upon arrival at each broadcast calling station, the surveyor looked and listened before broadcasting the pre-recorded alarm calls. Utilizing FoxPro game calls, pre-recorded northern goshawk alarm calls were broadcast for approximately 10 seconds followed by 30 seconds of looking and listening. After turning 120 degrees the sequence was then repeated. Once the sequence of 10 seconds of calling and 30 seconds of looking and listening was completed 3 times and no response was elicited the surveyor then repeated the sequence before moving to the next calling station. Surveys were timed in accordance to the survey requirements outlined in the 2006 Technical Guide and were based on local knowledge of nesting chronologies in the area and coordination with the US Forest Service. Additionally, surveyors searched for foraging raptors between calling stations when vantage points were available.

American three-toed woodpecker surveys are conducted simultaneously with the northern goshawk survey. Biologists listened for drumming activity while at the call stations and inventoried for three-toed woodpeckers in suitable habitat while walking linear transects between call stations. This methodology is also commonly used by the USFS.

General wildlife surveys include the identification of general terrestrial wildlife species and were conducted along transects between call stations. The results of the general survey are listed at the beginning of Section 5.

5.0 Survey Results

Species observed during the course of the inventories included, but are not limited to, red-tailed hawk (*Buteo jamaicensis*) (REHA), common raven (*Corvus corax*) (CORA), dark-eyed junco (*Junco hyemalis*), black-capped chickadee (*Poecile atricapillus*), Stellar's jay (*Cyanocitta stelleri*), red-naped sapsucker (*Sphyrapicus nuchalis*), Clark's nutcracker (*Nucifraga columbiana*), American robin (*Turdus migratorius*), mountain chickadee (*Poecile gambeli*), ruby-crowned kinglet (*Regulus calendula),* white-crowned sparrow (*Zonotrichia leucophrys),* western tanager (*Piranga ludoviciana)*, tree swallow

(*Tachycineta bicolor)*, Townsend's solitaire (*Myadestes townsendi),* and MacGillivray's warbler (*Geothlypis tolmiei*).

Information such as species, call station observed, and type of observation (e.g., aural (A) or visual (V)) were documented for species of concern; other species listed were observed and listed herein for reference only.

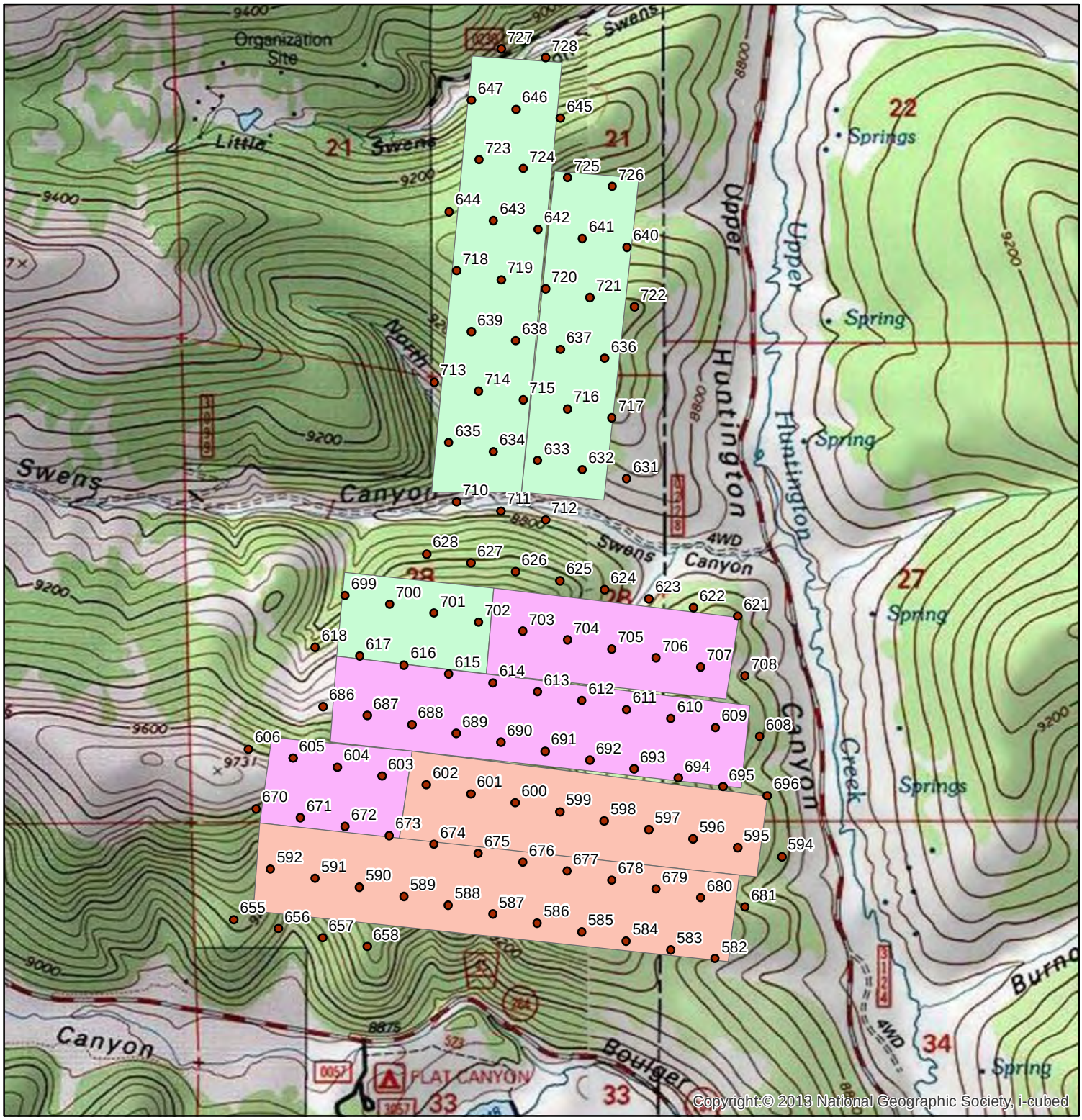
Table 1 summarizes the results of the survey by call station, raptor species, and type of observation. Only key observations are summarized. Common raven (CORA) observations are not listed in Table 1.

Station#	Call Station	Aural	Visual	Species	Notes
6/27/19	633		X	REHA	REHA across canyon
6/28/19	597	X		REHA	REHA vocalization can't see through the trees. Only called once.
6/28/19	587	X	X	REHA	REHA flying south, perched 25 meters away
7/8/19	678		X	GOEA	GOEA soaring
7/8/19	630		X	REHA	REHA soaring

Northern Goshawk was not documented during the course of either inventory. Red-tailed hawks were documented on three separate occasions. One of the observations noted the individual perching for a short time in a tree then leaving, not responding to the call. One Golden Eagle was documents soaring over the project area to the east towards Huntington Creek. The individual did not respond to the call.

There were no American three-toed woodpeckers observed during either survey. There were no other special status species observed during either survey.

The drilling areas are classified by the Utah Division of Wildlife Resources as crucial elk calving and mule deer fawning areas. No elk calves or mule deer fawns were observed during the course of the inventory.



2019 Call Stations

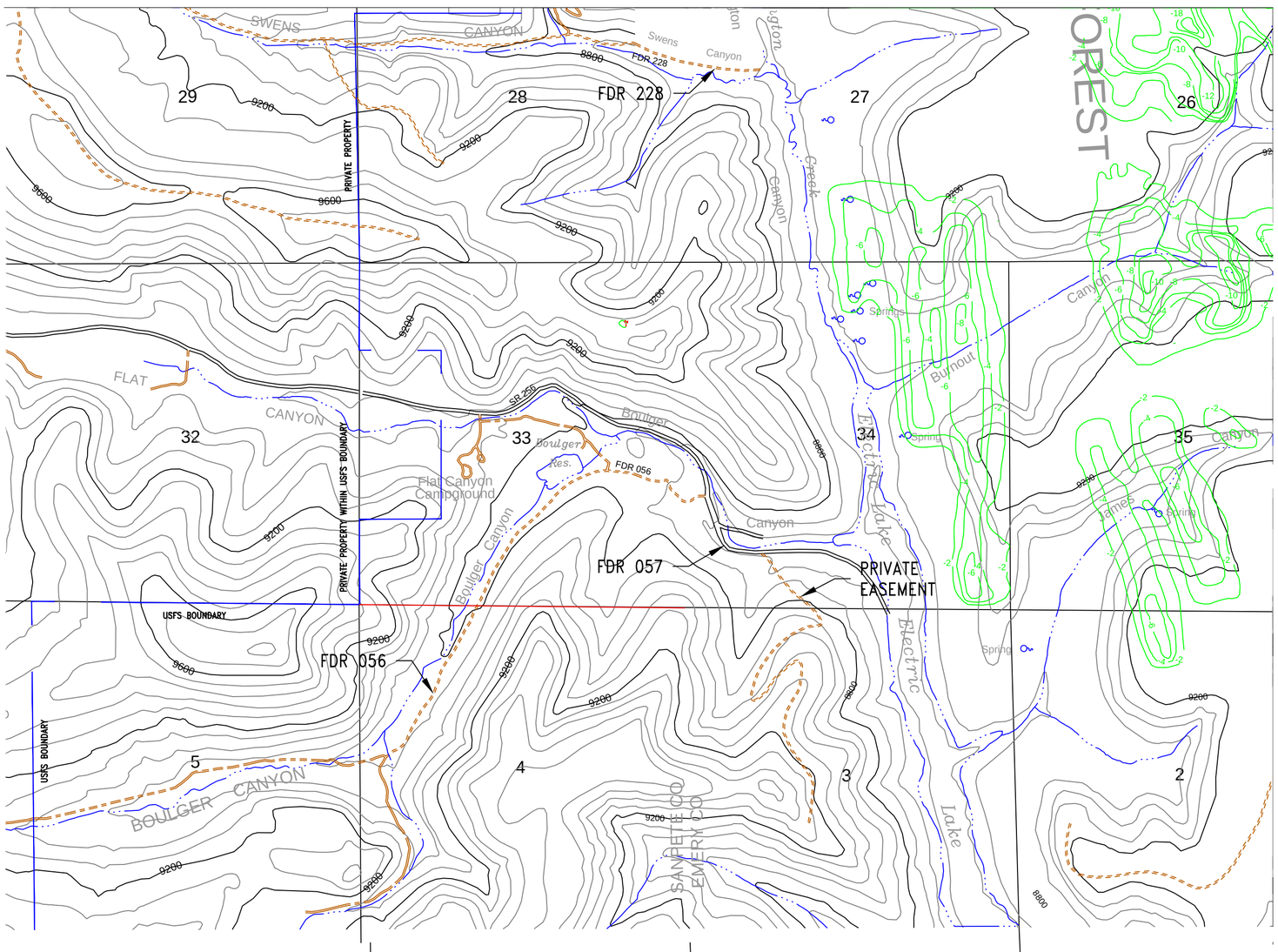
Projected Mine Year

- 2019
- 2020
- 2021

N
W E
S

0 0.1 0.2 0.4 0.6 0.8 Miles

2019 Survey Area Areas of Potential Subsidence



DATE	No.	REVISIONS	DR./CHKD.	DATE	No.	REVISIONS	DR./CHKD.
MARCH 06	1	2005 SUBSIDENCE	GAG/GAG	MARCH 14	9	2013 SUBSIDENCE	JCA/GAG
MARCH 07	2	2006 SUBSIDENCE	GAG/GAG	MARCH 15	10	2014 SUBSIDENCE	JCA/GAG
JUNE 08	3	2007 SUBSIDENCE	KMC/GAG	MARCH 16	11	2015 Prelim. SUBSIDENCE	GAG/GAG
MAY 09	4	2008 SUBSIDENCE	ARB/GAG	MARCH 17	12	2016 SUBSIDENCE	GAG/GAG
MARCH 10	5	2009 SUBSIDENCE	ARB/GAG	MARCH 18	13	2017 SUBSIDENCE	TWE/GAG
MARCH 11	6	2010 SUBSIDENCE	GAG/GAG	MARCH 19	14	2018 SUBSIDENCE	TWE/GAG
MARCH 12	7	2011 SUBSIDENCE	GAG/GAG	MARCH 20	15	2019 SUBSIDENCE	TWE/GAG
MARCH 13	8	2012 SUBSIDENCE	GAG/GAG				

NOTES:

1. COORDINATE BASE ON MINE GRID DATA.
2. MAP DIGITIZED FROM 1:24000 USGS QUADRANGLE MAPS, SCOFIELD, UTAH AND FAIRVIEW LAKES, UTAH.
3. MINE FACILITY, CONVEYOR, AND NEW ECCLES CANYON ROAD LOCATIONS FROM EXISTING RECORD DATA AND INCORPORATED TO MAP IN BEST FIT LOCATIONS.
4. UTM GRID TICK VALUES SHOWN ARE IN METERS.
5. Subsidence within black border performed by Aerographics

BASE PREPARED BY INTERMOUNTAIN AERIAL SURVEYS, SALT LAKE CITY, UTAH – M96147

-2

-2

SUBSIDENCE CONTOUR

N

S

3000" 150

Fish and Macroinvertebrate Assessment on Eccles and Boulger Creeks, 2019

FINAL REPORT

PN 1926-02 March 2020

Prepared for:
Canyon Fuel Company
Skyline Mine
HC 35 Box 380
Helper, UT 84526

Prepared by:
BIO-WEST, Inc.
Ron Kegerries
Ron Rogers
1063 W. 1400 N.
Logan, UT 84321

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Table 10. Calculated community tolerance quotient (CTQ) of macroinvertebrates collected from sampling locations on Eccles Creek, Carbon County, Utah (modified from Shiozawa [2013]). 18

INTRODUCTION

Eccles Creek is a first-order stream flowing west to east into Mud Creek, which flows north into Scofield Reservoir in Carbon County, Utah. In early August 2001, the advancing face of the Skyline Mine encountered fractured sandstone, which resulted in a significant inflow of water to the mine. From early September 2001 through July 2003, this water was discharged from the mine into Eccles Creek at mean monthly rates ranging from approximately 15.6 to 21.9 cubic feet per second (ft^3/sec), compared with the mean monthly discharge of about 4.0 ft^3/sec for the previous 2 years (Earthfax 2007; G. Galecki, Canyon Fuels Company, personal communication). Except for a period of lower discharge during most of 2004 (mean monthly discharge of 4.0 ft^3/sec), the mean monthly discharge from the mine since July 2003 ranged from 2.3–21.9 ft^3/sec (Earthfax 2007; G. Galecki, personal communication) and maintains the stream at near bankfull level (Shiozawa 2013; Kegerries and Mohn 2016). During nonpeak seasons the effects of increased base flows (or increased minimum instream flows) on the fish and macroinvertebrate community are less understood, as most studies focus on depleted base flows or increases in peak flows (e.g., Gido et al. 2010 and Carlisle et al. 2012). Thus, it becomes important to understand the effects of increased base flows on the fish and macroinvertebrate communities in Eccles Creek.

The opening of the Skyline Mine and widening of SR-264 in 1981, along with increased flow to the channel, have likely modified the morphology of the Eccles Creek stream bed through deposition, as well as calcification and hardening resulting from introduced calcium-bicarbonate-rich water. Thus, the establishment of a fish community and changes in the benthic macroinvertebrate community, such as decreased taxa richness and densities, have been documented (Shiozawa 2013, 2014; Galecki, memorandum). Fisheries sampling and monitoring were initiated in Eccles Creek in 2001 and no fish were captured during that effort. Subsequent sampling in 2004, 2007, 2010, 2013, and 2016 yielded captures of Cutthroat Trout *Oncorhynchus clarkii* (e.g., Shiozawa 2014; Kegerries and Edwards 2017). Benthic macroinvertebrate sampling and monitoring have been conducted on Eccles Creek from 1979 to 1985, 2001 to 2004, and in 2007, 2011, 2015, and 2016 (G. Galecki, 2015 memorandum to the Utah Division of Oil, Gas, and Mining, on macroinvertebrate and fish monitoring; Kegerries and Mohn 2016; Kegerries and Edwards 2017).

The Boulger Canyon sub-basin, occupies approximately 3.92 square miles. Included in this area are the upper drainage (above Boulger Reservoir), which is approximately 3.22 square miles, and the lower drainage, which occupies an area of approximately 0.70 square miles. Boulger Creek is a third order stream that flows to the northeast where it joins Flat Canyon Creek and then flows into Electric Lake. The stream in this area, which meanders tightly, is 8–10 feet wide and dominated by riffles and runs with a channel depth ranging from 6 inches to 2 feet. The substrate is composed of approximately 50% cobble, 15% gravel, and 35% sand/silt (USFS 2002). The Skyline Mine plans to expand operations and undermine the Boulder Canyon sub-basin beginning in approximately 2022 (the upper basin above the reservoir will be undermined in subsequent years). This will require Boulger Reservoir to be drained. It is proposed to allow the reservoir to refill in 2023 (G. Galecki, personal communication).

This report summarizes results of fish and macroinvertebrate community sampling in Eccles Creek and Boulger Creek during 2019 as a means to document the impact of increased discharge among the stream biota and assess stream health in Eccles Creek while documenting baseline biological conditions in Boulger Creek. Where applicable, summaries of previous data are presented for comparative purposes.

METHODS

In 2019, discharge for Eccles and Boulger creeks was determined before fish and macroinvertebrate sampling began, using a Marsh-McBirney, Inc., Flow-Mate Model 2000 velocity meter. The velocity-area procedure was conducted once at a cross section determined to be typical of the reaches to be sampled in a glide area free of obstructions. A tape measure was stretched perpendicular to the stream channel and the velocity meter was attached to a calibrated wading rod. The total wetted stream width (in feet) was divided into 10 equal segments or interval points of water-velocity measurements (Rantz et al. 1982).

For each water-velocity measurement, the distance from the initial point was recorded, along with the segment width and depth (all in feet). While pointing the velocity meter upstream at a right angle and standing downstream, the velocity meter was adjusted using the calibrated wading rod so that velocity was determined at 60% of the total depth. The velocity, measured in feet per second (ft/s), was then recorded, and the procedure was repeated at each of the 10 interval points across the transect. To calculate discharge, the depth and interval widths were multiplied to determine each interval area in square feet (ft^2). The area was then multiplied by the velocity to calculate interval discharge in ft^3/sec. Total discharge was then calculated by adding each of the interval discharges (Rantz et al. 1982).

Also, prior to biological sampling, data were obtained at each macroinvertebrate sampling station using a Hydrolab Quanta Multi-Probe to determine the current water quality parameters important to general aquatic ecosystem health. Water quality parameters measured included temperature (°C), conductivity (mS/cm), dissolved oxygen (mg/L), percent dissolved oxygen (%), total dissolved solids (TDS) (g/L), pH, and turbidity (nephelometric turbidity units [NTU]).

From September 25 to 27, 2019, four predetermined reaches in Eccles Creek (e.g., Shiozawa 2014) and three reaches in Boulger Creek (Figures 1 and 2; Table 1) were sampled for fish using two-pass depletion electrofishing with a Smith Root LR-24 backpack electrofisher. Fishing was conducted downstream to upstream in each reach with one person carrying the electrofisher and another person netting. All fish captured on the first pass were transferred to a bucket of water, identified, and measured to total length (TL). Those fish were released downstream of the sampling reach just before conducting the second pass. After both passes were completed, all fish were released back into the stream.

Quantitative and qualitative sampling for benthic macroinvertebrates was conducted at three sampling stations along Eccles Creek and three stations within Boulger Creek from September 25–27, 2019 (Figures 1 and 2; Table 2). The sampling stations are consistent with previous sampling events and monitoring efforts conducted intermittently since 1979 (e.g., Shiozawa 2013). The station codes for Eccles Creek used within this report correspond with previous report codes for comparative purposes (Table 2).

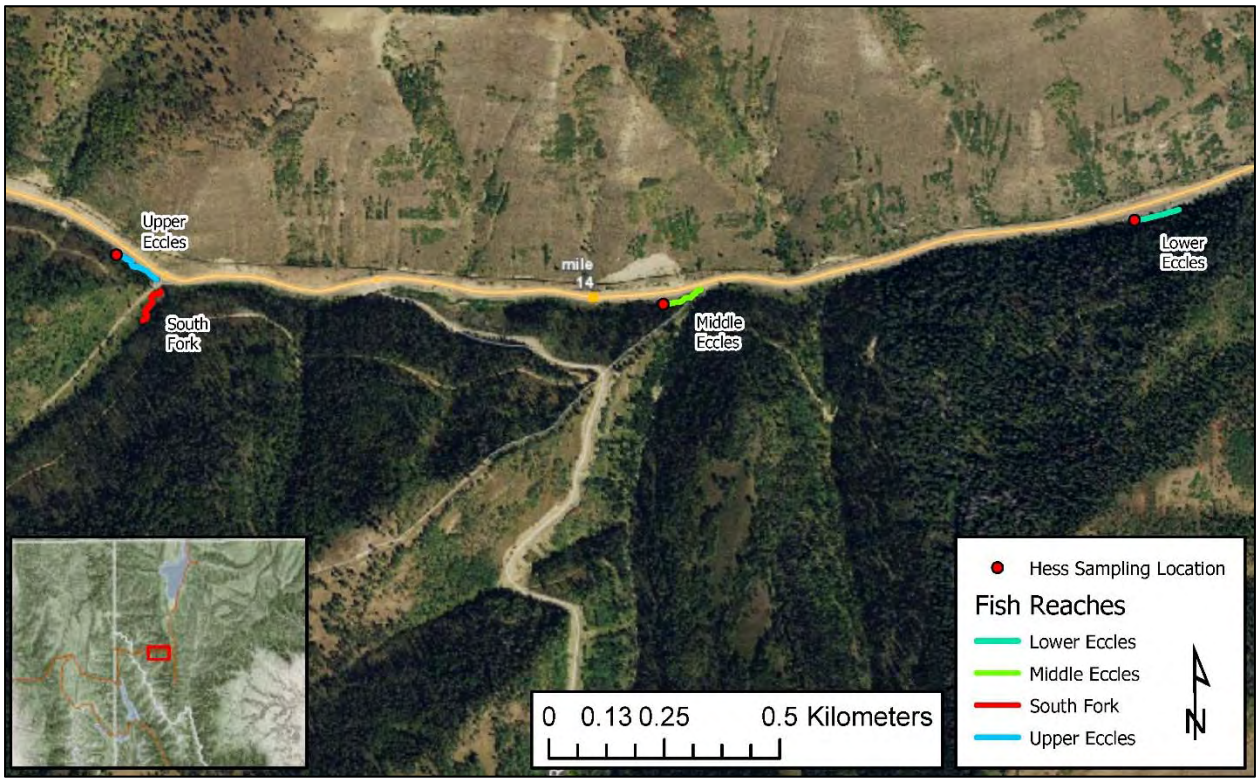

Figure 1. Fish and macroinvertebrate sampling reaches along Eccles Creek, Carbon County, Utah, on September 25–27, 2019.

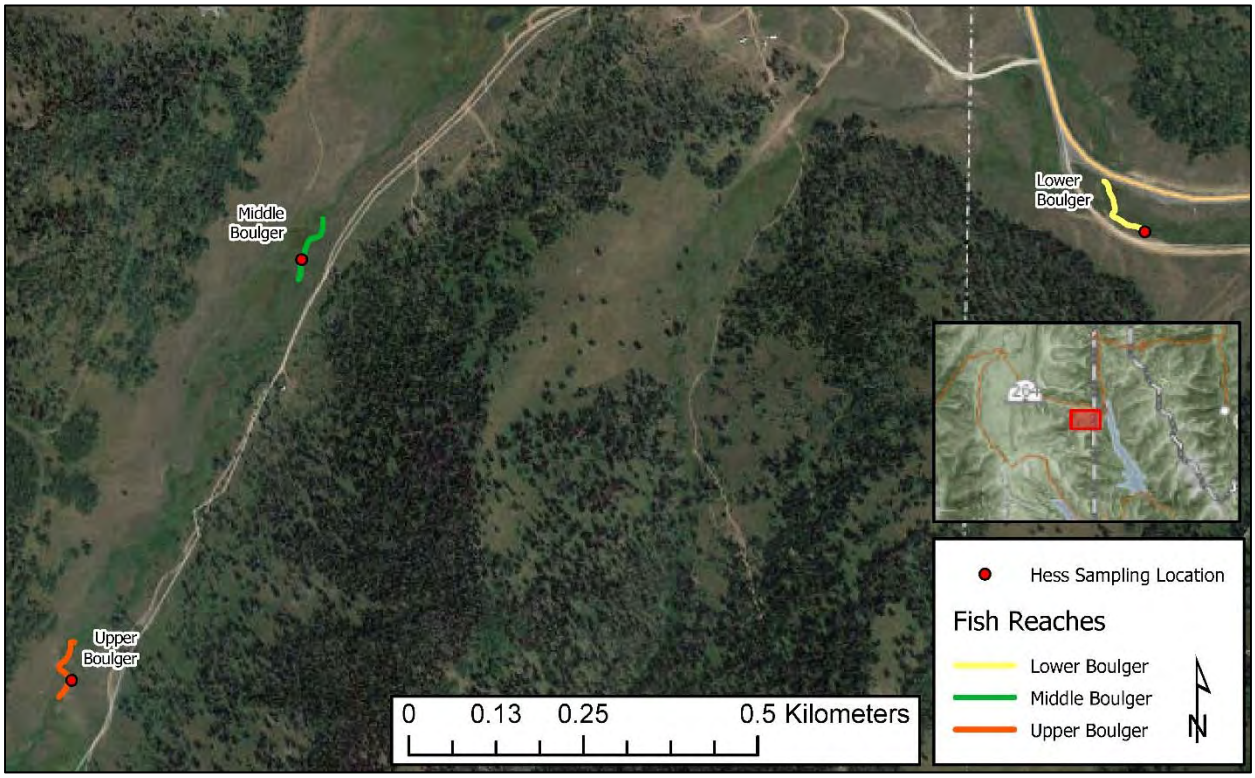

Figure 2. Fish and macroinvertebrate sampling reaches along Boulger Creek, Emery County, Utah, on September 25–27, 2019.

Table 1. Reach names and coordinates for fish sampling reaches on September 25–27, 2019, in Eccles and Boulger creeks, Carbon and Emery Counties, Utah.

STREAM REACH	STATION CODE	APPROXIMATE REACH LENGTH (m)	DOWNSTREAM		UPSTREAM	
			LATITUDE	LONGITUDE	LATITUDE	LONGITUDE
Upper Eccles	EC-2	94	39.682320	-111.191890	39.682769	-111.192812
Middle Eccles	EC-4	100	39.682082	-111.178149	39.681800	-111.179120
Lower Eccles	EC-5	103	39.683600	-111.166085	39.683392	-111.167242
South Fork Eccles Creek	SFEC	86	39.682090	-111.191800	39.681527	-111.192239
Upper Boulger	BG-U	101	39.636515	-111.262731	39.635792	-111.262944
Middle Boulger	BG-M	102	39.641944	-111.258534	39.641178	-111.258976
Lower Boulger	BG-L	106	39.641787	-111.244890	39.642415	-111.245534

Table 2. Station names and coordinates for macroinvertebrate sampling on September 25–27, 2019, in Eccles and Boulger creeks, Carbon and Emery counties, Utah.

STATION	STATION CODE	LOCATION	LAT/LONG	SAMPLE SIZE
Upper Eccles	EC-2	Upstream Hess Downstream	39.682769, -111.192812 39.682800, -111.192900 39.682320, -111.191890	8 kicks into 1 composite sample; 3 Hess samples
Middle Eccles	EC-4	Upstream Hess Downstream	39.681800, -111.179120 39.681800, -111.179100 39.682082, -111.178149	8 kicks into 1 composite sample; 3 Hess samples
Lower Eccles	EC-5	Upstream Hess Downstream	39.683392, -111.167242 39.683400, -111.167200 39.683600, -111.166085	8 kicks into 1 composite sample; 3 Hess samples
Upper Boulger	BG-U	Upstream Hess Downstream	39.635792, -111.262944 39.636025, -111.262778 39.636515, -111.262731	8 kicks into 1 composite sample; 3 Hess samples
Middle Boulger	BG-M	Upstream Hess Downstream	39.641178, -111.258976 39.641433, -111.258923 39.641944, -111.258534	8 kicks into 1 composite sample; 3 Hess samples
Lower Boulger	BG-L	Upstream Hess Downstream	39.642415, -111.245534 39.641759, -111.244857 39.641787, -111.244890	8 kicks into 1 composite sample; 3 Hess samples

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At each sampling site, riffles were chosen for collection of three replicate benthic macroinvertebrate samples within an approximately 100-m reach. Each of the individual samples was collected with a Hess-type cylindrical (0.086 square m [m^2]) bottom sampler with a 250-micron mesh window and 250-micron collecting net and dolphin bucket. The requirements for sampling with this device included substrate sizes ranging from gravel to cobble, water depth of less than 2 feet, and water velocity that was not too great to prevent holding the sampling gear in place and on the bottom of the streambed. Once the sampler was secured, all rock surfaces confined within the sampler were cleaned of all algae and macroinvertebrates. The substrate was then disturbed vigorously to a depth of approximately 10 cm (Cuffney et al. 1993; Metzeling et al. 2003). All detritus and macroinvertebrates dislodged during this process were washed downstream into the net and ultimately into the attached dolphin bucket. All contents of the dolphin bucket were then rinsed into a 500-milliliter (mL) or 1-L Nalgene bottle. The contents were then preserved with 95% ethanol to obtain a final concentration of at least 70% (Barbour et al. 1999). Hess samplers provide a quantitative estimate of both the density (number per area) and composition of the macroinvertebrate community in riffle-type habitats within each monitoring station. Because similar habitat types were sampled in each station using the Hess sampler, estimates of richness and abundance are directly comparable among stations. The replicates within these quantitative samples will also allow for statistical comparison among sampling events and years.

In addition to the quantitative samples collected with the Hess-type sampler, one composite kick-net sample was collected from eight riffles (riffle-kick method, Peck et al. 2006) within each reach. These composite samples were collected using a 500-micron mesh, D-frame kick-net (Cuffney et al. 1993; Barbour et al. 1999). In each of the eight kick-sample locations, a 0.5-m area of substrate was disturbed in front of the D-frame kick-net by hand agitating and scraping rocks clean or kicking into the substrate. Stream current then carried the invertebrates and +-periphyton from the disturbed area into the D-frame kick-net below (Cuffney et al. 1993; Barbour et al. 1999).

Sample processing and preservation in the field included rinsing large debris over a 250-micron mesh sieve, thereby removing it from the sample. Samples were then rinsed and placed into a 1-L or 500-mL wide-mouth Nalgene container and preserved in 95% ethanol to achieve at least a 70% final concentration (Cuffney et al. 1993; Barbour et al. 1999). Both Hess and kick-net samples were taken to the US Bureau of Land Management/Utah State University National Aquatic Monitoring Center (NAMC) in Logan, Utah, for further processing, identification, and analysis.

The NAMC processed and identified organisms in the benthic macroinvertebrate samples. Samples were randomly split to achieve approximately 600 organisms or more per split sample. All organisms were removed from the split sample, counted, and separated by family. These individuals were then identified to the lowest taxonomic level possible by qualified taxonomists. A synoptic reference collection was created, which was checked by a second taxonomist to ensure taxonomic accuracy. The number of each taxa collected was then entered into a spreadsheet, which was used to generate a list of 55 metrics that can be used as an index of the quality and health of the macroinvertebrate community. The NAMC provided the raw data and metrics and retained a reference collection within its lab. For additional information regarding the sample processing and metric calculations, please refer to NAMC (2016).

Data Analysis

Fish population estimates were derived from removal summation sampling (Zippin 1956, 1958) using the program MicroFish 3.0 (Van Deventer and Platts 1985; Van Deventer 1989). The number of fish captured for each pass was entered into the program to calculate an estimate for each reach with 95% confidence intervals. Abundance was also divided by the reach length to calculate fish density per meter. A one-way analysis of variance (ANOVA, α=0.05) was used to compare mean fish densities by reach.

Macroinvertebrate Metrics

Several commonly used metrics were selected to examine macroinvertebrate differences between stations and compare results from previous sampling events dating back to 1979. The calculated metrics used were obtained from the NAMC for each Hess replicate and the qualitative kick-net samples (Appendix A). For all quantitative analysis, mean values (± one standard error [SE]) for the three Hess-sample replicates were used, with the exception of EC-5, where only two Hess-samples were averaged due to a laboratory processing error. Because of this same error, the kick-net data from Boulger Creek Upper (BG-U) is also unavailable. Data from previous sampling events were summarized from tables presented in Shiozawa (2013).

The metrics used for assessing and comparing macroinvertebrate communities included taxa richness, total density of all macroinvertebrates, Shannon-Wiener diversity index, the US Forest Service (USFS) Community Tolerance Quotient (CTQ), the Hilsenhoff Biotic Index (HBI), and functional feeding groups. The relevance and calculated values for each of these metrics from all monitoring efforts during 2019 are described in Vinson (2006) and Miller and Judson (2011).

Taxa Richness

Taxa richness is the number of taxa observed in each sample (Hess or kick-net) at the lowest possible taxonomic resolution (Miller and Judson 2011). It provides an index for evaluating community diversity but, similar to total density, it does not discriminate against taxa by tolerance to altered conditions. Because degraded conditions often lead to a high abundance of just a few tolerant species, higher taxa richness usually indicates greater habitat diversity and/or more suitable water quality and indicates conditions suitable to a wider range of macroinvertebrates (Vinson 2006). For this report, taxa richness was determined for each station by the total number of unique taxa collected in all three Hess samples. Additionally, unique taxa collected from the qualitative kick-net samples were reported as ancillary data.

Total Density

An estimate of the total density of macroinvertebrates provides one method of comparing biological conditions across stations. However, a high overall density may not indicate good habitat conditions and a healthy macroinvertebrate community if it results from an abundance of tolerant species. Very low total density indicates oligotrophic or toxic conditions, while very high total densities of macroinvertebrates are often associated with nutrient enrichment, higher flows, or increases in fine sediments and a degraded condition (Vinson 2006). Density is reported as the number of individuals/m^2 for all historic collections and the mean number of individuals/m^2 for collections from 2019.

Shannon-Wiener Diversity Index

The Shannon-Wiener diversity index is a measure of macroinvertebrate heterogeneity and community structure ($-\Sigma(\text{Relative Abundance}]_{taxa}*\ln([\text{Relative Abundance}]_{taxa}))$) (Ludwig and Reynolds 1988; Miller and Judson 2011). This index takes into account the number of taxa in relation to their relative abundance results in a single value calculated per sample. Typically, Shannon-Weiner diversity is weighted toward rare taxa: the greater number of taxa, the more even the distribution, and the higher the index value (Miller and Judson 2011). For 2019 macroinvertebrate data, the Shannon-Wiener index is reported as the mean index value from the three Hess samples per station.

US Forest Service (USFS) Community Tolerance Quotient (CTQ)

The USFS CTQ has been widely used in the western United States. Taxa are assigned a tolerant quotient from 2 to 108 (Winget and Mangum 1979; Vinson 2006; Miller and Judson 2011). A dominance weighted CTQ was calculated ($\Sigma([\text{Tolerance Quotient}].*.\log([\text{Abundance}]_{taxa}))/\Sigma\log([\text{Abundance}]_{taxa})$) and values can range from 20–100, with lower values generally indicating better water quality (Miller and Judson 2011). Any community with values less than 65 represents high-quality habitats, values of 65–80 are moderate-quality habitats, and values greater than 80 are considered poor-quality habitats (Winget and Mangum 1979). The CTQ is reported as the mean value from the three Hess samples per station.

Hilsenhoff Biotic Index (HBI)

The HBI provides an indication of the overall pollution tolerances of the macroinvertebrate community in a site from the taxa collected (Hilsenhoff 1987, 1988). This index has been used to detect nutrient enrichment, high sediment loads, low dissolved oxygen, and thermal impacts. It was originally developed to detect organic pollution (Hilsenhoff 1988). Individual families were assigned an index value from 0 to 10 based on Hilsenhoff (1987, 1988) and the HBI calculated ($\Sigma([\text{Abundance}]_{taxa}*[\text{Tolerance}]_{taxa})/[\text{Abundance}]_{Total}$) (Miller and Judson 2011). Taxa with HBI values of 0–2 are considered intolerant, clean-water taxa. Taxa with HBI values of 9–10 are considered pollution-tolerant taxa. A family-level HBI was calculated for each sample. Stations with HBI values of 0–2 are considered clean, 2–4 slightly enriched, 4–7 enriched, and 7–10 polluted (Vinson 2006). In an effort to more fully assess the current condition of the macroinvertebrate community, the HBI is introduced in this report and presented as the mean HBI by sampling station. Continued HBI comparisons should allow for future tracking of nutrient enrichment, thermal changes, and perhaps changes in sediment loads through time.

Functional Feeding Groups

Macroinvertebrates can be classified based on their primary feeding behavior and mechanics; recognizing that all macroinvertebrates exhibit some omnivory (Vinson 2006; Miller and Judson 2011). Such groups are shredders, scrapers, collector-filterers, collector-gatherers, and predators (Merritt et al. 2008). These feeding mechanisms are primarily based on the location (i.e., water column or stream bed) and the particle size and type (i.e., leaf litter, fine particulate organic matter, or live prey) of food they eat (Vinson 2006). These feeding groups may also help characterize the source of the food resource and whether the habitats sampled are erosional or depositional (Vinson 2006).

Shredders typically feed on living or decomposing aquatic vascular plants and can be sensitive to changes in vegetation. In turn, they can be good indicators of toxins that may be assimilated in organic matter (Vinson 2006). Scrapers primarily feed on periphyton and attached algae. As sedimentation and nutrient enrichment occur, scraper abundance typically will decline as more filamentous algae and vascular plants become dominant in areas with increased sedimentation and organic pollution (Vinson 2006). Both collector-filterers and -gatherers feed on particulate organic matter either within the water column (filterer) or deposited on sediment (gatherer) and are sensitive to toxicants (Vinson 2006). Predators, as their name implies, feed on the tissue of living animals (primarily insects).

For this report, a brief analysis of relative abundance for macroinvertebrates by each feeding group was also performed. This was calculated by taking the mean number of organisms by feeding group for each site and reporting that number as a percentage of the total.

RESULTS

Discharge and Water Quality

Discharge was calculated at 8.35 ft^3/sec (Table 3) at Lower Eccles (EC-5) during the time of macroinvertebrate sampling. Temperature, dissolved oxygen, pH, and turbidity at all stations were within ranges identified for biologically healthy and productive systems (Wetzel 1983; Sigler and Sigler 1996; UDAR 2012) (Table 3). The only notable variation in water-quality parameters among stations was temperature. Sampling began downstream with a water temperature of 11.47°C and warmed as sampling progressed upstream (12.49°C) (Table 3). It is likely that the water temperature warmed as ambient air temperature increased, or the discharge water from the mine was cooled as it traveled downstream through the sampling reaches.

Table 3. Discharge and water-quality data collected at each station prior to macroinvertebrate sampling on Eccles and Boulger creeks, September 25–27, 2019.

STATION	DISCHARGE (ft^3/sec)	TEMPERATURE (°C)	CONDUCTIVITY (millisiemens [mS]/cm)	DISSOLVED OXYGEN (mg/L)	PH	TOTAL DISSOLVED SOLIDS (g/L)	DISSOLOVED OXYGEN (%)	TURBIDITY (NTU)
Upper Eccles	-	12.49	0.598	9.25	8.68	0.4	90.1	13.5
Middle Eccles	-	13.66	0.617	7.71	8.62	0.4	86.0	15.1
Lower Eccles	8.35[a]	11.47	0.740	8.04	8.71	0.5	86.6	15.6
Upper Boulger	-	8.92	0.272	9.11	8.76	0.2	92.2	14.7
Middle Boulger	-	4.58	0.292	9.20	8.76	0.2	83.4	14.2
Lower Boulger	2.08[a]	9.62	0.270	13.74	8.90	0.2	111.3	12.3

[a] Only measured once as stations were close with little input or diversion throughout.

Discharge was measured at 2.08 ft^3/sec in Boulger Creek below the Boulger Reservoir dam. Temperature, dissolved oxygen, pH, and turbidity at all stations were within ranges identified for biologically healthy and productive systems (Wetzel 1983; Sigler and Sigler 1996; UDAR 2012) (Table 3). Boulger Creek Lower had the warmest temperatures during sampling (9.62°C) and Boulger Creek Upper had a temperature of 8.92°C (Table 3). Boulger Creek Middle had the coolest water temperature (4.58°C), but this is likely because sampling occurred early in the morning before warming throughout the day (Table 3).

Fish Community

Seven unique fish species were captured in Eccles and Boulger creeks in 2019 (Table 4). Two were hybrid species; Rainbow Trout *Oncorhynchus mykiss* x Cutthroat Trout and Brook Trout *Salvelinus fontinalis* x Brown *Salmo trutta*, commonly known as Tiger Trout. The most common species in descending order of abundance were Mottled Sculpin *Cottus bairdii* (n=184), Tiger Trout (n=179), and Cutthroat Trout (n=173). Additionally, 71 Redside Shiner *Richardsonius balteatus*, 2 Kokanee Salmon *O. nerka*, 1 Rainbow Trout, and 1 Rainbow Trout x Cutthroat Trout hybrid were captured (Table 4).

Table 4. Number of fish captured by species for each stream reach sampled in Eccles and Boulger creeks, September 25–27, 2019.

STREAM REACH	CUTTHROAT TROUT	RAINBOW TROUT	TIGER TROUT	CUTTHROAT x RAINBOW	KOKANEE	MOTTLED SCULPIN	REDSIDE SHINER	TOTAL
Upper Eccles	69	0	0	0	0	0	0	69
Middle Eccles	38	0	0	0	0	0	0	38
Lower Eccles	57	0	0	1	0	0	0	58
South Fork Eccles Creek	4	0	0	0	0	0	0	4
Upper Boulger	7	0	0	0	0	69	0	76
Middle Boulger	5	0	0	0	0	62	0	67
Lower Boulger	0	1	179	0	2	46	71	299
TOTAL	173	1	179	1	2	184	71	611

Upper Eccles Creek had the highest Cutthroat Trout population estimate (*N*=73 [95% CI=66–80]), followed by Lower Eccles Creek station (*N*=69 [95% CI=50–88]), and Middle Eccles Creek station (*N*=39 [95% CI=35–43]). Only four Cutthroat Trout were captured at the South Fork Eccles Creek tributary, which produced a population estimate of 4 (95% CI 0–9) (Table 5).

Cutthroat Trout were captured in the Middle and Upper Boulger Creek stations, which produced population estimates of *N*=5 (95% CI= 5–5) and *N*=7 (95% CI= 7–7), respectively (Table 5). A population estimate was not produced for Lower Boulger Creek because no Cutthroat Trout were captured; however, the site had the highest number of fish captured (n=299) (Table 4) and the most diversity with five fish species: Kokanee Salmon, Mottled Sculpin, Redside Shiner, Rainbow Trout, and Tiger Trout. Cutthroat Trout densities were 0.07 and 0.05 trout per linear meter sampled. Because Boulger Creek has not been sampled before under these methods and under this scope of work, these depletion-based population estimates and density calculations will serve as baseline data.

Table 5. Total Cutthroat Trout captured and population estimates with 95% confidence intervals, capture probability, and confidence range for reaches sampled in Eccles and Boulger creeks, September 25–27, 2019.

SITE	TOTAL CUTTHROAT TROUT CAPTURED	POPULATION ESTIMATE	95% CONFIDENCE INTERVAL	CAPTURE PROBABILITY	CONFIDENCE RANGE (± % OF ESTIMATE)
Upper Eccles	69	73	66–80	0.750	9.6
Middle Eccles	38	39	35–43	0.809	10.3
Lower Eccles	57	69	50–88	0.576	27.5
South Fork Eccles Creek	4	4	0–9	0.667	125.0
Upper Boulger	7	7	7–7	1.000	0.0
Middle Boulger	5	5	5–5	1.000	0.0
Lower Boulger	0	NA	NA	NA	NA

Although Cutthroat Trout population estimates are typically higher in the lower reaches of mainstem Eccles Creek, this was not the case in 2019, where the Upper Eccles Creek population estimate was the highest. However, mean population estimates for the three mainstem sites were not found to be significantly different among sites (ANOVA, F2,17=2.89, P=0.0865) (Figure 3 and Table 6). It should be noted that only four Cutthroat Trout were captured in South Fork Eccles Creek near the confluence with Eccles Creek. During our sampling, the South Fork had little flowing water due to beaver dams and sampling was mostly limited to these pools and the pool at the confluence of the main stem Eccles Creek. Therefore, the calculated population estimates were not included in analyses with the mainstem sites. Similar results were noted from calculated trout densities (number of trout per linear meter sampled) where Upper Eccles Creek had the highest trout densities (Figure 3 and Table 6). Again, there were no significant differences in mean trout densities comparing calculated densities among the three mainstem Eccles Creek sites (ANOVA, $F_{2,17}$=2.19, P=0.1468). Population estimates and trout densities have both varied throughout the six sampling years (Figure 3 and Table 6). Population estimates and trout densities were highest in 2013. Population estimates for Middle and Lower Eccles has decreased since in 2016 and 2019; however, all Cutthroat Trout densities declined in 2016 followed by an increase in 2019 (Table 6).

Size-structure analysis in Eccles Creek revealed various size classes of Cutthroat Trout were present (Figure 4). In general, Upper Eccles Creek contained smaller fish (mean TL=158.9 [SE=7.9]), and larger Cutthroat Trout seemed to be lower in the creek (Middle Eccles Creek mean TL=246.2 [SE=7.2]; Lower Eccles Creek mean TL=235.9 [SE=4.2]) (Figure 4). Three of the four Cutthroat Trout captured in South Fork Eccles Creek were 75–80 mm in TL while one fish was 271 mm TL; the tributary is likely not large enough to support larger fish. Upper Boulger Creek contained seven Cutthroat Trout ranging in length from 99–174 mm TL with a mean length of 118.1 mm (SE=10.0). In Middle Boulger Creek, four Cutthroat Trout were captured ranging in size from 45–235 mm TL, with a mean length of 141.2 mm (SE=33.2) (Figure 5). No Cutthroat Trout were captured in Lower Boulger Creek.

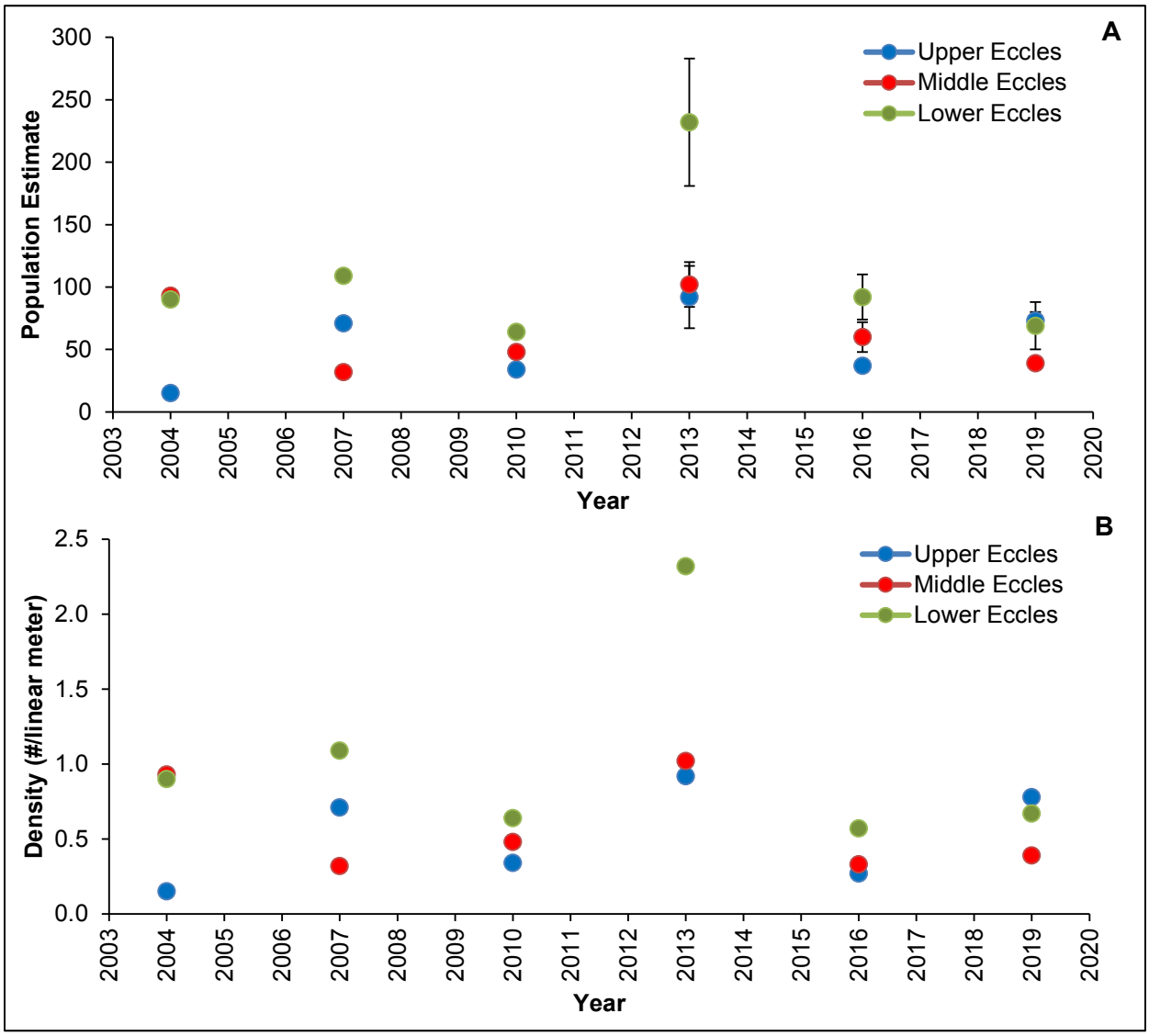

Figure 3. **Fish population estimates (with 95% confidence intervals when available) (A) and densities (B) in Eccles Creek since 2004.**

Table 6. **Comparisons of population estimates and fish densities for Eccles Creek since 2004 (modified from Shiozawa 2014).**

SITE	POPULATION ESTIMATE						DENSITY PER LINEAR STREAM METER					
	2004	2007	2010	2013	2016	2019	2004	2007	2010	2013	2016	2019
Upper Eccles	15	71	34	92	37	73	0.15	0.71	0.34	0.92	0.27	0.78
Middle Eccles	93	32	48	102	60	39	0.93	0.32	0.48	1.02	0.33	0.39
Lower Eccles	90	109	64	232	92	69	0.90	1.09	0.64	2.32	0.57	0.67
South Fork Eccles Creek	1	0	0	3	2	4	0.01	0.00	0.00	0.03	0.01	0.05
TOTAL	**98**	**212**	**146**	**429**	**191**	**185**	**0.50**	**0.53**	**0.36**	**1.07**	**0.29**	**0.47**

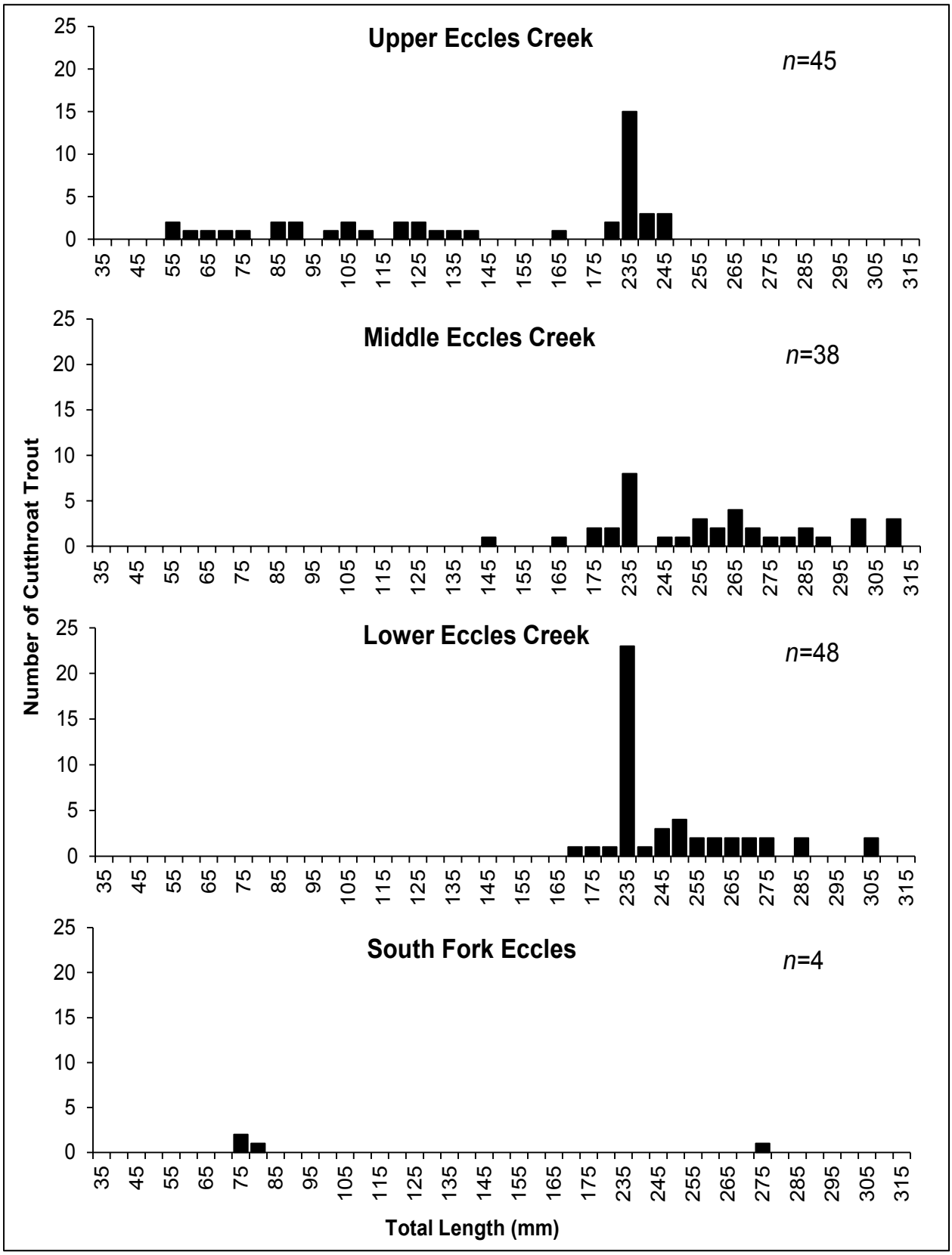

Figure 4. Length-frequency distributions of Cutthroat Trout captured in Eccles Creek, September 25–26, 2019.

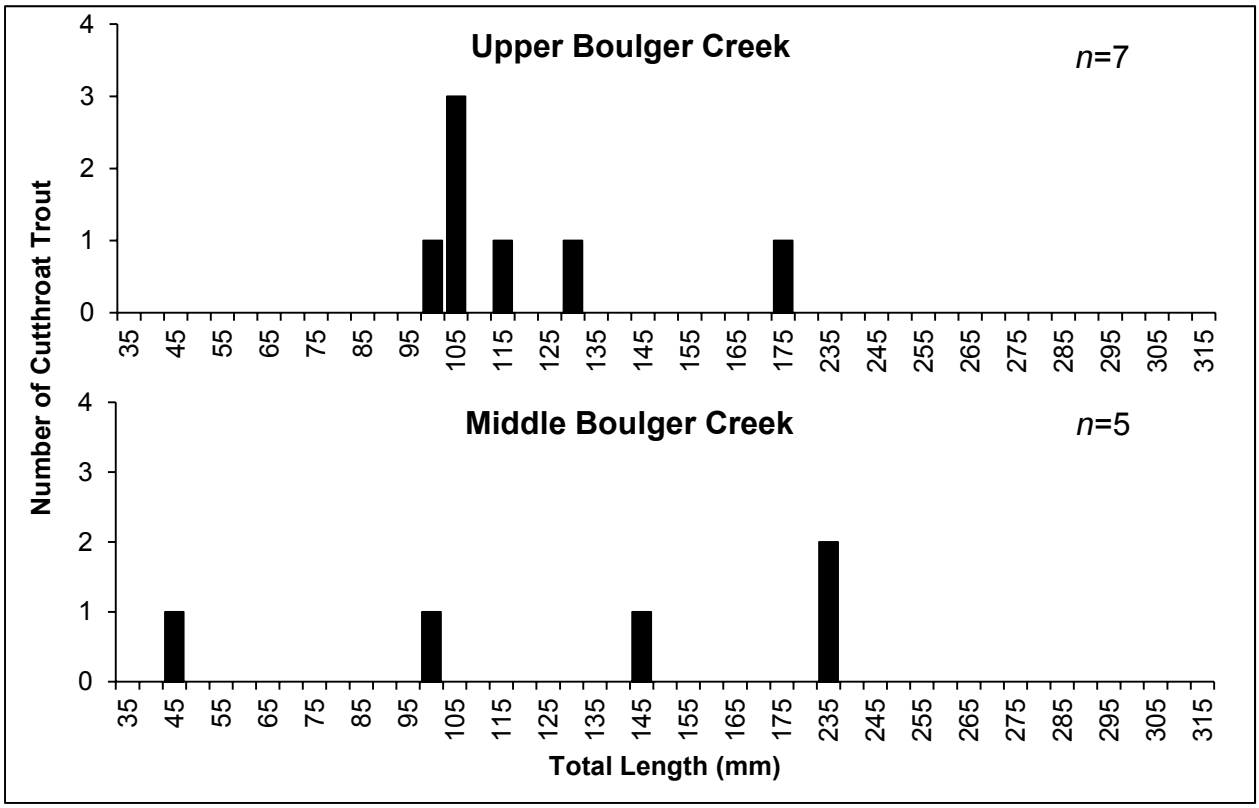

Figure 5. Length-frequency distributions of Cutthroat Trout captured in Boulger Creek, September 26–27, 2019.

Macroinvertebrate Community

Taxa Richness

From all of the Eccles Creek sampling stations combined, 32 total taxa were collected (Appendix A), similar to what was reported in Kegerries and Edwards (2017). Lower Eccles Creek (EC-5) exhibited the lowest species richness for the stations with a total of 18 taxa in 2019 (Table 7). Middle Eccles Creek (EC-4) had the highest taxa in 2019 (n=25), and Upper Eccles Creek (EC-2) followed with 22 taxa (Table 7). The decline in taxa richness after the construction of the mine and highway (after 1979) is evident (Table 7 and Figure 6). Since then, the number of species present in Eccles Creek has remained fairly stable or perhaps even increased through time (Figure 6).

The combined Boulger Creek sampling stations yielded a total of 43 taxa from 2019 field collection efforts (Appendix A). All three stations at Boulger Creek had fairly similar numbers of taxa. The Middle Boulger Creek station (BG-M) had the highest number of taxa (n=31), while Upper Boulger Creek (BG-U) and Lower Boulger Creek (BG-L) had 30 and 29 total taxa, respectively.

Table 7. Number of macroinvertebrate taxa collected from sampling locations on Eccles Creek, Carbon County, Utah (modified from Shiozawa [2013]).

DATE	UPPER ECCLES (EC-2)	MIDDLE ECCLES (EC-4)	LOWER ECCLES (EC-5)
JUN 1979[a]	35	35	38
AUG 1979[a]	42	37	21
JUN 1990[b]	6	7	12
OCT 1990[b]	NS[l]	17	13
SEP 1991[b]	6	15	14
NOV 2001[c]	NS	6	NS[l]
JUL 2002[d]	6	14	6
OCT 2002[e]	11	7	11
JUN 2003[f]	11	9	9
OCT 2003[g]	5	13	11
JUN 2004[h]	10	14	21
OCT 2004[i]	7	16	24
SEP 2007[j]	7	24	17
JUL 2008[j]	7	15	11
JUL 2011[k]	20	23	22
SEP 2011[k]	14	24	23
OCT 2015	20	25	24
SEP 2016	16	23	26
OCT 2019	18	25	22

[a] Winget 1980, [b] Ecosystems Research Institute 1992, [c] Shiozawa 2002a, [d] Shiozawa 2002b, [e] Shiozawa 2003, [f] Shiozawa and Hansen 2003, [g] Shiozawa 2005a, [h] Shiozawa 2005b, [i] Shiozawa 2007, [j] Shiozawa and Fordham 2010, [k] Shiozawa 2013, [l] NS= not sampled.

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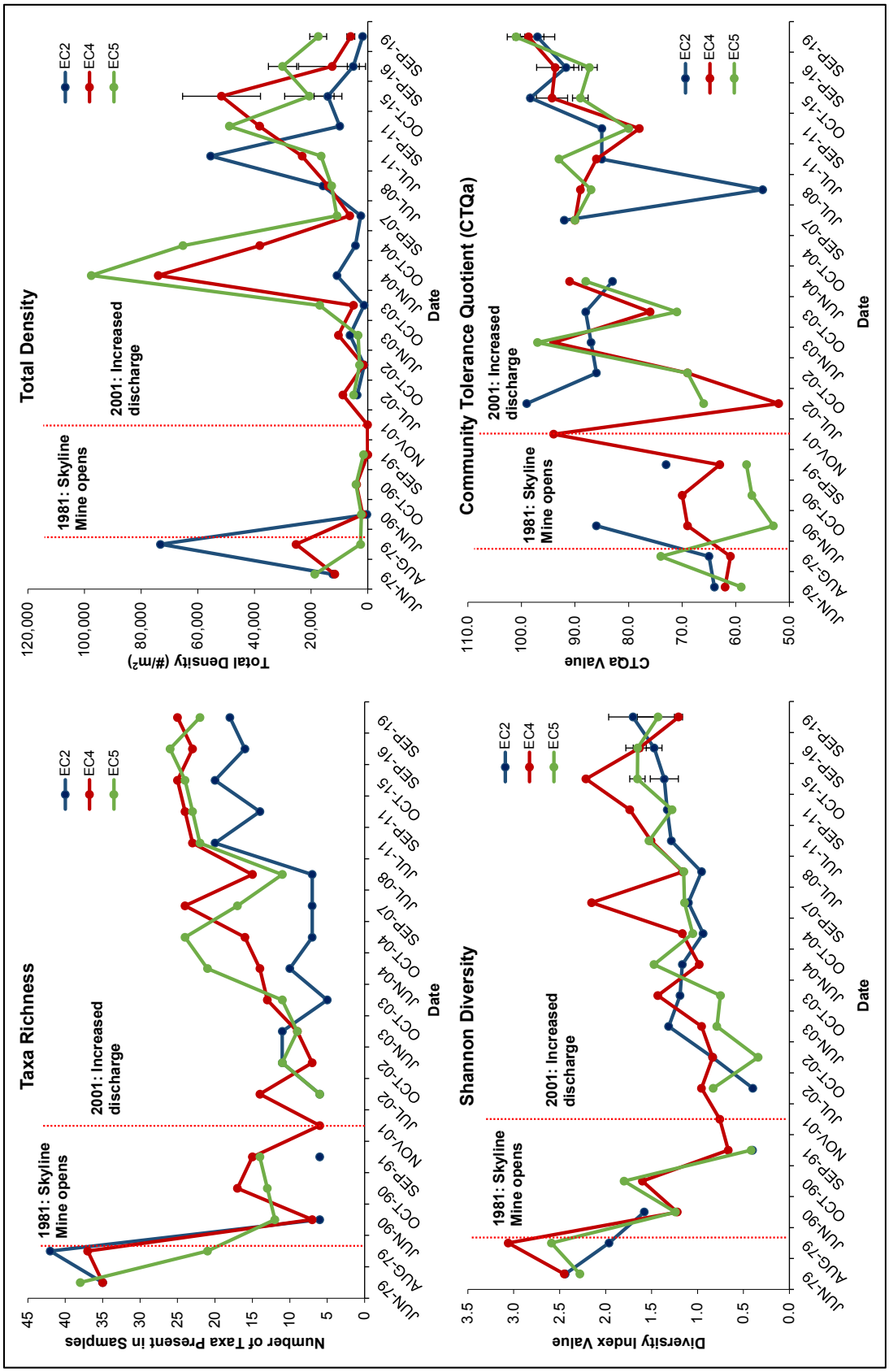

Figure 6. Historic and current data for taxa richness, total density, Shannon–Weiner diversity index, and community tolerance quotient (CTQ) for Eccles Creek, Carbon County, Utah.

Total Density

Macroinvertebrate densities varied by sampling station in 2019, with EC-5 having the highest mean density (17,451 individuals/m^2), followed by EC-4 and EC-2 (5,959 and 1,774 individuals/m^2, respectively) (Table 8). Comparisons with conditions before mine operation were difficult to establish because of the seasonal differences in sampling (summer 1979 vs. fall 2019). However, densities in 2019 for EC-5 were higher than in August 1979 (Table 8). Macroinvertebrate densities appeared to decline throughout the 1990s and early 2000s (Figure 6); however, variations in densities could be seasonally driven due to the presence (or absence) of certain taxa found within the stream at different life cycles. Compared to 2016, macroinvertebrate densities appear to have decreased (Figure 6).

Table 8. Total density (number/m^2) of macroinvertebrates collected from sampling locations on Eccles Creek, Carbon County, Utah (modified from Shiozawa [2013]).

DATE	UPPER ECCLES (EC-2)	MIDDLE ECCLES (EC-4)	LOWER ECCLES (EC-5)
JUN 1979[a]	12,341	11,634	18,661
AUG 1979[a]	73,181	25,273	2,526
JUN 1990[b]	267	1,719	2,212
OCT 1990[b]	NS[l]	3,928	4,104
SEP 1991[b]	89	1,419	1,468
NOV 2001[c]	NS[l]	61	NS[l]
JUL 2002[d]	3,703	8,757	4,927
OCT 2002[e]	1,260	1,491	2,879
JUN 2003[f]	6,265	10,351	3,387
OCT 2003[g]	1,267	5,004	16,919
JUN 2004[h]	10,865	73,950	97,614
OCT 2004[i]	4,339	38,093	65,206
SEP 2007[j]	2,436	6,332	10,878
JUL 2008[j]	15,772	13,926	12,743
JUL 2011[k]	55,421	23,157	16,427
SEP 2011[k]	9,873	38,176	48,847
OCT 2015	14,043	51,608	20,605
SEP 2016	5,070	12,559	30,061
OCT 2019	1,774	5,959	17,451

[a] Winget 1980, [b] Ecosystems Research Institute 1992, [c] Shiozawa 2002a, [d] Shiozawa 2002b, [e] Shiozawa 2003, [f] Shiozawa and Hansen 2003, [g] Shiozawa 2005a, [h] Shiozawa 2005b, [i] Shiozawa 2007, [j] Shiozawa and Fordham 2010, [k] Shiozawa 2013, [l] NS= not sampled.

For EC-2, three taxa made up 63% of the mean macroinvertebrate density (Appendix A): 27% from taxa in the Chironomidae family, 23% from the class Oligochaeta, and 13% from the Baetidae family. At EC-4, three taxa made up 65% of the mean macroinvertebrate density (Appendix A): 38% from the Elmidae family, 14% from the Hydropsychidae family, and 13% from the Chironomidae family. Three taxa made up 60% of the mean macroinvertebrate density at EC-5 (Appendix A): 51% from two taxa in the Chironomidae family and 9% from the Baetidae family. In total, 64% of the mean macroinvertebrate density at the three Eccles Creek sampling stations was derived from chironomids and elmids.

For Boulger Creek quantitative sampling stations, macroinvertebrate mean densities varied. Upper Boulger Creek mean macroinvertebrate density was calculated at 12,003 individuals per m^2 (SE=401.1) while Middle Boulger Creek mean density was calculated at 6,386 individuals per m^2 (SE=1,419). The highest mean macroinvertebrate density in Boulger Creek were found at the lower site below Boulger Reservoir and above Electric Lake (16,151 individuals per m^2 [SE=2,958]) (Appendix A).

Shannon-Wiener Diversity Index

The calculated mean of the Shannon-Wiener diversity index for each station indicates that current values are lower for all stations compared to pre-mine sampling values (Figure 6 and Table 9). Diversity decreased throughout the 1990s before leveling off in the early 2000s, around the time when discharge increased within the channel (Figure 6).

Table 9. Mean Shannon-Wiener diversity index from macroinvertebrates collected from sampling locations on Eccles Creek, Carbon County, Utah (modified from Shiozawa [2013]).

DATE	UPPER ECCLES (EC-2)	MIDDLE ECCLES (EC-4)	LOWER ECCLES (EC-5)
JUN 1979[a]	2.44	2.45	2.28
AUG 1979[a]	1.964	3.06	2.59
JUN 1990[b]	1.58	1.22	1.24
OCT 1990[b]	NS[l]	1.6	1.8
SEP 1991[b]	0.4	0.666	0.416
NOV 2001[c]	NS[l]	0.757	NS[l]
JUL 2002[d]	0.398	0.957	0.829
OCT 2002[e]	0.836	0.835	0.341
JUN 2003[f]	1.314	0.955	0.789
OCT 2003[g]	1.19	1.432	0.75
JUN 2004[h]	1.165	0.982	1.474
OCT 2004[i]	0.939	1.165	1.052
SEP 2007[j]	1.1	2.152	1.141
JUL 2008[j]	0.956	1.162	1.149
JUL 2011[k]	1.285	1.506	1.528
SEP 2011[k]	1.329	1.737	1.276
OCT 2015	1.362	2.214	1.654
SEP 2016	1.472	1.631	1.651
OCT 2019	1.703	1.207	1.43

[a] Winget 1980, [b] Ecosystems Research Institute 1992, [c] Shiozawa 2002a, [d] Shiozawa 2002b, [e] Shiozawa 2003, [f] Shiozawa and Hansen 2003, [g] Shiozawa 2005a, [h] Shiozawa 2005b, [i] Shiozawa 2007, [j] Shiozawa and Fordham 2010, [k] Shiozawa 2013, [l] NS= not sampled.

The diversity index value at EC-2 (1.703) has been increasing since 2008. The EC-4 value was 1.207 in 2019, which follows the decrease that has been under way since 2015. The EC-5 station had a value of 1.430 in 2019, which was a slight decrease from 2015 and 2016 results. Although lower than 1979 values, diversity appears to be increasing or stable and may be approaching values observed before mining operations commenced. Qualitative kick-net sampling results in Eccles Creek show diversity values similar to those obtained with Hess samplers ranging from 1.137 to 1.592 (Appendix A).

The Shannon-Wiener Diversity Index value for Boulger Creek increased from the upper to lower reaches (Appendix A). In 2019, BG-U had an index value of 0.928, BG-M had a value of 1.443, and BG-L had an index value of 1.596. The qualitative kick-net sample at BG-M was higher than any of the quantitative samples at 2.181 (Appendix A).

US Forest Service (USFS) Community Tolerance Quotient (CTQ)

Mean CTQ values for 2019 were similar across the Eccles Creek stations, which indicates similar water quality (Table 10). The highest value was found at EC-5 (101), while the lowest value was at the farthest upstream station, EC-2 (97) (Table 10). These values represent the highest values since 1979 at EC-4 and EC-5. Qualitative kick-net samples also had similar values at all stations, with a CTQ value of 96–101 (Appendix A). These CTQ values suggest poor-quality habitat. Although variable through time, CTQ values have increased since 1979 (pre-mine) (Figure 6). Such an increase likely indicates a change in water quality or habitat that creates an environment more suitable to tolerant organisms. Finding high numbers of intolerant organisms would indicate that the stream is healthy (low CTQ score). All three stations have low numbers of intolerant taxa (0–2) (Appendix A).

Table 10. Calculated community tolerance quotient (CTQ) of macroinvertebrates collected from sampling locations on Eccles Creek, Carbon County, Utah (modified from Shiozawa [2013]).

DATE	UPPER ECCLES (EC-2)	MIDDLE ECCLES (EC-4)	LOWER ECCLES (EC-5)
JUN 1979[a]	64	62	59
AUG 1979[a]	65	61	74
JUN 1990[b]	86	69	53
OCT 1990[b]	NS[l]	70	57
SEP 1991[b]	73	63	58
NOV 2001[c]	NS[l]	94	NS[l]
JUL 2002[d]	99	52	66
OCT 2002[e]	86	69	69
JUN 2003[f]	87	94	97
OCT 2003[g]	88	76	71
JUN 2004[h]	83	91	88
OCT 2004[i]	NS[l]	NS[l]	NS[l]
SEP 2007[j]	92	90	90
JUL 2008[j]	55	89	87
JUL 2011[k]	85	86	93
SEP 2011[k]	85	78	80
OCT 2015	98.3	94.3	89
SEP 2016	91.7	93.7	87.3
OCT 2019	97	98.7	101

[a] Winget 1980, [b] Ecosystems Research Institute 1992, [c] Shiozawa 2002a, [d] Shiozawa 2002b, [e] Shiozawa 2003, [f] Shiozawa and Hansen 2003, [g] Shiozawa 2005a, [h] Shiozawa 2005b, [i] Shiozawa 2007, [j] Shiozawa and Fordham 2010, [k] Shiozawa 2013, [l] NS= not sampled.

Mean CTQ values ranged from 72.3 to 76.0 at the Boulger Creek stations in 2019. Additionally, a broader range of values was observed in the kick-net samples (63.0–84.0) during 2019. These values would indicate the stream has poor-quality habitat. However, there were 1–5 intolerant taxa collected in Boulger Creek samples.

Hilsenhoff Biotic Index (HBI)

The HBI was used to provide an indication of overall pollution tolerances of macroinvertebrates within a single station. Mean HBI values ranged from 3.51 (EC-2) to 4.57 (EC-5), while EC-4 had an HBI value of 4.06.

In Boulger Creek the mean HBI values generally increased from downstream to upstream. Mean HBI values ranged from 4.48 at BG-L to 5.60 at BG-U, while BG-M had an HBI value of 4.59.

Hilsenhoff Biotic Index values between 4 and 7 would be considered "enriched," and would indicate that only relatively tolerant taxa would be able to inhabit these waters. Areas with HBI values above 7 would be considered polluted, while areas with values less than 2 would be considered to have clean water. The HBI scores for kick-net samples were very similar and showed a pattern similar to Hess sampler-obtained values. Tracking this metric through time is another means of determining the overall health of the macroinvertebrate community and whether or not change is occurring.

Functional Feeding Groups

Functional feeding groups provide a primary indication of change in stream communities. In Eccles Creek the collector-gatherers are the primary feeding group while collector-filterers are secondary (Figure 7). Boulger Creek was largely dominated by collector-gathers and shredders, whereas few scrappers or predators were documented in 2019 (Figure 8). Dipteran orders that are largely gatherers and filter feeders dominate the aquatic community in this stream. The Baetis (Ephemeroptera) that were collected and some of the caddisflies (Trichoptera) are considered collectors and scrapers, while the one Plecoptera species collected is a predator of these aquatic insects. Shredders, which require more plant detritus and are common in higher-order, healthy streams, were found in very low proportions relative to any of the other feeding groups.

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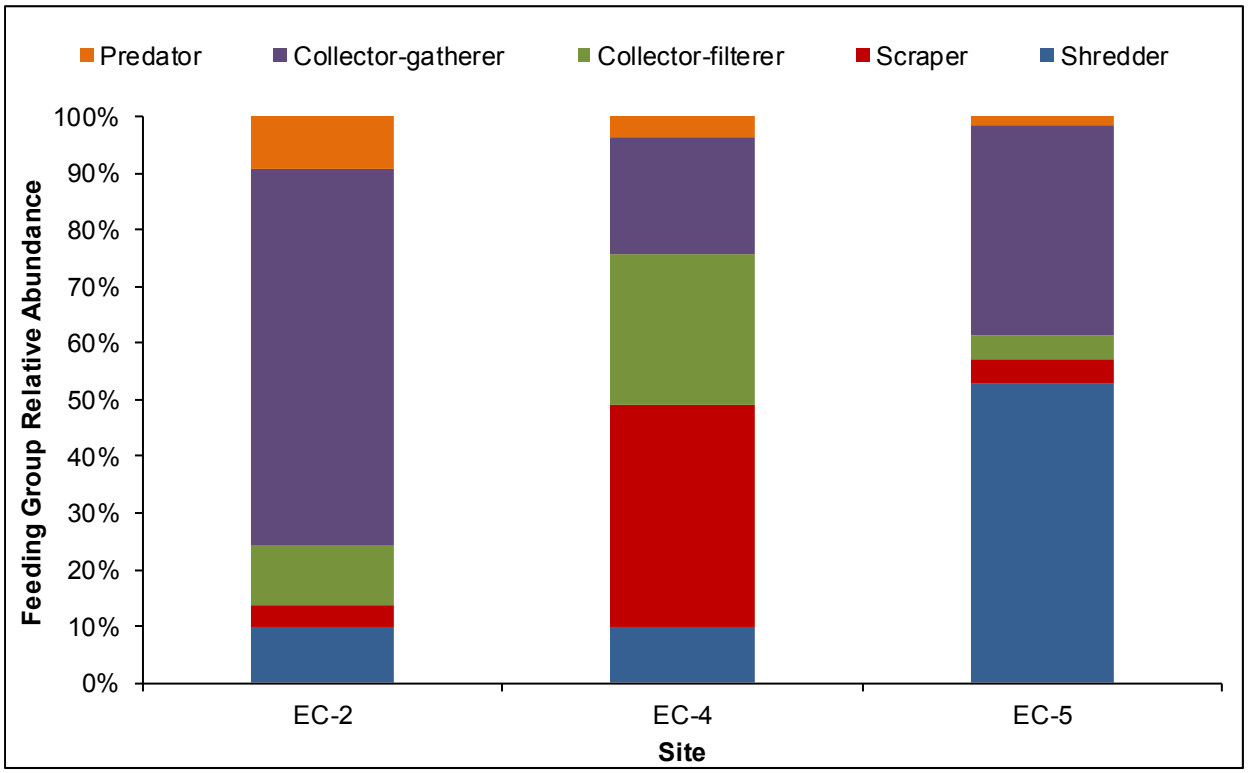

Figure 7. Functional feeding group taxa composition in 2019 at each sampling station on Eccles Creek, Carbon County, Utah.

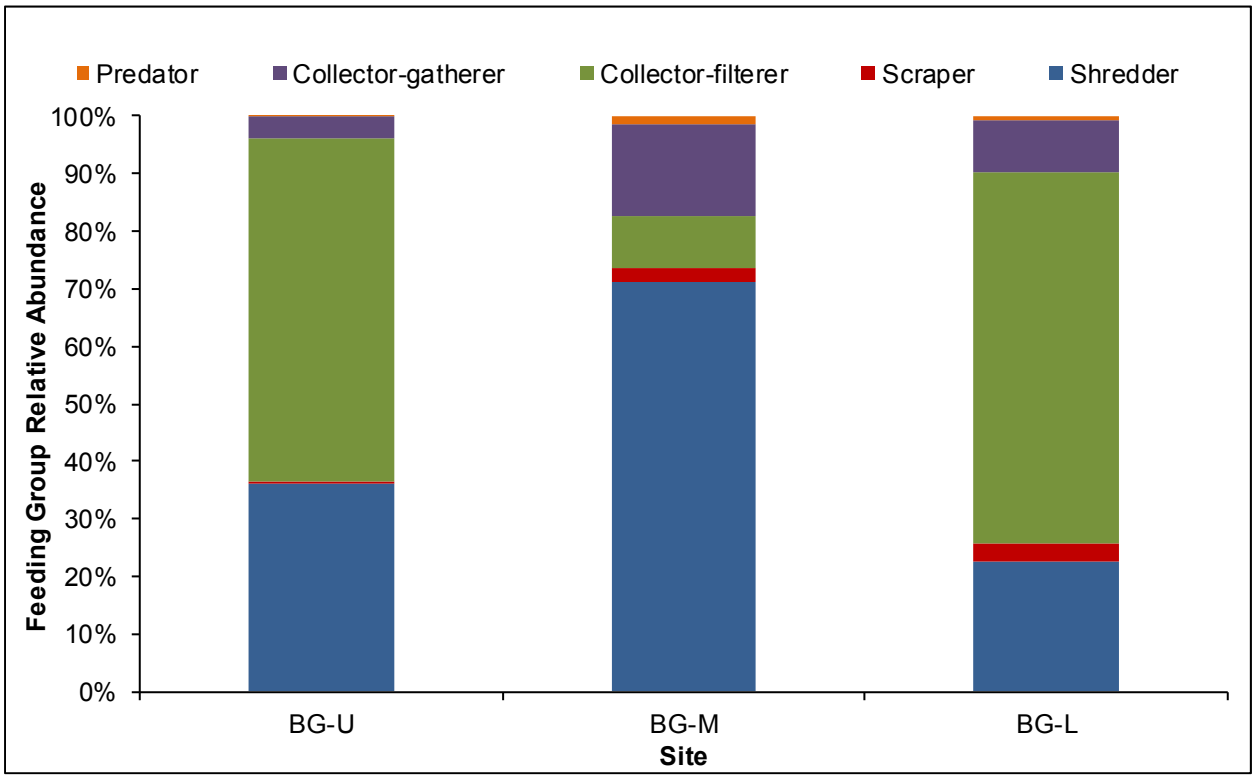

Figure 8. Functional feeding group taxa composition in 2019 at each sampling station on Boulger Creek, Emery County, Utah.

DISCUSSION

Fish

Depletion-based Cutthroat Trout population estimates and densities in Eccles Creek in 2019 decreased from the relatively high estimates calculated in 2013. The exception was Upper Eccles Creek, where the population estimate increased from 2016. However, the 2019 numbers were similar to those from other years. It was speculated that trout spawning habitat was being covered and degraded through calcification, thereby reducing the number of trout. However, sampling in 2013 yielded the highest population estimates since 2004 (Shiozawa 2013). In 2016, the numbers of fish seemed similar to those found before 2013 (Kegerries and Edwards 2017). Although population estimates were slightly lower in 2019, Cutthroat Trout densities increased from 2016. The effect of calcification on the trout community is still not understood; it likely effects the formation and quality of spawning habitat, as well as food diversity throughout the creek. However, it has been hypothesized that increased decomposition of calcium-crusted wood may provide more spawning habitat (Shiozawa 2013). The capture of small fish suggests that spawning likely took place within the creek, but the immigration and emigration of trout downstream in the system is also not understood at this time.

Many size classes, and likely year classes, of trout inhabit Eccles Creek, which is indicative of successful reproduction and recruitment over time. Length comparisons of age-0 trout (less than approximately 130 mm based on the length-frequency histograms) suggests relatively good growth from spring to fall. In one study, back-calculated lengths at annulus formation for trout in the Uinta Mountains, Utah, were around 70 mm (Belk et al. 2009). Age-0 Cutthroat Trout in nearby Winter Quarters Creek, Utah, ranged from 30 to 70 mm by fall (Shiozawa 2010). As reported (Shiozawa 2013; Kegerries and Edwards 2017), there appear to be elevated growth rates in Eccles Creek, which likely result from constant warm flows from groundwater additions.

Overall, and at this point, the fish community in Eccles Creek appears to be healthy and the stream is habitable by various size classes of fish year-round. The macroinvertebrate data suggest that there is an available food source, albeit with limited diversity. Continued monitoring would help discern how ongoing changes in habitat quality may relate to the fish community.

Cutthroat Trout population estimates and densities in Upper and Middle Boulger Creek in 2019 serve as baseline data for future monitoring efforts. The estimates and calculations are relatively low compared to Eccles Creek, but other fish species were also captured in all Boulger Creek sites. Sampling indicated that stocked Tiger Trout and Kokanee Salmon from Electric Lake inhabit Lower Boulger Creek below the Boulger Reservoir Dam. Neither of those species were found above Boulger Reservoir. Rainbow Trout are also stocked into Boulger Reservoir, but were not found in the creek upstream. Mottled Sculpin were common in all three of the Boulger Creek sites, while Redside Shiner were also found in Lower Boulger Creek. Although very few Cutthroat Trout were captured, it is apparent that Boulger Creek provides habitat suitable to other fish species.

Because few Cutthroat Trout were found in Upper and Middle Boulger Creek and none below Boulger Reservoir, it is likely that Boulger Creek does not provide an abundance of Cutthroat Trout habitat and that movement of Cutthroat Trout is hindered by reservoirs. Although multiple

size classes of fish were present in Boulger Creek, the limited captures make it difficult to accurately assess reproduction or recruitment. Future monitoring and sampling will likely provide more insight into the habitability and utilization of Boulger Creek by Cutthroat Trout.

Macroinvertebrates

The apparent increase of macroinvertebrate taxa richness in Eccles Creek since 1990 is positive, especially considering that recent richness values are nearing or exceeding the baseline observations made in 1979 (Winget 1980), at least at EC-5. These data show that impacts to the stream community, which occurred sometime after 1979 and before 1990, are likely due to the initiation of mining and road-widening activities. Although the exact impacts under mining operations or road-widening activities are unknown, the addition of impervious surfaces (e.g., pavement) can increase runoff rates (Trombulak and Frissell 2000), thus increasing sedimentation and perhaps effecting the macroinvertebrate species composition as the substrate composition changes. Increasing taxa richness may indicate system health, but taxa diversity should also be considered in this determination. For example, of the taxa currently present, there is little diversity in taxonomic order. Even though the number of taxa seems to be increasing or at least stable, most of the taxa are filter-feeding dipterans and EPT abundance decreased in 2019. Increased calcification and hardening of the channel from calcium-rich water (post 2001) are likely responsible for the community shift to new filter-feeder and collector-gatherer species from other areas colonizing the stream and, thus, increasing taxa richness. Filterers and gatherers dominate this macroinvertebrate community. However, shredders rebounded in 2019 where they represented more than 50 percent of the macroinvertebrate community collected at EC-5. This could indicate an increase in detritus and organic matter available in the stream.

Mean densities of macroinvertebrates in Eccles Creek at EC-5 were near or exceeded 1979 baseline densities, but EC-4 and EC-2 declined again and were some of the lowest densities recorded. The increase in density from 2003–2011 is likely related to the increase in taxa richness, at least for the dipterans that make up nearly 50 percent of the total density for all three Eccles Creek stations. Ephemeropterans (mostly baetids) make up an additional 8 percent; therefore, nearly 60 percent of the total macroinvertebrate density is derived from two taxonomic orders. The skewed abundance is likely due to stressors within the system that have altered macroinvertebrate habitat through time. Those stressors could be related to landscape disturbances and modified flow regimes.

Based on the current taxa there are likely new colonizers of filter feeders that can tolerate the impacted system. Additionally, there seems to be an increase in community tolerance over time with values that remain high, which suggests that habitat quality has degraded since earlier sampling events. This metric will be important to monitor, as it may be a better gauge of system health compared with taxa richness or density. Currently, all stations score poorly (97–101) and approaching the upper limit (108) of the CTQ values.

The HBI is another method for assessing pollution, sedimentation, and nutrient enrichment (Hilsenhoff 1987). Much like the CTQ values, HBI scores indicate that stream reaches have been degraded and more tolerant species are present. Like the CTQ, this metric is another way to track macroinvertebrate health and provide an indication of increased stress or recovery of the system moving forward.

It is apparent that anthropogenic activities have impacted the Eccles Creek macroinvertebrate community through time. More apparent, but not well understood, is the impact after mining began and the road was widened in 1981. Less apparent, based on the macroinvertebrate data, is the impact of increased discharge since 2001. It is likely that the stream is eroding along cut banks and causing increased sedimentation in pools formed by what appear to be former beaver dams and deadfall, combined with calcification and hardening. Stream aggradation was documented in 2015 at all Eccles Creek survey locations (Earthfax 2015). That report also documented water levels at or near bankfull during those surveys. Bankfull flows are channel-forming flows with the highest rate of sediment transport and erosion (Rosgen 1996). Erosion and deposition can combine to create unfavorable habitat for invertebrates that require interstitial space (space between substrate particles) to thrive, as that space fills with fine sediments and the substrate becomes more embedded (Barbour et al. 1999). Although at times taxa richness, density, and even diversity have increased, community composition must be taken into account. Based on the CTQ values and HBI scores, it appears that the system remains under stress.

The macroinvertebrate assessment for Boulger Creek sites in 2019 will serve as baseline data. Changes in taxa richness, abundance, and diversity can be assessed during subsequent sampling events, much like what has been achieved herein for Eccles Creek. Based on the CTQ values (72.3–76.0) Boulger Creek is of moderate-quality habitat. The HBI scores also indicate some enrichment through organic and nutrient pollution (Hilsenhoff 1987). However, there are intolerant species present within Boulger Creek and their abundance is higher than in Eccles Creek.

The draining of Boulger Reservoir will likely not have much impact on the upstream fish and macroinvertebrate community. The stream channel will begin to reestablish within its historic channel under the reservoir during dewatering. This could temporarily increase fish and macroinvertebrate habitats, although the silt laden stream bed and lack of vegetative cover would create less than desirable habitat during the dewatering. Downstream effects could include siltation from de-watering the reservoir and the stream channel cutting through the reservoir silt deposits. This effect will likely be temporary and shouldn't greatly affect Cutthroat Trout as they don't appear to inhabit that reach of stream.

Because the current fish and macroinvertebrate monitoring within Eccles Creek and Boulger Creek reaches and sites appears to be sufficient to track changes through time and identify potential avenues for remediation, it should be continued. For both fish and macroinvertebrate sampling, using the current methodology for future monitoring will enable statistical comparisons of metrics and quantitative assessments to determine whether changes within the system are biologically significant. The sampling methods, reporting, and analysis of means as contained in this report will allow for statistical analysis with calculations of error and significance. Maintaining sampling efforts during the same season each year will also allow for unbiased sampling and analysis, as well as determination of seasonal differences within the macroinvertebrate community.

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APPENDIX A: ECCLES CREEK MACROINVERTEBRATE SAMPLING RESULTS INCLUDING TAXA COLLECTED AND CALCULATED METRICS FROM THE NATIONAL AQUATIC MONITORING CENTER IN 2019

Table 1. Metrics calculated for macroinvertebrate community analysis of Eccles Creek in 2019.

SampleID	170924	170925	170926	170927	170928	170929	170930	170931	170933	170934	170935	170936	170937	170938	170939	170940	170941	170942	170943	170944	170945	170946
Station (Customer)	EC-2	EC-2	EC-2	EC-2	EC-4	EC-4	EC-4	EC-4	EC-5	EC-5	EC-5	BG-U	BG-U	BG-U	BG-M	BG-M	BG-M	BG-M	BG-L	BG-L	BG-L	BG-L
Waterbody	Eccles Creek	Eccles Creek	Eccles Creek	Eccles Creek	Eccles Creek	Eccles Creek	Eccles Creek	Eccles Creek	Eccles Creek	Eccles Creek	Eccles Creek	Boulger Creek	Boulger Creek	Boulger Creek	Boulger Creek	Boulger Creek	Boulger Creek	Boulger Creek	Boulger Creek	Boulger Creek	Boulger Creek	Boulger Creek
County	Carbon	Carbon	Carbon	Carbon	Carbon	Carbon	Carbon	Carbon	Carbon	Carbon	Carbon	Emery	Emery	Emery	Emery	Emery	Emery	Emery	Emery	Emery	Emery	Emery
State	UT	UT	UT	UT	UT	UT	UT	UT	UT	UT	UT	UT	UT	UT	UT	UT	UT	UT	UT	UT	UT	UT
Latitude	39.68302	39.68302	39.68302	39.68302	39.681794	39.681794	39.681794	39.681794	39.683401	39.683401	39.683401	39.63602	39.63602	39.63602	39.64143	39.64143	39.64143	39.64143	39.64218	39.64218	39.64218	39.64218
Longitude	-111.19312	-111.19312	-111.19312	-111.19312	-111.180406	-111.180406	-111.180406	-111.180406	-111.167527	-111.167527	-111.167527	-111.26278	-111.26278	-111.26278	-111.25893	-111.25893	-111.25893	-111.25893	-111.24489	-111.24489	-111.24489	-111.24489
Collection Date	9/26/2019	9/26/2019	9/26/2019	9/26/2019	9/25/2019	9/25/2019	9/25/2019	9/25/2019	9/25/2019	9/25/2019	9/25/2019	9/26/2019	9/26/2019	9/26/2019	9/27/2019	9/27/2019	9/27/2019	9/27/2019	9/26/2019	9/26/2019	9/26/2019	9/26/2019
Habitat Sampled	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle
Collection Method	Hess net	Hess net	Hess net	Kick net	Hess net	Hess net	Hess net	Kick net	Hess net	Hess net	Kick net	Hess net	Hess net	Hess net	Hess net	Hess net	Hess net	Kick net	Hess net	Hess net	Hess net	Kick net
Area sampled (m^2)	0.09	0.09	0.09	0.74	0.09	0.09	0.09	0.74	0.09	0.09	0.74	0.09	0.09	0.09	0.09	0.09	0.09	0.74	0.09	0.09	0.09	0.74
Field Split	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Lab Split	100	100	100	75	100	100	100	15.63	34.38	62.5	12.5	50	56.25	100	56.25	100	100	12.5	62.5	25	100	18.75
Split Count	223	158	98	740	433	745	431	663	650	776	726	623	793	563	616	319	303	717	653	633	769	860
Fixed Count	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Big Rare Count	0	0	0	10	0	0	0	5	6	3	10	14	8	0	7	0	0	5	8	7	0	4
Richness*	10	6	10	4	8	4	5	7	5	7	7	8	6	3	8	8	6	13	8	11	5	7
Abundance	2478	1756	1089	750	4811	8278	4789	668	21074	13829	736	14000	15753	6256	12246	3544	3367	722	11698	28211	8544	864
Shannon's Diversity*	1.818430603	1.198761204	2.090477875	1.136916592	1.265413097	1.142657449	1.211894611	1.501673757	1.152551392	1.707539174	1.592529744	1.334105175	1.158285147	0.291139839	1.389715455	1.609004548	1.329808259	2.181397262	1.736740746	2.024519076	1.028181456	1.371399127
Simpson's Diversity*	0.804597701	0.606896552	0.889655172	0.643678161	0.556321839	0.632183908	0.650574713	0.717241379	0.604597701	0.822988506	0.772413793	0.595402299	0.577011494	0.131034483	0.629885057	0.744827586	0.668965517	0.871264368	0.795402299	0.850574713	0.583908046	0.655172414
Evenness*	0.789734377	0.669041367	0.907883006	0.820111964	0.608535066	0.824253118	0.752992459	0.771707654	0.716120444	0.877501551	0.818398396	0.641568973	0.646451249	0.265006902	0.668311865	0.773767627	0.742180121	0.850464067	0.835195754	0.844290032	0.638845057	0.704759738
# of EPT Taxa*	3	1	4	1	3	2	2	2	2	2	2	5	2	1	4	4	4	8	3	6	3	4
EPT Taxa Abundance	1122	78	344	190	489	3933	889	157	5679	1053	376	4244	3104	844	4015	1156	1367	527	8409	18589	4289	567
Dominant Family	Chiron-omidae	Chiron-omidae	Chiron-omidae	Chiron-omidae	Elmidae	Elmidae	Elmidae	Elmidae	Chiron-omidae	Chiron-omidae	Hydrop-sychidae	Chiron-omidae	Chiron-omidae	Chiron-omidae	Chiron-omidae	Chiron-omidae	Chiron-omidae	Hepta-geniidae	Baetidae	Baetidae	Chiron-omidae	Baetidae
Abundance of Dominant Family	1067	422	378	404	3722	3078	2111	331	12313	6649	283	8100	8310	5289	6973	1544	1656	206	4996	9289	3667	304
Dominant Taxa	Ortho-cladiinae	Oligochaeta	Ortho-cladiinae	Ortho-cladiinae	Optioservus	Optioservus	Optioservus	Optioservus	Ortho-cladiinae	Chiron-ominae	Hydrop-syche	Ortho-cladiinae	Ortho-cladiinae	Ortho-cladiinae	Ortho-cladiinae	Ortho-cladiinae	Ortho-cladiinae	Cinygmula	Baetis	Baetis	Ortho-cladiinae	Baetis
Abundance of Dominant Taxa	867	1111	222	366	3267	2111	1389	213	11635	4267	245	7756	8121	5278	5728	1356	1556	144	4231	7911	3589	301
Hilsenhoff Biotic Index*	4.6	2.2	3.733333333	4.666666667	4	3.966666667	4.2	3.7	5.266666667	3.866666667	4.6	5.3	5.7	5.8	5.266666667	3.933333333	4.566666667	3.466666667	4.3	4.166666667	4.966666667	3.966666667
# of Intolerant Taxa*	1	0	2	0	0	1	1	1	0	0	0	4	1	1	1	1	2	5	2	4	2	3
Intolerant Taxa abundance	200	0	44	13	44	1333	144	44	549	118	51	2922	1859	300	1930	622	622	220	1187	4300	478	126
# of Tolerant Taxa*	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	0	0	0	1	0	0
Tolerant Taxa abundance	0	0	0	0	0	0	0	0	0	0	0	811	711	33	237	100	44	31	107	2133	89	49
USFS Community Tolerance Quotient (d)*	96	103	92	96	103	95	98	96	99	103	101	57	82	86	75	74	68	63	80	73	75	84
# of shredder taxa*	0	0	0	0	0	0	0	1	0	0	0	2	1	1	1	0	1	2	0	1	1	0
Shredder Abundance	11	11	11	6	11	22	0	2	0	224	1	1222	849	100	790	11	200	35	53	311	133	4
# of scraper taxa*	2	1	1	0	2	1	1	1	1	2	1	2	0	1	2	2	2	3	1	1	1	2
Scraper abundance	122	67	22	7	3278	2111	1389	215	937	1884	95	1511	1165	433	1383	478	389	269	2884	7556	778	257
# of collector-filterer taxa*	1	0	1	0	1	2	2	2	1	0	2	0	1	0	0	0	0	1	1	1	0	1
Collector-filterer abundance	433	0	189	28	378	3489	767	140	2727	284	306	333	3253	0	59	33	33	57	964	422	44	12

Table 1. (Cont.)

SampleID	170924	170925	170926	170927	170928	170929	170930	170931	170933	170934	170935	170936	170937	170938	170939	170940	170941	170942	170943	170944	170945	170946
Station (Customer)	EC-2	EC-2	EC-2	EC-2	EC-4	EC-4	EC-4	EC-4	EC-5	EC-5	EC-5	BG-U	BG-U	BG-U	BG-M	BG-M	BG-M	BG-M	BG-L	BG-L	BG-L	BG-L
# of collector-gatherer taxa*	4	3	3	2	2	1	1	1	3	3	3	3	3	1	5	4	2	4	4	6	3	3
Collector-gatherer abundance	1578	1600	656	656	344	1400	1844	163	15923	10429	212	10233	10020	5656	9177	2411	2467	258	6998	18378	7389	475
# of predator taxa*	2	1	5	2	3	0	1	2	0	2	1	0	1	0	0	2	0	2	2	2	0	1
Predator abundance	322	56	156	52	322	278	44	32	614	456	82	556	406	56	547	400	156	81	727	1367	178	97
# of clinger taxa*	3	2	4	0	2	3	3	3	2	1	3	2	0	1	1	2	2	3	3	4	2	3
Long-lived Taxa*	1	2	1	0	1	2	2	2	1	1	1	0	0	1	0	0	1	0	1	1	1	1
# of Ephem-eroptera taxa*	1	1	1	1	1	0	0	0	1	1	1	3	1	0	2	2	2	4	2	3	2	3
Ephemeroptera abundance	511	56	133	145	78	311	56	8	2855	527	39	2744	1986	678	2500	633	956	405	7553	16489	3944	440
# of Pleco-ptera taxa*	1	0	1	0	0	0	0	0	0	0	0	2	1	1	1	0	1	3	1	1	0	1
Plecoptera abundance	144	0	33	1	0	0	0	1	65	18	18	1300	928	111	940	222	256	68	289	756	89	40
# of Trich-optera taxa*	1	0	2	0	2	2	2	2	1	1	1	0	0	0	1	2	1	1	0	2	1	0
Trichoptera abundance	467	22	178	44	411	3622	833	148	2759	509	319	200	189	56	575	300	156	54	567	1344	256	87
# of Cole-optera taxa*	1	2	1	0	1	1	1	1	1	1	1	0	0	1	0	0	1	0	1	1	1	1
Coleoptera abundance	44	78	67	7	3722	3078	2111	331	1778	2293	131	189	119	89	586	222	122	29	907	2844	456	143
# of Elmidae Taxa*	1	2	1	0	1	1	1	1	1	1	1	0	0	1	0	0	1	0	1	1	1	1
Elmidae abundance	11	22	22	0	222	189	178	15	97	142	5	0	0	11	0	0	22	0	107	178	11	5
# of Mega-loptera taxa*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Megaloptera abundance	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
# of Diptera taxa*	4	2	4	2	3	1	1	3	2	3	4	2	4	1	4	3	1	3	4	4	1	2
Diptera abundance	1189	489	500	452	411	1122	1567	159	13488	7336	202	9344	12393	5322	7368	1756	1767	138	2293	6644	3800	150
# of Chiro-nomidae taxa*	3	2	2	1	2	1	1	1	2	2	1	1	1	1	3	2	1	2	2	2	1	1
Chironomidae abundance	1067	422	378	404	133	1000	1433	133	12313	6649	148	8100	8310	5289	6973	1544	1656	50	1280	4378	3667	90
# of Crust-acea taxa*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crustacea abundance	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
# of Oligo-chaete taxa*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oligochaete abundance	0	1111	133	100	133	56	222	14	0	3111	3	67	79	0	178	389	111	19	71	0	0	4
# of Mollusca taxa*	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mollusca abundance	111	0	44	1	22	0	0	1	0	0	1	0	0	0	0	11	0	3	0	0	0	0
# of Insect taxa*	8	5	9	3	7	4	4	6	5	6	7	7	6	3	8	7	6	11	8	11	5	7
Insect abundance	2356	644	911	649	4622	8133	4567	647	20944	10682	709	13778	15615	6256	11969	3133	3256	694	11609	28078	8544	860
# of Non-insect taxa*	2	1	1	1	1	0	1	1	0	1	0	1	0	0	0	1	0	2	0	0	0	0
Non-insect abundance	122	1111	178	101	189	144	222	21	129	3147	26	222	138	0	277	411	111	28	89	133	0	4

[a]Standardized to OTU and fixed count, see Metadata for details.

Table 2. Macroinvertebrate taxa collected for each station on Eccles Creek in 2019.

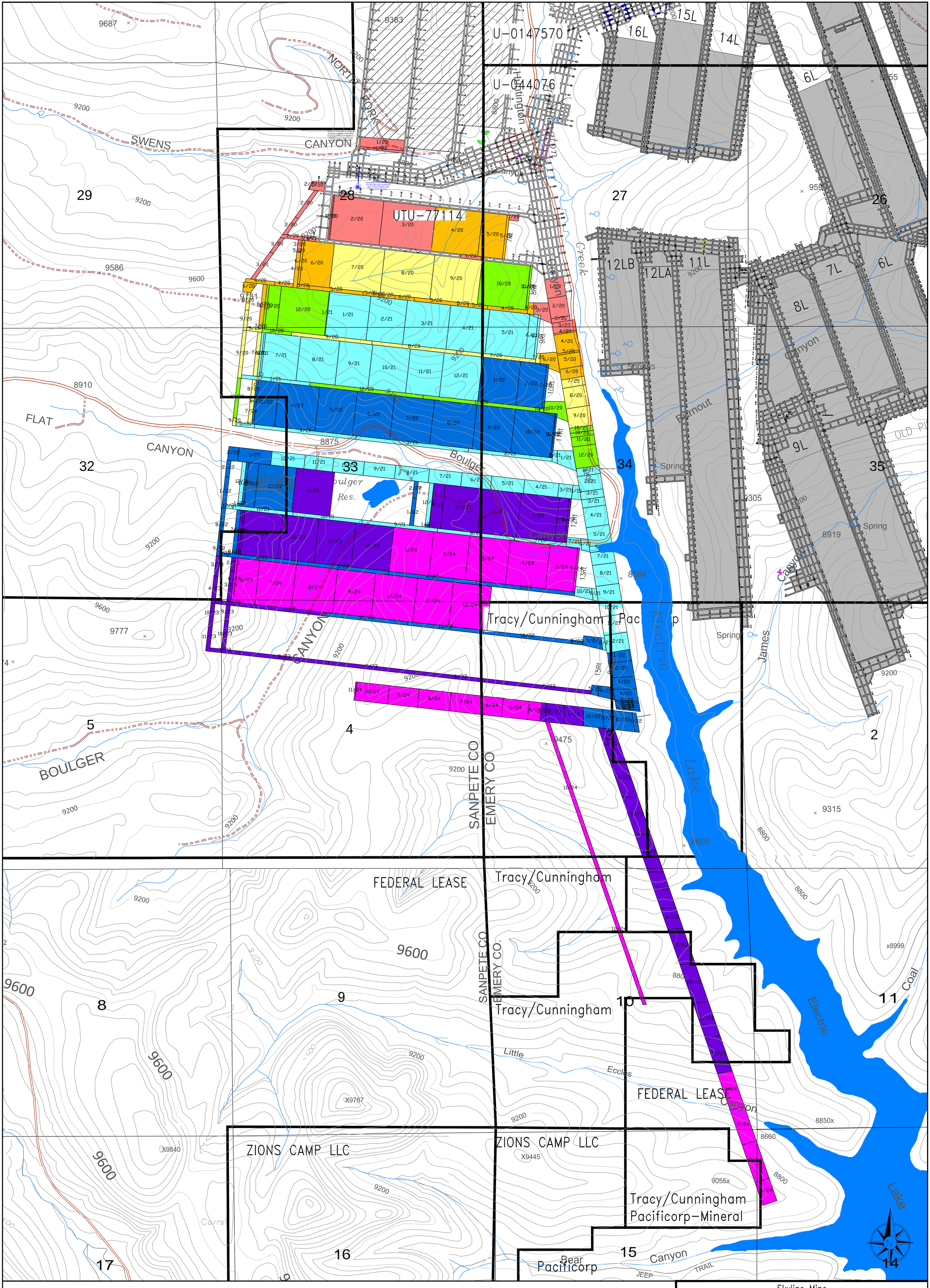
								SampleID	170924	170925	170926	170927	170928	170929	170930	170931	170933	170934	170935	170936	170937	170938	170939	170940	170941	170942	170943	170944	170945	170946
								Station (NAMC)	EC-2	EC-2	EC-2	EC-2	Middle Eccles	Middle Eccles	Middle Eccles	Middle Eccles	Lower Eccles	LowerEccles	Lower Eccles	BG-U	BG-U	BG-U	BG-M	BG-M	BG-M	BG-M	BG-L	BG-L	BG-L	BG-L
								Station (Cust.)	EC-2	EC-2	EC-2	EC-2	EC-4	EC-4	EC-4	EC-4	EC-5	EC-5	EC-5	BG-U	BG-U	BG-U	BG-M	BG-M	BG-M	BG-M	BG-L	BG-L	BG-L	BG-L
								Water-body	Eccles Creek	Eccles Creek	Eccles Creek	Eccles Creek	Eccles Creek	Eccles Creek	Eccles Creek	Eccles Creek	Eccles Creek	Eccles Creek	Eccles Creek	Boulger Creek	Boulger Creek	Boulger Creek	Boulger Creek	Boulger Creek	Boulger Creek	Boulger Creek	Boulger Creek	Boulger Creek	Boulger Creek	Boulger Creek	Boulger Creek
								County	Carbon	Carbon	Carbon	Carbon	Carbon	Carbon	Carbon	Carbon	Carbon	Carbon	Carbon	Emery	Emery	Emery	Emery	Emery	Emery	Emery	Emery	Emery	Emery	Emery
								State	UT	UT	UT	UT	UT	UT	UT	UT	UT	UT	UT	UT	UT	UT	UT	UT	UT	UT	UT	UT	UT	UT
								Lat.	39.68302	39.68302	39.68302	39.68302	39.681794	39.681794	39.681794	39.681794	39.683401	39.683401	39.683401	39.63602	39.63602	39.63602	39.64143	39.64143	39.64143	39.64143	39.64218	39.64218	39.64218	39.64218
								Long.	-111.19312	-111.19312	-111.19312	-111.19312	-111.180406	-111.180406	-111.180406	-111.180406	-111.167527	-111.167527	-111.167527	-111.26278	-111.26278	-111.26278	-111.25893	-111.25893	-111.25893	-111.25893	-111.24489	-111.24489	-111.24489	-111.24489
								Collect. Date	9/26/2019	9/26/2019	9/26/2019	9/26/2019	9/25/2019	9/25/2019	9/25/2019	9/25/2019	9/25/2019	9/25/2019	9/25/2019	9/26/2019	9/26/2019	9/26/2019	9/27/2019	9/27/2019	9/27/2019	9/27/2019	9/26/2019	9/26/2019	9/26/2019	9/26/2019
								Habitat Sampled	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle
								Collect. Method	Hess net	Hess net	Hess net	Kick net	Hess net	Hess net	Hess net	Kick net	Hess net	Hess net	Kick net	Hess net	Hess net	Hess net	Hess net	Hess net	Hess net	Kick net	Hess net	Hess net	Hess net	Kick net
								Area sampled (m^2)	0.09	0.09	0.09	0.74	0.09	0.09	0.09	0.74	0.09	0.09	0.74	0.09	0.09	0.09	0.09	0.09	0.09	0.74	0.09	0.09	0.09	0.74
								Field Split	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
								Lab Split	100	100	100	75	100	100	100	15.63	34.38	62.5	12.5	50	56.25	100	56.25	100	100	12.5	62.5	25	100	18.75
								Split Count	223	158	98	740	433	745	431	663	650	776	726	623	793	563	616	319	303	717	653	633	769	860
Code	Phy-lum	Class	Order	Family	SubFamily	Genus	Species																							
19	Anne-lida	Oligo-chaeta							0	1111	133	180	133	56	222	99	0	3111	32	67	79	0	178	389	111	186	71	0	0	29
58	Arthro-poda	Arach-nida	Trombidi-formes						11	0	0	0	22	0	0	0	0	0	0	44	0	0	0	0	0	22	0	0	0	0
65	Arthro-poda	Arach-nida	Trombidi-formes	Hydryph-antidae		Protzia			0	0	0	0	0	56	0	52	32	18	141	0	0	0	0	0	0	11	18	133	0	0
59	Arthro-poda	Arach-nida	Trombidi-formes	Hygro-batidae					0	0	0	0	0	22	0	0	0	0	0	22	0	0	0	0	0	0	0	0	0	0
61	Arthr-opoda	Arach-nida	Trombidi-formes	Hygro-batidae		Hygrobates			0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
63	Arthro-poda	Arach-nida	Trombidi-formes	Lebertiidae		Lebertia			0	0	0	0	0	0	0	0	0	0	32	67	20	0	99	11	0	22	0	0	0	0
67	Arthro-poda	Arach-nida	Trombidi-formes	Sperch-ontidae		Sperchon			0	0	0	0	0	0	0	0	97	18	54	0	0	0	0	0	0	0	0	0	0	0
2171	Arthro-poda	Arach-nida	Trombidi-formes	Torren-ticolidae		Testu-dacarus			0	0	0	0	0	11	0	0	0	0	11	0	0	0	0	0	0	11	0	0	0	0
94	Arthro-poda	Colle-mbola	Collem-bola						0	0	0	0	0	0	0	0	0	0	0	22	0	0	0	0	0	0	0	0	0	0
121	Arthro-poda	Insecta	Coleo-ptera	Elmidae					0	0	0	0	0	0	0	0	0	0	0	0	20	0	296	0	0	65	124	89	111	22
1743	Arthro-poda	Insecta	Coleo-ptera	Elmidae	Elminae	Cleptelmis	addenda		0	11	0	0	0	0	0	17	0	0	0	0	40	11	0	22	0	43	18	44	11	137
129	Arthr-opoda	Insecta	Coleo-ptera	Elmidae	Elminae	Heter-limnius	corpulentus		0	0	0	0	0	0	0	0	0	0	0	144	0	0	290	189	122	195	0	44	0	0
135	Arthro-poda	Insecta	Coleo-ptera	Elmidae	Elminae	Optio-servus			44	67	22	11	3267	2111	1389	1842	937	1884	1027	44	59	78	0	11	0	11	711	2578	322	872
137	Arthro-poda	Insecta	Coleo-ptera	Elmidae	Elminae	Optio-servus	divergens		0	0	0	0	11	0	0	17	0	0	0	0	0	0	0	0	0	0	0	0	11	0
1076	Arthro-poda	Insecta	Coleo-ptera	Elmidae	Elminae	Optio-servus	quadri-maculatus		0	0	44	2	444	967	722	986	840	409	389	0	0	0	0	0	0	0	53	89	0	0
908	Arthro-poda	Insecta	Diptera	Ceratop-ogonidae	Ceratop-ogoninae	Probezzia			33	11	44	2	222	67	0	52	129	320	238	22	0	0	99	56	22	0	89	44	22	7
851	Arthro-poda	Insecta	Diptera	Ceratop-ogonidae	Dasyh-eleinae	Dasyhelea			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
180	Arthr-poda	Insecta	Diptera	Chirono-midae					56	33	11	47	0	78	67	138	614	213	357	133	119	11	119	89	22	54	124	89	0	29
182	Arthro-poda	Insecta	Diptera	Chirono-midae	Chirono-minae				22	0	11	0	0	11	0	17	0	4267	22	44	51	0	375	0	11	43	142	178	22	14
183	Arthro-poda	Insecta	Diptera	Chirono-midae	Diamesinae				122	67	133	22	0	0	11	0	32	0	34	0	0	0	731	89	56	86	36	156	33	23
184	Arthro-poda	Insecta	Diptera	Chirono-midae	Ortho-cladiinae				867	322	222	659	89	911	1344	977	11635	1920	1178	7756	8121	5278	5728	1356	1556	346	924	3911	3589	577
186	Arthro-poda	Insecta	Diptera	Chirono-midae	Prodia-mesinae				0	0	0	0	0	0	0	0	0	213	0	0	0	0	0	0	0	0	0	0	0	0

Table 2. (Cont.)

Code	Phy-lum	Class	Order	Family	SubFamily	Genus	Species	170924	170925	170926	170927	170928	170929	170930	170931	170933	170934	170935	170936	170937	170938	170939	170940	170941	170942	170943	170944	170945	170946
187	Arthro-poda	Insecta	Diptera	Chirono-midae	Tany -podinae			0	0	0	0	44	0	11	17	32	36	0	167	20	0	20	11	11	11	53	44	22	0
4055	Arthro-poda	Insecta	Diptera	Empididae	Hemerodro-miinae			0	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201	Arthro-poda	Insecta	Diptera	Empididae	Hemero-dromiinae	Chelifera		22	0	22	14	0	0	0	9	32	0	11	0	0	0	0	22	0	0	0	0	0	0
2253	Arthro-poda	Insecta	Diptera	Empididae	Hemero-dromiinae	Neoplasta		67	11	44	54	0	0	11	43	129	18	32	0	0	0	0	0	0	0	0	0	0	0
216	Arthro-poda	Insecta	Diptera	Psycho-didae	Psycho-dinae	Pericoma		0	0	0	0	0	0	0	0	0	0	0	811	711	33	237	100	44	335	107	2133	89	353
221	Arthro-poda	Insecta	Diptera	Simuliidae				0	0	0	0	0	0	0	0	0	0	0	22	1521	0	0	0	0	11	0	0	0	0
223	Arthr-opoda	Insecta	Diptera	Simuliidae	Simuliinae	Simulium		0	0	0	0	0	11	0	17	65	0	11	311	1732	0	59	22	33	573	782	89	11	43
225	Arthro-poda	Insecta	Diptera	Stratio-myidae				0	0	0	0	0	0	0	0	0	71	11	0	0	0	0	0	0	0	0	0	0	0
706	Arthro-poda	Insecta	Diptera	Stratio-myidae	Stratio-myinae	Calop-aryphus		0	0	0	2	11	11	0	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0
226	Arthro-poda	Insecta	Diptera	Stratio-myidae	Stratio-myinae	Eupa-ryphus		0	0	0	0	22	0	11	9	0	89	22	22	0	0	0	0	0	11	0	0	0	0
234	Arthro-poda	Insecta	Diptera	Tipulidae				0	11	0	0	0	11	0	0	0	53	0	0	0	0	0	0	0	0	0	0	0	0
236	Arthro-poda	Insecta	Diptera	Tipulidae	Limoniinae	Antocha	monticola	0	0	11	5	0	22	111	35	787	18	177	0	0	0	0	0	11	0	36	0	11	29
237	Arthro-poda	Insecta	Diptera	Tipulidae	Limoniinae	Dicranota		0	0	0	0	11	0	0	17	32	0	43	44	119	0	0	0	0	22	0	0	0	0
241	Arthro-poda	Insecta	Diptera	Tipulidae	Limoniinae	Hexatoma		0	0	0	0	0	0	0	9	0	0	0	11	0	0	0	0	0	0	0	0	0	0
243	Arthro-poda	Insecta	Diptera	Tipulidae	Limoniinae	Limnophila		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0
247	Arthr-opoda	Insecta	Diptera	Tipulidae	Tipulinae	Tipula		0	0	0	9	11	0	0	9	0	118	11	0	0	0	0	0	0	0	0	0	0	0
303	Arthro-poda	Insecta	Ephem-eroptera	Amel-etidae		Ameletus		0	0	0	0	0	0	0	0	0	0	0	44	0	0	0	0	0	11	0	0	0	0
250	Arthro-poda	Insecta	Ephem-eroptera	Baetidae		Baetis		511	56	133	257	33	178	56	52	2855	384	422	378	632	233	643	111	433	908	4231	7911	3056	2169
834	Arthro-poda	Insecta	Ephem-eroptera	Baetidae		Diphetor	hageni	0	0	0	0	44	122	0	17	0	107	0	22	0	0	20	0	0	0	764	1378	278	22
262	Arthro-poda	Insecta	Ephem-eroptera	Ephem-erellidae				0	0	0	0	0	11	0	0	0	36	0	622	130	44	810	278	178	389	0	222	156	58
267	Arthro-poda	Insecta	Ephem-eroptera	Ephem-erellidae		Drunella	doddsii	0	0	0	0	0	0	0	0	0	0	0	500	514	44	40	44	89	476	129	311	11	43
970	Arthro-poda	Insecta	Ephem-eroptera	Ephem-erellidae		Drunella	grandis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	22	0	44	0	0
5846	Arthro-poda	Insecta	Ephem-eroptera	Ephem-erellidae		Ephem-erella	tibialis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32	0	0	0	0
276	Arthro-poda	Insecta	Ephem-eroptera	Hepta-geniidae				0	0	0	0	0	0	0	0	0	0	0	222	277	211	711	0	178	670	1938	4311	378	786
279	Arthro-poda	Insecta	Ephem-eroptera	Hepta-geniidae		Cinygmula		0	0	0	0	0	0	0	0	0	0	0	600	316	89	237	200	22	1557	53	0	22	0
292	Arthro-poda	Insecta	Ephem-eroptera	Leptoph-lebiidae		Parale-ptophlebia		0	0	0	0	0	0	0	0	0	0	0	356	119	56	40	0	44	314	438	2311	44	94
403	Arthro-poda	Insecta	Plec-optera					0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0
404	Arthro-poda	Insecta	Plec-optera	Capniidae				0	0	0	0	0	0	0	0	0	0	0	911	198	44	691	11	144	141	0	89	11	0
5757	Arthro-poda	Insecta	Plec-optera	Chloro-perlidae	Chloro-perlinae			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
419	Arthro-poda	Insecta	Plec-optera	Chloro-perlidae	Chloro-perlinae	Sweltsa		0	0	0	0	0	0	0	0	0	0	0	22	0	0	20	22	22	11	36	0	0	0
429	Arthro-poda	Insecta	Plec-optera	Nemou-ridae				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2360	Arthro-poda	Insecta	Plec-optera	Nemou-ridae		Zapada		0	0	0	0	0	0	0	0	0	0	0	22	0	0	0	0	0	0	0	0	0	0
439	Arthro-poda	Insecta	Plec-optera	Nemou-ridae	Nemo-urinae	Zapada		0	0	0	0	0	0	0	0	0	0	0	22	40	0	0	0	0	76	0	0	0	0
909	Arthro-poda	Insecta	Plec-optera	Nemou-ridae	Nemo-urinae	Zapada	cinctipes	0	0	0	0	0	0	0	0	0	0	0	89	198	44	0	0	22	108	0	0	0	0
455	Arthro-poda	Insecta	Plec-optera	Perlo-didae				78	0	11	0	0	0	0	9	65	18	108	22	40	11	158	144	44	173	53	0	0	22
462	Arthro-poda	Insecta	Plec-optera	Perlo-didae	Isoperlinae	Isoperla		67	0	22	2	0	0	0	0	0	0	77	0	0	0	20	33	0	184	200	667	78	267
944	Arthro-poda	Insecta	Plec-optera	Perlo-didae	Perlodinae	Megarcys	signata	0	0	0	0	0	0	0	0	0	0	0	33	20	0	31	11	0	12	0	0	0	0

Table 2. (Cont.)

Code	Phy-lum	Class	Order	Family	SubFamily	Genus	Species		170924	170925	170926	170927	170928	170929	170930	170931	170933	170934	170935	170936	170937	170938	170939	170940	170941	170942	170943	170944	170945	170946
474	Arthr-opoda	Insecta	Plec-optera	Taenio-pterygidae					0	0	0	0	0	0	0	0	0	0	0	178	415	11	20	0	22	22	0	0	0	0
483	Arthro-poda	Insecta	Tricho-ptera	Brachy-centridae		Brachy-centrus			11	0	0	0	33	0	100	112	0	18	0	0	0	0	0	0	0	0	0	0	0	0
809	Arthro-poda	Insecta	Trich-optera	Brachy-centridae		Brachy-centrus	americanus		0	0	0	0	0	1189	22	182	420	18	227	0	0	0	0	0	0	0	0	0	0	0
484	Arthro-poda	Insecta	Trich-optera	Brachy-centridae		Micrasema			0	0	0	0	0	11	0	9	0	0	0	0	0	0	0	0	0	32	53	222	122	22
495	Arthro-poda	Insecta	Trich-optera	Hydrop-sychidae					122	0	11	18	122	278	289	251	549	160	411	0	0	0	0	0	0	0	89	89	0	7
807	Arthro-poda	Insecta	Trich-optera	Hydrop-sychidae	Arcto-psychinae	Arcto-psyche	grandis		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	64	244	0	22
499	Arthro-poda	Insecta	Trich-optera	Hydrop-sychidae	Hydrop-sychinae	Hydro-psyche			267	0	133	32	211	2011	356	641	1693	89	2611	0	0	0	0	0	0	0	29	0	33	14
506	Arthro-poda	Insecta	Trich-optera	Hydrop-tilidae					11	0	0	0	0	11	22	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0
509	Arthro-poda	Insecta	Trich-optera	Hydrop-tilidae	Hydro-ptilinae	Hydroptila			0	11	11	0	33	0	0	0	32	142	22	0	0	0	0	0	0	0	0	0	11	0
514	Arthro-poda	Insecta	Trich-optera	Hydrop-tilidae	Hydro-ptilinae	Ochro-trichia			0	11	0	5	0	0	22	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
528	Arthro-poda	Insecta	Trich-optera	Limne-philidae					11	0	11	2	0	0	0	0	0	53	0	0	0	0	79	0	11	0	0	0	0	7
536	Arthro-poda	Insecta	Trich-optera	Limne-philidae	Dicos-moecinae	Dicos-moecus			0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0
584	Arthro-poda	Insecta	Trich-optera	Rhyac-ophilidae		Rhya-cophila			44	0	0	14	11	33	11	0	65	0	43	22	138	33	40	0	11	11	213	311	56	288
1206	Arthro-poda	Insecta	Trich-optera	Rhyaco-philidae		Rhya-cophila	brunnea/-vemna group		0	0	0	0	0	89	11	61	0	0	76	78	51	11	62	78	33	338	64	122	0	98
2913	Arthro-poda	Insecta	Trich-optera	Rhyaco-philidae		Rhya-cophila	rotunda group		0	0	11	7	0	0	0	1	0	29	1	0	0	0	0	0	0	0	0	0	0	0
550	Arthro-poda	Insecta	Trich-optera	Uenoidae	Threm-matinae	Oligoph-lebodes			0	0	0	0	0	0	0	0	0	0	0	89	0	11	395	222	100	184	53	356	33	144
589	Arthro-poda	Insecta	Trich-optera	Uenoidae	Uenoinae	Neoth-remma			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
647	Moll-usca	Bivalvia	Vener-oida	Pisidiidae	Pisidiinae	Pisidium			33	0	44	0	11	0	0	0	0	0	11	0	0	0	0	11	0	32	0	0	0	0
927	Moll-usca	Gastro-poda	Basom-mato-phora	Lym-naeidae	Lymn-aeinae	Lymnaea			0	0	0	0	11	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1369	Moll-usca	Gastro-poda	Neotaen-ioglossa	Hydro-biidae		Pota-mopyrgus	antipodarum		78	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
652	Nem-ata								0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0
655	Platy-helm-inthes	Turb-ellaria							0	0	0	0	0	0	0	0	0	0	0	0	40	0	0	0	0	0	0	0	0	0



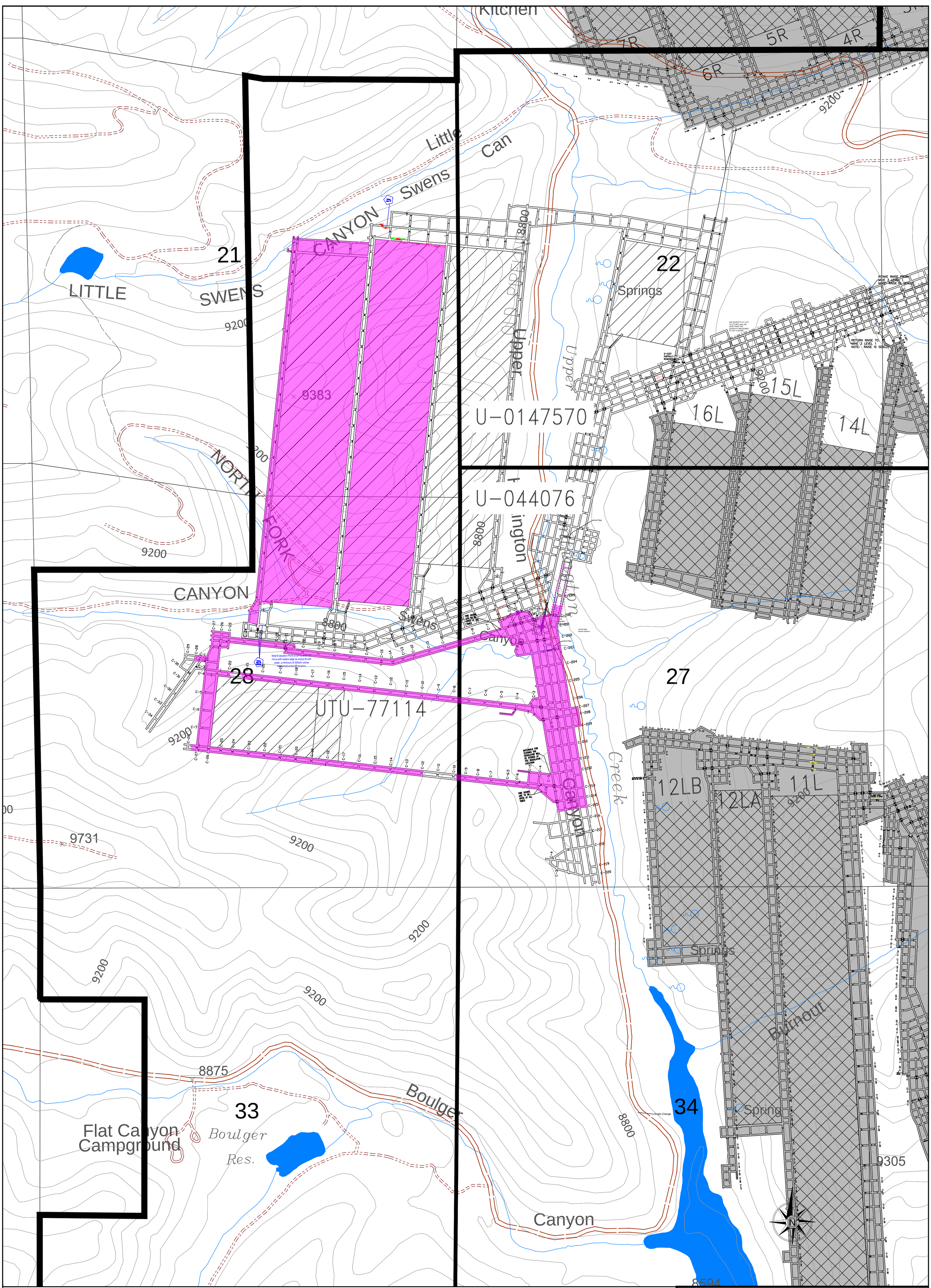
LEGEND

- 1st QUARTER 2019
- 2nd QUARTER 2019
- 3rd QUARTER 2019
- 4th QUARTER 2019
- 2021
- 2022
- 2023
- 2024

Skyline Mine
5 Year
2020 Budget

Canyon Fuel Company, LLC
Skyline Mines

HCR 35 BOX380, HELPER, UT, 84526 435-448-2632	DATE: 1/8/20	CK.BY: JLayton	REVISION:
CAD FILE:	SCALE: 1"=800'	DR.BY: TEARL	
DWG. NO.:			



LEGEND

- Mined 2019
- Mined
- Mined and Sealed

Skyline Mine
As-Mined
2019

Canyon Fuel Company, LLC
Skyline Mines

HCR 35 BOX380, HELPER, UT, 84526 435-448-2632	DATE: 3/26/20	CK.BY:GGalecki	REVISION: 0
CAD FILE:	SCALE: 1"=500'	DR.BY:TEarl	
DWG. NO.:			

Pace Analytical®
Formerly Inter-Mountain Laboratories
1673 Terra Avenue Sheridan, WY 82801
p

Operator Response Received 8/3/2020

Date: 7/27/2020

CLIENT: Canyon Fuel Company
Project: Supplement to S2002097
Lab Order: S2007156

CASE NARRATIVE

Report ID: S2007156001

Samples WRS2019-1 and WRS2019-2 were originally received on February 11, 2020. On July 5, 2020 additional analyses were requested for these samples.

Samples were analyzed using the methods outlined in the following references:

U.S.E.P.A. 600/2-78-054 "Field and Laboratory Methods Applicable to Overburden and Mining Soils", 1978
American Society of Agronomy, Number 9, Part 2, 1982
USDA Handbook 60 "Diagnosis and Improvement of Saline and Alkali Soils", 1969
Wyoming Department of Environmental Quality, Land Quality Division, Guideline No. 1, 1984
New Mexico Overburden and Soils Inventory and Handling Guideline, March 1987
State of Utah, Division of Oil, Gas, and Mining: Guidelines for Management of Topsoil and Overburden for Underground and Surface Coal Mining, April 1988
Montana Department of State Lands, Reclamation Division: Soil, Overburden, and Regraded Spoil Guidelines, December 1994
State of Nevada Modified Sobek Procedure
Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW846, 3rd Edition

All Quality Control parameters met the acceptance criteria defined by EPA and Pace Analytical (Formerly Inter-Mountain Laboratories) except as indicated in this case narrative.

Reviewed by: Karen A Secor
Karen Secor, Soil Lab Supervisor

Pace Analytical®
Formerly Inter-Mountain Laboratories
1673 Terra Avenue Sheridan, WY 82801 ph: (307) 672-8945

Soil Analysis Report

Canyon Fuel Company
HC 35 Box 380
Helper, UT 84526

Report ID: S2007156001

Project: Supplement to S2002097
Date Received: 7/5/2020

Date Reported: 7/27/2020
Work Order: S2007156

Lab ID	Sample ID	Boron ppm	Selenium ppm	Total Carbon %	TOC %	Total Sulfur %	T.S. AB t/1000t	Neutral. Potential t/1000t	T.S. ABP t/1000t
S2007156-001	WRS2019-1	0.68	<0.02	20.9	20.2	0.17	5.31	59.2	53.9
S2007156-002	WRS2019-2	0.89	0.03	43.0	42.2	0.51	16.1	69.3	53.3

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential
Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage, TOC=Total Organic Carbon

Reviewed by: Karen A Secor
Karen Secor, Soil Lab Supervisor

Canyon Fuel Company, LLC
A Subsidiary of Wolverine Fuels, LLC

Skyline Mine
Gregg A. Galecki, Sr. Environmental Engineer
HC35, Box 380
Helper, Utah 84526
(435) 448-2636
Fax (435) 448-2632

February 7, 2020

Ms. Karen Secor
Inter-Mountain Laboratories, Inc.
1633 Terra Avenue
Sheridan, Wyoming 82801

RE: Two (2) Sample for Analysis According to the Parameters Listed in Table 3 of the Utah Division of Oil, Gas and Mining 2008 Guidelines for Topsoil and Overburden

Dear Ms. Secor:

Please find enclosed in one (1) box a total of two (2) sample (WRS2019-1 and WRS2019-2) for analysis in accordance with the parameters listed in Table 3 of the Utah Division of Oil, Gas and Mining 2008 Guidelines for Topsoil and Overburden. Let me know if you need a copy of Table 3.

I'll forward a purchase order number ASAP.

If you have any questions regarding these samples, please give me a call at (435) 448-2636.

Sincerely,

Gregg A. Galecki

Gregg A. Galecki
Sr. Environmental Engineer – Skyline Mines
Canyon Fuel Company, LLC.
(435) 448-2636
ggalecki@wolverinefuels.com

Rec'd 2/11/20
Karen Secor
52002097