Technical Report No. 20-07

Glacier Creek Aquatic Studies, 2020

by

Dylan Krull

December 2020

Alaska Department of Fish and Game **Habitat Section**

Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used without definition in reports by Habitat Section and the Divisions of Sport Fish and Commercial Fisheries. All others, including deviations from definitions listed below, are noted in the text at first mention, as well as in the titles or footnotes of tables, and in figures or figure captions.

Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm
nanometer	nm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity (negative log of)	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
id est (that is)	i.e.
latitude or longitude	lat. or long.
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Measures (fisheries)

fork length	FL
mideye-to-fork	MEF
mideye-to-tail fork	METF
standard length	SL
total length	TL

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	e
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	E
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	$\log_2$, etc.
minute (angular)	'
not detected	N
no data	ND
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

TECHNICAL REPORT NO. 20-07

GLACIER CREEK AQUATIC STUDIES, 2020

By

Dylan Krull

Alaska Department of Fish and Game
Habitat Section, Region I
802 3rd Street, Douglas, Alaska 99824

December 2020

This investigation was fully financed by Constantine North, Inc.

Cover: Lower Glacier Creek on October 28, 2020.

Technical Reports are available through the Alaska State Library, Alaska Resources Library and Information Services (ARLIS) and on the Internet: http://www.adfg.alaska.gov/index.cfm?adfg=habitat_publications.main. This publication has undergone editorial and peer review.

Note: Product names or specific company names used in this publication are included for completeness but do not constitute product endorsement. The Alaska Department of Fish and Game, in accordance with State of Alaska ethics laws, does not favor one group over another through endorsement or recommendation.

Alaska Department of Fish and Game, Habitat Section
802 3rd Street, Douglas, Alaska, 99824, USA

This document should be cited as:
Krull, D. 2020. Glacier Creek aquatic studies, 2020. Alaska Department of Fish and Game, Technical Report No. 20-07, Douglas, AK.

TABLE OF CONTENTS

Page

LIST OF TABLES

Table **Page**

LIST OF FIGURES

Figure **Page**

LIST OF APPENDICES

ACKNOWLEDGEMENTS

Constantine North, Inc. provided financial support for this project. Camp Manager Darsie Culbeck provided logistical support and Environmental Manager Allegra Cairns provided Glacier Creek water quality and discharge data and reviewed the draft report.

Alaska Department of Fish and Game Habitat Section Southeast Regional Supervisor Kate Kanouse collaborated on study design and assisted with sampling. Habitat Biologist William Kane assisted with sampling, processed periphyton samples, and updated the sampling methods. Habitat Biologist Greg Albrecht verified data entry, benthic macroinvertebrate identification, and provided benthic macroinvertebrate identification quality control. Habitat Biologist Kelsey Dean assisted with processing the benthic macroinvertebrate samples, and Habitat Biologist Evan Fritz verified data entry. Habitat Section Operations Manager Dr. Al Ott, and Ms. Kanouse reviewed and edited the report. Thank you all for your contribution.

EXECUTIVE SUMMARY

Constantine North, Inc. (CNI) began exploratory drilling at the Palmer Exploration Project in 2006 and has identified barite, copper, gold, silver, and zinc deposits within the volcanogenic massive sulfide deposit that may support a hard rock mine. CNI contracted with the Alaska Department of Fish and Game (ADF&G) Habitat Section to study aquatic resources in Glacier Creek, a glacial water body draining the area. With CNI, Habitat Section biologists developed a plan to study periphyton, benthic macroinvertebrates, fish, and sediment at two sites in Glacier Creek in spring 2016–2020 to document baseline aquatic productivity and sediment conditions.

We sampled the lower and middle reaches of Glacier Creek on June 2 and 3, 2020. Mean chlorophyll *a* density was 3.91 mg/m^2 at Lower Glacier Creek, the greatest observed, and 1.19 mg/m^2 at Middle Glacier Creek, within the range observed since 2016. The 2020 mean benthic macroinvertebrate density at each site was within the ranges observed since 2016. The macroinvertebrate communities were again dominated by Diptera: Chironomidae insects; generally, Chironomidae insects are fast colonizers, easily adapt to changing habitats, and can exercise more than one feeding strategy (Entrekin et al. 2007).

We captured 10 Dolly Varden char *Salvelinus malma* in Lower Glacier Creek and 6 Dolly Varden char in Middle Glacier Creek and processed those fish as whole body samples. All fish were in good condition, and we captured one 110 mm rainbow trout *Oncorhynchus mykiss* in Lower Glacier Creek for the first time. Most median whole body Dolly Varden char concentrations of analyzed elements were greater among the Lower Glacier Creek samples, while arsenic and silver concentrations were often not detected at both sites. Most concentrations were within the ranges observed in whole body Dolly Varden char samples collected from reference and exploration sites elsewhere in Alaska (Legere and Timothy 2016).

We sampled fine sediment at each site for aluminum, arsenic, cadmium, copper, iron, lead, mercury, selenium, silver, and zinc and found median element concentrations generally similar among sites. The baseline cadmium, copper, and zinc concentrations were near or above the freshwater sediment guidelines suggested by Buchman (2008); while we find the sediment guidelines useful for evaluating the data, we also recognize organisms can respond differently in nature.

INTRODUCTION

The Palmer Exploration Project is located in the Porcupine Mining District about 55 km north of Haines by air in the southeastern extent of the Saint Elias Mountains near the U.S./Canada border (Figure 1). At the site, placer gold mining in Glacier Creek and its tributaries occurred during the 20th century, and in 1969 local prospector Merrill Palmer discovered base-metal sulfides and barite that initiated exploration drill programs by several different companies in the following years, including CNI beginning in 2006 (CNI 2015). The project is located on the same volcanogenic massive sulfide belt as the Greens Creek Mine[a], and CNI has identified barite, copper, gold, silver, and zinc as potential mineable resources (CNI 2015). From 2014–2018, CNI constructed a 6.73 km single lane gravel road to support mineral exploration on the mountainside in the Glacier Creek valley. In 2020, CNI conducted a limited field season focused on collecting environmental data; no exploration drilling occurred.

[a] Owned and operated by Hecla Greens Creek Mining Company on Admiralty Island in Southeast Alaska.

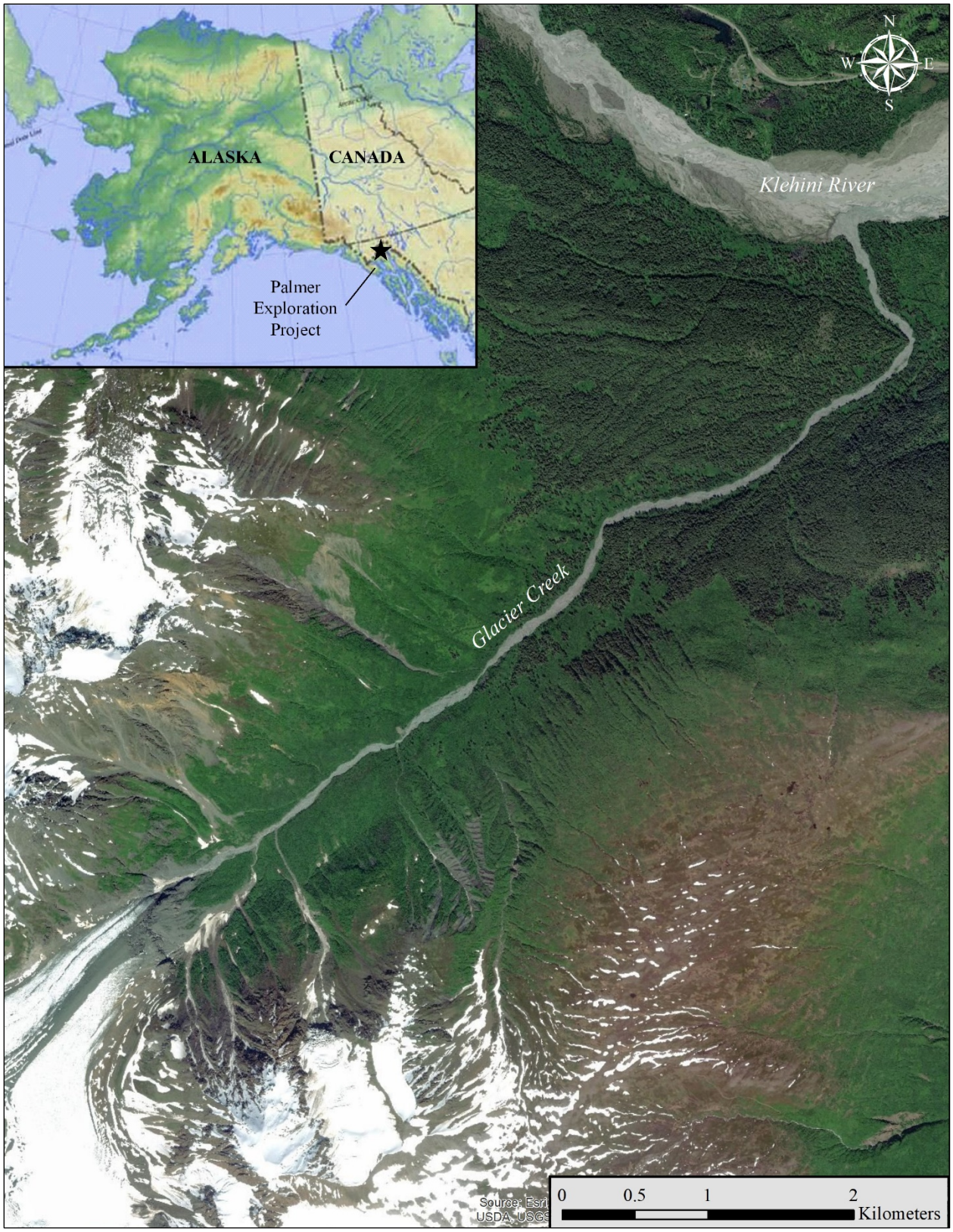


Figure 1.–Palmer Exploration Project area map.

Tetra Tech (2013) and ADF&G biologists have documented[b] Dolly Varden char in Glacier Creek and three tributaries. Since 2016, CNI contracted with the ADF&G Habitat Section to conduct baseline studies in Glacier Creek. Following review of CNI's water quality sample data, Habitat biologists developed a study plan to investigate and document aquatic resources in Glacier Creek, similar to aquatic sampling programs at the Greens Creek Mine (Kane 2020) and Kensington Gold Mine (Timothy and Kanouse 2014), underground hard rock mines in Southeast Alaska. The study plan includes sampling periphyton, benthic macroinvertebrates, and fish, aquatic resources influenced by water and sediment quality through natural processes to provide baseline information on aquatic productivity in Glacier Creek. We conducted these studies in spring 2016–2020; reports summarizing sampling results from previous years are in Kanouse and Legere (2016), Legere and Kanouse (2017–2018), and Krull (2019).

PURPOSE

The purpose of this investigation and technical report is to document the baseline condition, abundance, and composition of biological communities and sediments in Glacier Creek.

AQUATIC STUDIES

We completed the following studies in Glacier Creek:

- chlorophyll density and composition;
- benthic macroinvertebrate density and community composition;
- Dolly Varden char condition and whole body element concentrations; and
- sediment composition and element concentrations.

STUDY AREA

Glacier Creek is about 7 km long, drains a 39 km^2 watershed between its headwaters at the Saksaia Glacier and confluence with the Klehini River, and contributes about 5% of the total Klehini River drainage area measured from the U.S. Geological Survey gage at the Klehini River bridge—about 20 km downstream of the prospect.[c]

Continuous discharge data do not exist for Glacier Creek. Based on the relative size of the Glacier Creek and Klehini River drainage areas, Integral Consulting, Inc.[d] estimated mean Glacier Creek discharge between May and September at 150 ft^3/s, less than the discharges measured in June 2015, August 2015, June 2016, and September 2017 which ranged 146–272 ft^3/s; CNI staff measured streamflow in Lower Glacier Creek on August 18, 2018 and September 19, 2018, and estimated discharge was 155 ft^3/s and 57 ft^3/s. During winter, spring, and fall of 2019 and 2020, CNI staff measured discharge about 2 km upstream of the Middle Glacier Creek sampling site

---

[b] Matthew Kern, Habitat Biologist, to Jackie Timothy, Southeast Regional Supervisor, ADF&G Division of Habitat. Memorandum: Glacier Creek investigation trip report; dated 6/26/2014. Unpublished document, can be obtained from the Southeast Regional Supervisor, ADF&G Habitat Section, 802 3rd St, Douglas, AK.

[c] Marcia Greenblatt and Alice Conovitz, Integral Consulting, to Darwin Green, Constantine North. Memorandum: Klehini River and Glacier Creek hydrologic data summary; dated 2/24/2016. Unpublished document, can be obtained from Constantine North, Inc., 800 W. Pender St. Ste. 320, Vancouver, BC, Canada.

[d] Marcia Greenblatt and Alice Conovitz, Integral Consulting, to Darwin Green and Allegra Cairns, Constantine North. Memorandum: Klehini River and Glacier Creek hydrologic data summary–fall 2016 update; dated 12/19/2016. Unpublished document, can be obtained from Constantine North, Inc., 800 W. Pender St. Ste. 320, Vancouver, BC, Canada.

which ranged 3.36–71.66 ft^3/s (A. Cairns, Environmental Manager, Constantine North Inc., Vancouver, personal communication).

CNI's 2008–2014, 2017–2019 Glacier Creek year-round basic water quality data documents total suspended solids ranging 3–2,470 mg/L, turbidity ranging 0.2–2,760 nephelometric turbidity units (NTU), and pH ranging 6.59–8.33 (DOI 2016; A. Cairns, Environmental Manager, Constantine North Inc., Vancouver, personal communication).

The lower 1 km of Glacier Creek (Stream No. 115-32-10250-2077-3151) provides habitat for coho salmon *O. kisutch*, cutthroat trout *O. clarkii*, and Dolly Varden char (Giefer and Blossom 2020).We captured Dolly Varden char while opportunistically sampling fish use 2016–2020; in October 2019, we documented one pair of coho salmon; and in 2020 we captured one rainbow trout.[e,f,g,h] Further upstream in the drainage, we captured Dolly Varden char 0.6 km upstream of the Christmas Creek confluence, a nonglacial tributary located 4.5 km upstream of the Glacier Creek confluence with the Klehini River; previously, Tetra Tech (2013) and ADF&G documented the upper extent of Dolly Varden char below the Christmas Creek confluence. In 2018, we sampled fish use near the upper extent of Glacier Creek and did not find fish.[i]

We sampled two locations in Glacier Creek: Lower Glacier Creek and Middle Glacier Creek (Figure 2).

---

[e] Dylan Krull, Habitat Biologist, to Jackie Timothy, Southeast Regional Supervisor, ADF&G Division of Habitat. Memorandum: 2018 Palmer Project Glacier Creek coho surveys; dated 12/7/2018. Unpublished document, can be obtained from the Southeast Regional Supervisor, ADF&G Habitat Section, 802 3rd St, Douglas, AK.

[f] Dylan Krull, Habitat Biologist, to Kate Kanouse, Southeast Regional Supervisor, ADF&G Habitat Section. Memorandum: 2020 Palmer Project biomonitoring; dated 8/6/2020. Unpublished document, can be obtained from the Southeast Regional Supervisor, ADF&G Habitat Section, 802 3rd St, Douglas, AK.

[g] Jesse Lindgren, Habitat Biologist, to Kate Kanouse, Southeast Regional Supervisor, ADF&G Habitat Section. Memorandum: 2019 Palmer Project Glacier Creek fish surveys; dated 12/19/2019. Unpublished document, can be obtained from the Southeast Regional Supervisor, ADF&G Habitat Section, 802 3rd St, Douglas, AK.

[h] Dylan Krull, Habitat Biologist, to Kate Kanouse, Southeast Regional Supervisor, ADF&G Habitat Section. Memorandum: 2020 Palmer Project Glacier Creek fish surveys; dated 11/24/2020. Unpublished document, can be obtained from the Southeast Regional Supervisor, ADF&G Habitat Section, 802 3rd St, Douglas, AK.

[i] Dylan Krull, Habitat Biologist, to Jackie Timothy, Southeast Regional Supervisor, ADF&G Division of Habitat. Memorandum: Waterfall and Hangover Creeks fish investigations; dated 10/22/2018. Unpublished document, can be obtained from the Southeast Regional Supervisor, ADF&G Habitat Section, 802 3rd St, Douglas, AK.

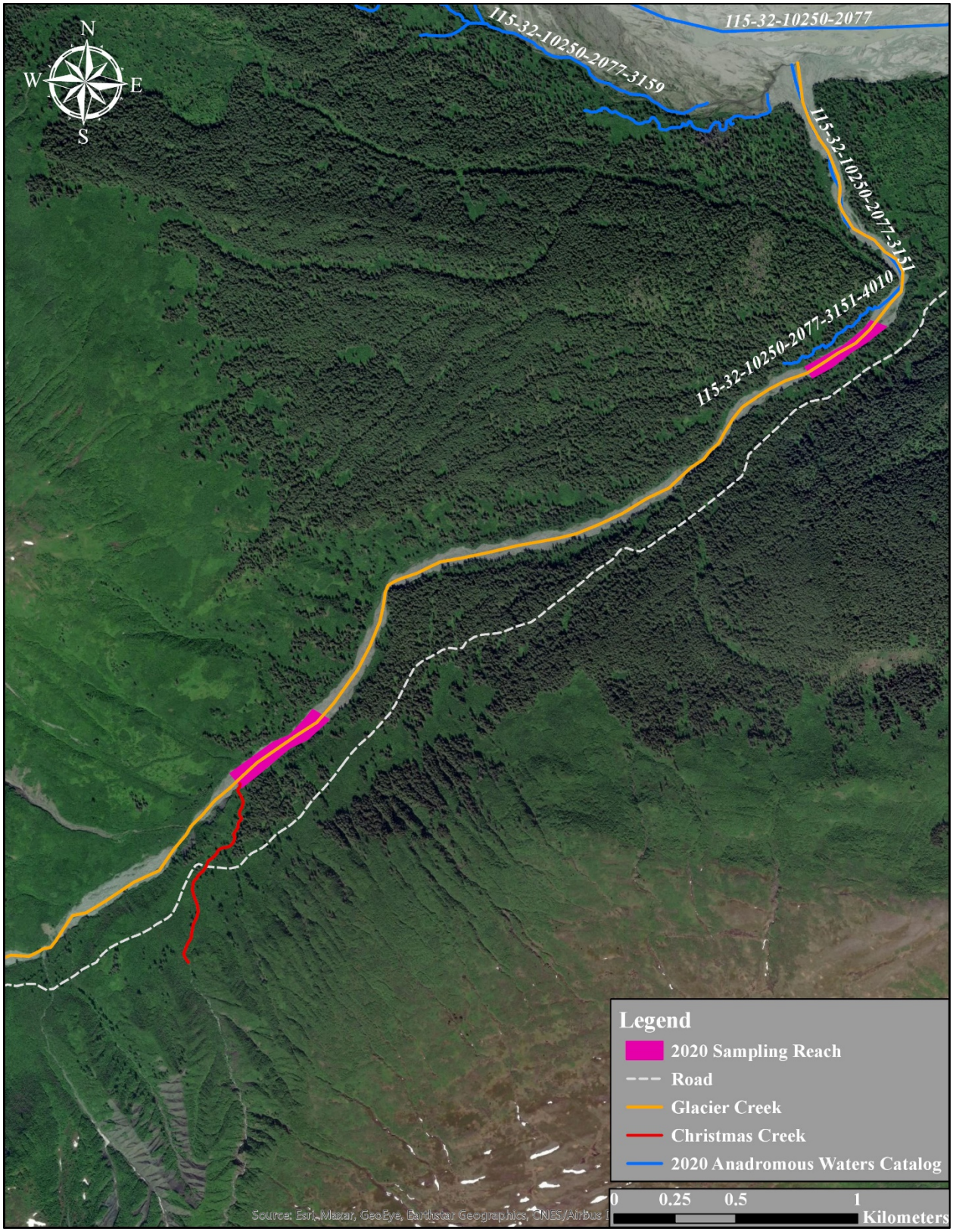


Figure 2.–Glacier Creek sample site map.

Lower Glacier Creek

The Lower Glacier Creek sample site is located at the former Glacier Creek bridge near 230 m elevation, about 1.5 km upstream of the Klehini River (Table 1; Figure 3). We accessed the site from the old bridge crossing at the end of Porcupine Road.

Lower Glacier Creek is a medium glacial outwash channel, which exhibit high rates of aggradation and scour resulting in active channels that move throughout the floodplain (Paustian 2010). Streambed gradient ranges 1–5% and the substrate is composed of cobble, gravel, sand, and silt. In 2020, we sampled a 347 m reach, a larger reach than most sample years due to low water level and fewer suitable fish sampling areas available; we collected periphyton, benthic macroinvertebrate, and sediment samples in channel braids and along the main channel margin upstream of the old crossing, and fish throughout the sample reach. We observed young-of-year Dolly Varden char while electrofishing (20–30 mm FL), which suggests successful spawning may have occurred in Glacier Creek last fall. We also captured one rainbow trout, the first documented in Glacier Creek.

Comparing stream characteristics of the Lower Glacier Creek sample site 2016–2020, we observed different main channel courses and channel braids each year. In 2020, we observed braided channels on river right above the old bridge crossing, and the main channel flowing down the center of the floodplain.

Table 1.–2020 Lower Glacier Creek sample site location data.

	Latitude	Longitude
Upper extent	59.41653	-136.30419
Lower extent	59.41845	-136.29940

Note: WGS84 datum.

Figure 3.–Lower Glacier Creek, looking downstream from the top of the sampling reach.

Middle Glacier Creek

The Middle Glacier Creek sample site is located near 350 m elevation, about 4.5 km upstream of the Klehini River (Table 2; Figure 4). We accessed the site by hiking down from the access road.

Middle Glacier Creek also is characterized as a medium glacial outwash channel (Paustian 2010). Streambed gradient ranges 4–8% and the substrate is composed of cobble, gravel, sand, and silt. In 2020, we sampled a 440 m reach from the Christmas Creek confluence downstream, a larger reach than most sample years due to low water level and fewer suitable fish sampling areas available. We collected periphyton, benthic macroinvertebrate, and sediment samples in channel braids and along the main channel margin, and fish throughout the sample reach. We observed one young-of-year Dolly Varden char (20 mm FL) while electrofishing.

Comparing stream characteristics of the Middle Glacier Creek sample site 2016–2020, we observed different main channel courses and channel braids each year. In 2020, the main channel shifted to the river right since sampling last year, which intercepted Christmas Creek where it flows into the Glacier Creek floodplain.

Table 2.–2020 Middle Glacier Creek sample site location data.

	Latitude	Longitude
Upper extent	59.40073	-136.34446
Lower extent	59.40321	-136.33845

Note: WGS84 datum.

Figure 4.–Middle Glacier Creek (right) and Christmas Creek confluence (left).

METHODS

Data sets are reviewed annually to ensure accuracy and consistency with modifications to methods; corrections and updates are reported in the document and appendices. The most recent technical report presents the current data sets and should be used to analyze data from previous years.

WATER QUALITY

Basic water quality data were collected with a Hanna HI98194 and a Hach 2100P Portable Turbidimeter; the instruments were calibrated per the manufacturer's instructions prior to sampling. Historical data is provided in Appendix A.

PERIPHYTON: CHLOROPHYLL DENSITY AND COMPOSITION

Periphyton is composed of primary producing organisms, such as algae, cyanobacteria, and heterotrophic microbes, and detritus attached to the submerged surfaces of aquatic ecosystems. Algal density and community structure are influenced by water and sediment characteristics through physical, chemical, and biological factors, and disturbances that change throughout the year (Barbour et al. 1999).

Periphyton is sampled in Lower and Middle Glacier Creek to estimate algal density and community composition at each site, using concentrations of chlorophylls *a*, *b*, and *c.* The concentration of chlorophyll *a* (Chl-*a*) pigment in periphyton samples provides an estimate of active algal biomass (density), while concentrations of chlorophyll *b* (Chl-*b*) and chlorophyll *c* (Chl-*c*) pigments estimate the composition of algal organisms present, such as green algae that produce Chl-*b*, and diatoms and brown algae that produce Chl-*c*. The chlorophyll data are used to document baseline primary productivity.

Sample Collection and Analysis

Sampling methods are adapted from Barbour et al. (1999). Ten smooth, flat, undisturbed, and perennially wetted rocks were collected from submerged cobble in riffle habitats in less than 0.45 m water depth at each sample site and submerged in the creek in the same orientation they were collected. To collect a sample from each rock, a 5 × 5 cm square of high-density foam was held on the sample area; the area around the foam was scrubbed with a toothbrush to remove algae and other organisms outside the sample area. The rock was rinsed by submerging it in the stream while holding the foam in place; the toothbrush also was rinsed in the stream.

A 47 mm diameter Type A/E 1 µm glass fiber filter was placed into a Nalgene® filter receptacle attached to a vacuum pump with a gauge. The foam square was removed and the underside of the foam and the sample area were gently scrubbed in a circular pattern with the toothbrush into the filter receptacle. Stream water in a wash bottle was used to rinse loosened periphyton from the foam, rock, toothbrush, and the inside of the filter receptacle onto the filter. The sample area was scrubbed a second time and the rinse cycle was repeated. With most of the water pumped through the filter, maintaining pressure less than 34 kPa, a few drops[j] of saturated magnesium carbonate solution was added to the filter[k] before the sample was pumped dry. The glass fiber filter was removed from the receptacle, folded in half with the sample inside, and wrapped in a white coffee

[j] This measurement is not exact as the amount of water and $MgCO_3$ used to create a saturated solution varies and does not affect sample integrity; supernatant solution was used to avoid $MgCO_3$ solids.

[k] To prevent acidification and conversion of chlorophyll to phaeophytin.

filter for additional moisture absorption. The samples were placed in a sealed, labeled plastic bag with desiccant and stored in a light-proof cooler containing frozen icepacks during transportation; samples were stored in a -20°C freezer in the ADF&G Douglas laboratory until processing.

USEPA (1997) protocol was followed for chlorophyll extraction and measurement, determining instrument and estimated detection limits, and data analysis.[1] Samples were removed from the freezer, cut into small pieces, and placed into individual 15 mL screw cap centrifuge tubes containing 10 mL of 90% buffered acetone. The centrifuge tubes were capped and shaken to ensure complete submersion of the sample. Secured in a vial rack covered with aluminum foil, the samples were stored in a refrigerator for 12–24 hours to allow for saturation and chlorophyll extraction.

The samples were centrifuged for 20 min at 500 relative centrifugal force. Prior to sample measurement, two cuvettes containing 90% buffered acetone were placed into a Shimadzu UV-1800 spectrophotometer to calibrate absorbance of the solvent at wavelengths 664 nm, 647 nm, 630 nm, and 750 nm. Each sample supernatant was decanted into an individual cuvette and absorbance was measured at each wavelength. Each sample was treated with 80 µL of 0.1 N hydrochloric acid for 90 seconds to convert the chlorophyll to phaeophytin, and absorbance was measured at wavelengths 665 nm and 750 nm. To minimize stray light and improve resolution, sample cuvettes were cleaned with a nonabrasive wipe prior to placement in the spectrophotometer.

Trichromatic equations were used to estimate Chl-*a*, Chl-*b*, and Chl-*c* concentrations, correcting for turbidity using the 750 nm absorbance value (APHA 2012, USEPA 1997). Chl-*a* concentrations were corrected when phaeophytin was detected. When Chl-*a* was not detected in a sample, the concentration is reported as the spectrophotometer estimated detection limit and the values for Chl-*b* or Chl-*c* are excluded. The 2020 estimated detection limit for Chl-*a* concentration was 0.25 mg/m^2.

Data Presentation

For each site and by year, mean Chl-*a*, Chl-*b*, and Chl-*c* densities are presented in a table, Chl-*a* sample densities in a figure, and mean proportions of Chl-*a,* Chl-*b,* and Chl-*c* in a figure. A comparison of mean Chl-*a* densities among sites also is presented in a figure. The 2016–2020 sample density data are provided in Appendix B.

BENTHIC MACROINVERTEBRATE DENSITY AND COMMUNITY COMPOSITION

Benthic macroinvertebrates (BMI) classified in the orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies), collectively known as EPT taxa, have complex and short life cycles and many genera are sensitive to changes in water and sediment quality (Barbour et al. 1999). These organisms are secondary producers, feed upon periphyton and other macroinvertebrates, and provide a food source for fish.

BMIs in Lower and Middle Glacier Creek are presented to estimate density and community composition and document baseline conditions at each site.

[1] Deviations from USEPA (1997) include samples storage longer than 3.5 weeks, and cutting sample filters to reduce acetone exposure for laboratory staff (as opposed to homogenization).

Sample Collection and Analysis

Six BMI samples were collected from each site using a Surber stream bottom sampler in riffles and runs with gravel and cobble substrate and varying flow velocities—habitats that support greater BMI densities and taxonomic richness (Barbour et al. 1999). Other habitat types (e.g. pools) were excluded to reduce data variability.

The Surber stream bottom sampler has a 0.093 m^2 sample area and material is captured in a 200 mL cod end, both constructed with 300 µm mesh net. After securing the frame on the streambed with the opening facing the upstream current, rocks within the sample area were scoured with a scrub brush; gravel, sand, and silt were disturbed to about 10 cm depth to dislodge macroinvertebrates into the net. The net was rinsed in the stream to ensure all organisms drifted into the cod end, and each sample was transferred from the cod end to a labeled 500 mL plastic bottle. Samples were preserved in 95% ethanol at a ratio of three parts ethanol to one part sample. Samples exceeding the capacity of the cod end were discarded in the field to minimize detritus and substrate in samples and ensure proper sample preservation.

Entire samples were processed with an elutriator system with a 0.3 mm sieve to sort macroinvertebrates from debris[m] and organisms were identified to the lowest practical taxonomic level[n] using Merritt and Cummins (1996) and Stewart and Oswood (2006). Quality control of benthic macroinvertebrate enumeration was completed for two samples.

BMI density was calculated for each sample by dividing the number of macroinvertebrates by 0.093 m^2—the Surber sampling area. Mean density was estimated for each site by calculating the mean density among the six samples. Taxa richness is reported as the number of taxonomic groups identified to the lowest practical level; terrestrial[o] organisms were excluded from all calculations.

Data Presentation

For each site and by year, a table is presented summarizing mean BMI density, total taxa, total EPT taxa, % EPT insects, and % Chironomidae insects. BMI densities and community composition are illustrated in figures and BMI density and taxa richness data comparisons among sites also are presented. The 2020 sample data and the 2016–2020 data summaries are provided in Appendix C.

RESIDENT FISH CONDITION

Age, sex, season, maturation, diet, gut contents, fat reserve, and muscular development affect fish condition. Length and weight data of fish captured in Lower and Middle Glacier Creek were used to assess resident Dolly Varden char condition.

---

[m] Gordon Willson-Naranjo and Greg Albrecht, Habitat Biologists, to Jackie Timothy, Southeast Regional Supervisor, ADF&G Division of Habitat. Memorandum: Benthic macroinvertebrate elutriation trials amendment; dated 12/17/2013. Unpublished document can be obtained from the Southeast Regional Supervisor, ADF&G Habitat Section, 802 3rd St, Douglas, AK.

[n] Insects of the orders Ephemeroptera, Plecoptera, Trichoptera, and Diptera to genus, except nonbiting midges to family Chironomidae, and all others to class or order. Damaged and degraded organisms that cannot be identified are not reported.

[o] Including adult terrestrial insects of the orders Ephemeroptera, Plecoptera, Trichoptera, and Diptera.

Sample Collection and Analysis

Resident Dolly Varden char FL was recorded to the nearest 1 mm and weight to the nearest 0.1 g. Fulton's condition factor (K) was calculated for individual fish using the equation given in Anderson and Neumann (1996), where weight (W) is divided by the cubed length (L), and the product multiplied by 100,000:

$$K = \frac{W}{L^3} \times 100{,}000$$

Data Presentation

For each site the mean fish condition factor of Dolly Varden char is presented and compared among sites; 2016–2019 data and provided in Appendix D.

RESIDENT FISH ELEMENT CONCENTRATIONS

Element bioavailability and bioaccumulation depends on physical and chemical factors and interactions among biological communities (Tchounwou et al. 2012). Similar to other studies in Alaska (Legere and Timothy 2016), resident Dolly Varden char samples from Lower and Middle Glacier Creek were analyzed for whole body concentrations of silver (Ag), arsenic (As), cadmium (Cd), copper (Cu), mercury (Hg), lead (Pb), selenium (Se), and zinc (Zn) to document baseline concentrations and variability. These elements were selected based on CNI's Glacier Creek water sample data and potential target elements identified in the ore body.

Sample Collection and Analysis

Fish were captured using a Smithroot LR-24 backpack electrofisher and 10 resident Dolly Varden char were retained.[p,q] The target size range for sample retention was fish measuring 90–130 mm FL, as other Southeast Alaska Dolly Varden char sampling programs require (Timothy and Kanouse 2014, Legere and Timothy 2016, Kane 2020). A 90 mm fish provides the minimum weight requirement for laboratory testing, while a 130 mm fish is 2–3 years old and young enough to reasonably conclude it is resident due to sampling timing and location—about 60 km upriver from Chilkat Inlet. Due to general scarcity of fish at both sample sites, all fish captured were retained as samples regardless of size between 2016 and 2019; the sampling reach extent also was contingent on capture efforts each year. In 2020, we discontinued submitting composite samples of two smaller fish due to dilution needed to process samples at the lab resulting in greater method reporting limits.

Wearing latex gloves, each fish was placed in an individually labeled plastic bag. During transport, samples were stored in a cooler with frozen icepacks and in a freezer while onsite. At the ADF&G Douglas laboratory FL and weight were measured in the sample bags, correcting for bag weight. Samples were stored in a -20ºC freezer in the lab until shipped to a private lab for analyses.

Samples were shipped to ALS Environmental in Kelso, WA in a cooler with frozen icepacks via overnight freight, maintaining written chain of custody documentation. ALS Environmental measured total concentrations of Ag, As, Cd, Cu, Hg, Pb, Se, and Zn in each sample on a dry-weight basis, following USEPA (2002) method 1631E for Hg, and USEPA (1994) method 6020A[r]

---

[p] In 2016 and 2019, baited minnow traps were also used to capture fish in Lower Glacier Creek.

[q] In 2017, 2018, and 2020, only six samples were retained from Middle Glacier Creek due to scarcity of fish.

[r] In 2016, 2018, and 2019, the same lab used EPA method 200.8 (USEPA 1994).

for the other elements. The laboratory provided Tier II quality control information including results for sample duplicates, matrix spikes, standard reference materials, and blanks.

Data Presentation

For each site and by year, Dolly Varden char whole body element concentrations are presented in a figure; comparisons of element concentrations data among sites also are presented. A table with the raw data, presenting the mean value for duplicate sample results and 2020 laboratory report are in Appendix D.

In 2018, the lab reported greater Ag and As method reporting limits than previous years, largely due to underweight samples (K. Clarkson, Senior Project Manager, ALS Environmental, Kelso, personal communication). Therefore, to avoid misrepresenting sample results below method reporting limits as whole body element concentrations data, element concentrations undetected are illustrated as an empty circle (◦) at the method reporting limit, while measured element concentrations are illustrated as a solid circle (•).

SEDIMENT ELEMENT CONCENTRATIONS

Sediment element concentrations are influenced by a variety of factors, such as geochemical composition and weathering within the watershed, sediment grain size, organic content, and development (Tchounwou et al. 2012). Subsequently, sediment element concentrations influence aquatic productivity. Fine sediments were sampled at Lower and Middle Glacier Creek for total organic carbon, acid volatile sulfide, and total concentrations of Ag, aluminum (Al), As, Cd, Cu, iron (Fe), Hg, Pb, Se, and Zn to document baseline conditions and variability. These elements were selected based on CNI's Glacier Creek water sample data and potential target elements identified in the ore body.

Sample Collection and Analysis

Wearing latex gloves, five samples were collected from sand/silt bars within actively flowing channels and retained the top 4 cm of sediment in glass jars for element analyses and plastic bags for particle size analyses. Samples were stored in a cooler with frozen icepacks in the field and in a hotel refrigerator while in Haines. On June 4, 2020, CNI staff transported the sediment samples in coolers with ice packs via a courier to ALS Environmental in Whitehorse, BC.

ALS Environmental measured total organic carbon, acid volatile sulfide, and total Ag, Al, As, Cd, Cu, Fe, Hg, Pb, Se, and Zn concentrations on a dry-weight basis using Canadian methods listed in Table 3.[s,t] The laboratory provided quality control results for laboratory controls and blanks.

[s] The 2016 Glacier Creek sediment samples were processed by an ALS Environmental lab in Kelso, WA. In 2017–2020, CNI sent the sediment samples to a different ALS lab; though methods used by each lab were different, the results are comparable. The parameters analyzed were different between labs; data comparisons between years are presented where applicable.

[t] Sample particles less than 2 mm are sieved and processed.

Table 3.–2020 sediment tests, analytes, and methods.

Test Description	Analyte	Method
Particle size distribution	Particle size determination	SSIR-51 Method 3.2.1
Total inorganic carbon in soil	Total inorganic carbon	CSSS (2008) P216-217
Total organic carbon calculation	Total organic carbon	CSSS (2008) 21.2
Total Carbon by combustion method	Total carbon	CSSS (2008) 21.2 (mod)
Mercury in soil by CVAAS	Hg	EPA 200.2 / 1631 Appendix (mod)
Inorganic carbon as CaCO3 equivalent	Inorganic carbon	Calculation
Metals in soil by CRC ICPMS	Ag, Al, As, Cd, Cu, Fe, Pb, Se, and Zn	EPA 6020B (mod)
Sulfide, acid volatile	Acid volatile sulfides	APHA 4500S2J

Data Presentation

For each site and by year, sediment element concentrations data are presented in a figure; mean values are reported when sample duplicate data are available. Consistent with the whole body Dolly Varden char element concentration data presentations, sediment element concentrations undetected are illustrated as an empty circle (◦) at the method reporting limit and a solid circle (•) for measured element concentrations.

The data are compared with the threshold effects concentrations (TEC) and the probable effects concentrations (PEC) for inorganics in freshwater sediment guidelines developed by the National Oceanic and Atmospheric Administration (Buchman 2008). The guidelines are based on results of controlled laboratory bioassays, where element concentrations below the TECs rarely affect aquatic life survival and growth, and element concentrations above the PECs can affect aquatic life survival and growth.

Sediment element concentrations data are compared among sites and presented as a figure. Appendix E contains the 2016–2020 composition and raw element data in a table and the 2020 laboratory report.

RESULTS

LOWER GLACIER CREEK

We sampled Lower Glacier Creek on June 3, 2020, and measured basic water quality at 1200 hours (Table 4).

Table 4.–Lower Glacier Creek water quality data.

Sample Date	Temperature (°C)	Dissolved Oxygen (mg/L)	Conductivity (µS/cm)	Turbidity (NTU)	pH
06/03/20	5.74	12.02	233	17	7.85

Periphyton: Chlorophyll Density and Composition

The 2020 Lower Glacier Creek mean Chl-*a* density was 3.91 mg/m^2, greater than the 2016–2019 mean densities (Table 5; Figure 5). As in previous years, the samples contained about 85% Chl-*a* and 15% Chl-*c*, and none of the samples contained Chl-*b* (Figure 6).

Table 5.–Lower Glacier Creek mean chlorophylls *a*, *b*, and *c* densities.

Sample Date	Chl-*a* (mg/m^2)	Chl-*b* (mg/m^2)	Chl-*c* (mg/m^2)
06/07/16	2.27	0.00	0.35
06/08/17	1.73	0.00	0.26
05/30/18	1.25	0.02	0.24
06/06/19	0.43	0.01	0.04
06/03/20	3.91	0.00	0.47

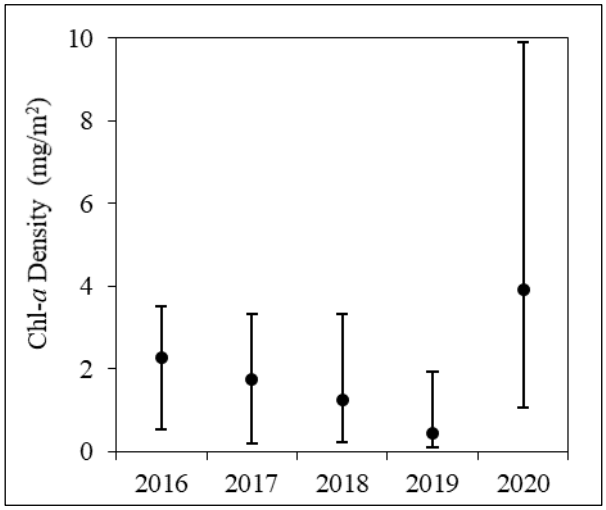


Figure 5.–Lower Glacier Creek chlorophyll *a* densities.

Note: Minimum, mean, and maximum values shown.

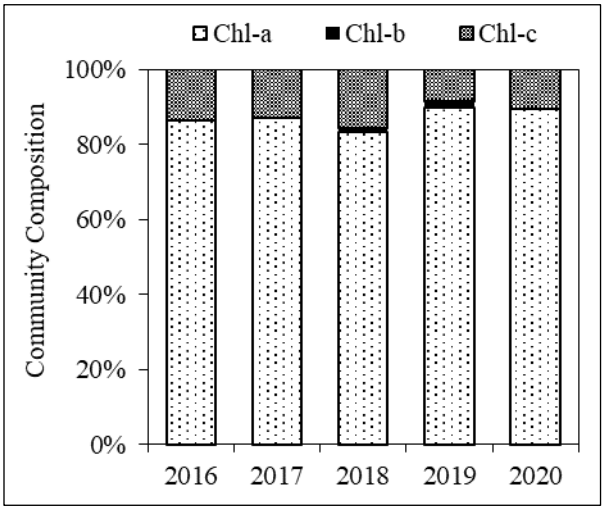


Figure 6.–Lower Glacier Creek mean proportions of chlorophylls *a*, *b*, and *c*.

Benthic Macroinvertebrate Density and Community Composition

Among the 2020 Lower Glacier Creek BMI samples, we identified 25 taxa and estimated mean density at 754 BMI/m^2, of which 19% were EPT insects (Table 6; Figures 7, 8). The dominant taxon was Diptera: Chironomidae, representing 74% of the samples, as in previous years.

Table 6.–Lower Glacier Creek benthic macroinvertebrate data summaries.

	06/07/16	06/08/17	05/30/18	06/06/19	06/03/20
Mean BMI density (per m^2)	995	2,136	217	473	754
Total BMI taxa	17	30	16	12	25
Number of EPT taxa	9	13	10	5	12
Proportion of EPT insects	10%	17%	69%	30%	19%
Proportion of Chironomidae insects	85%	78%	26%	67%	74%

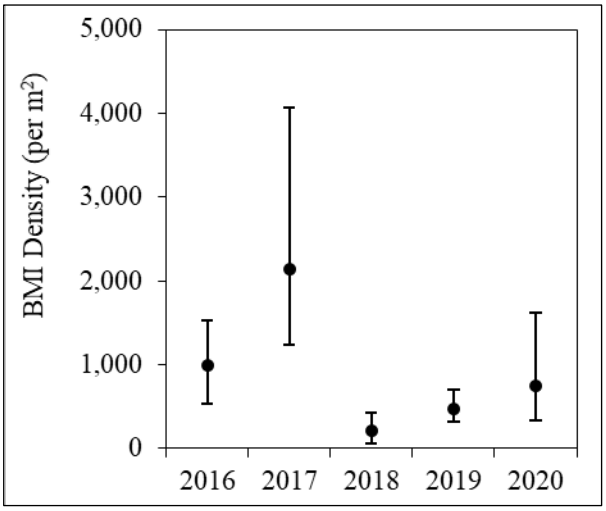


Figure 7.–Lower Glacier Creek benthic macroinvertebrate densities.

Note: Minimum, mean, and maximum values shown.

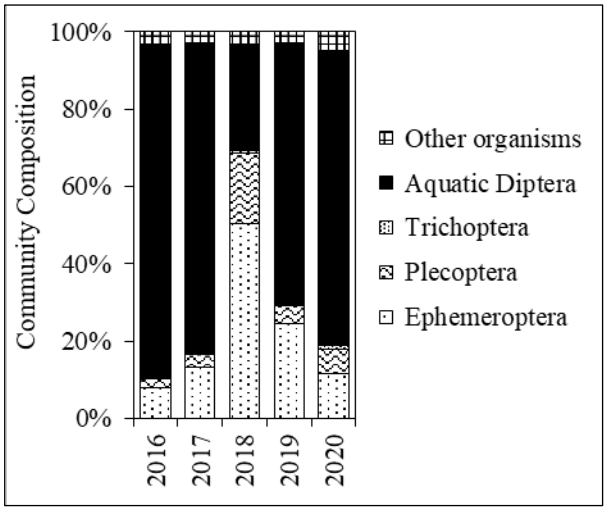


Figure 8.–Lower Glacier Creek mean benthic macroinvertebrate community compositions.

Resident Fish Condition and Element Concentrations

Of the 10 individual whole body Dolly Varden char (98–123 mm) samples we retained from Lower Glacier Creek in 2020, mean fish condition was 1.1, similar to previous years. We captured one rainbow trout (110 mm FL) while sampling, the first documented in Glacier Creek. The 2020 whole body Dolly Varden char element concentrations were similar to concentrations observed 2016–2019 (Figure 9).

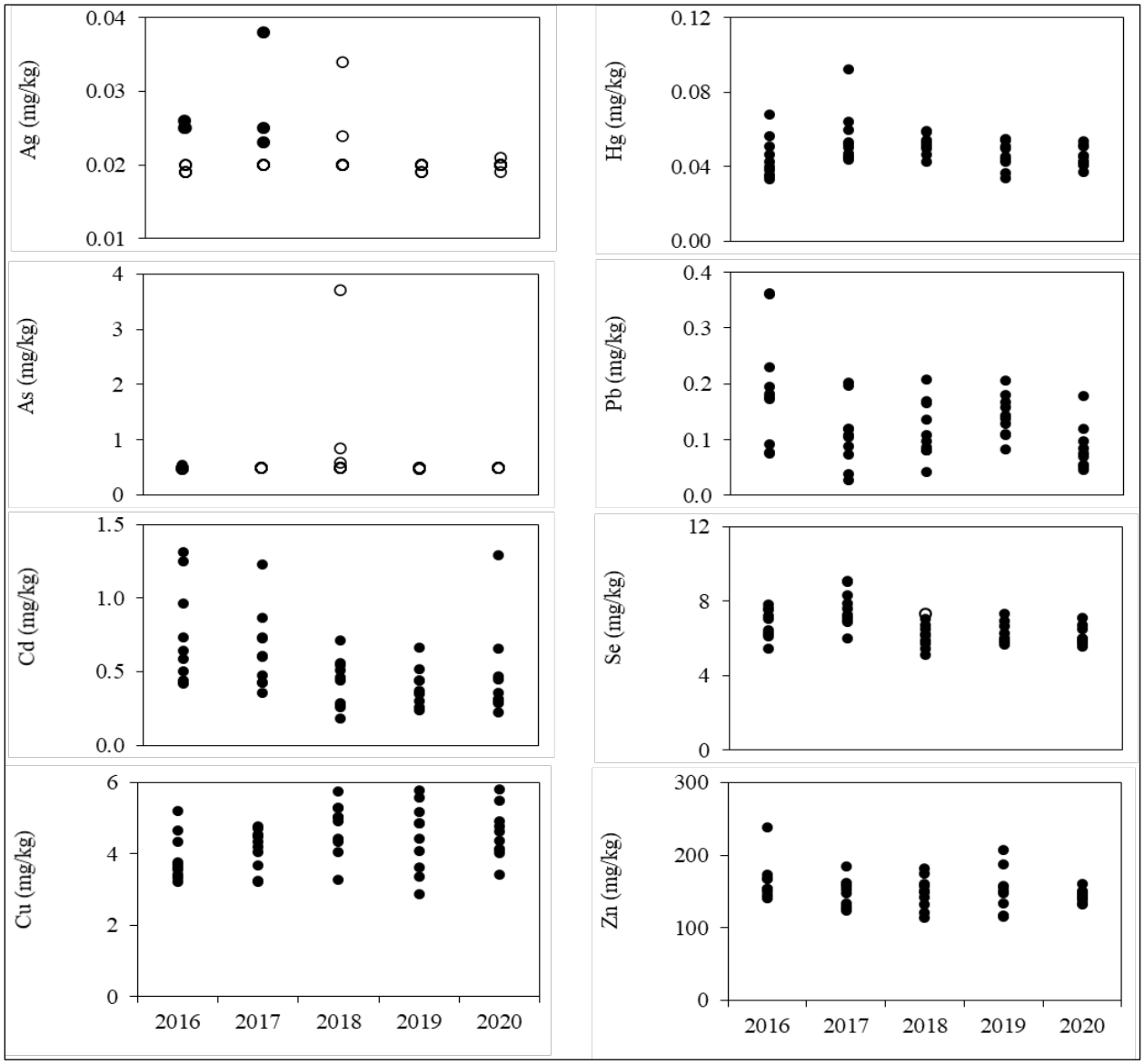


Figure 9.–Lower Glacier Creek whole body Dolly Varden char element concentrations.
Note: Element concentrations undetected (o) are presented at the method reporting limit.

Sediment Composition and Element Concentrations

The 2020 Lower Glacier Creek sediment samples included particle sizes less than 9.5 mm. Total organic carbon concentrations were less than 0.498%, and acid volatile sulfide was not detected. The predominant elements were Fe and Al, and the 2020 element concentrations generally were similar to the 2016–2019 results, except one Se and two Cd concentrations were greater.

We evaluated the 2020 sediment sample element concentration data against the guidelines for freshwater sediments published in Buchman (2008), and similar to the 2016–2019 results we found Cd, Cu, and Zn concentrations near or above the TEC values, and As, Hg, and Pb concentrations below the TEC values (Figure 10).

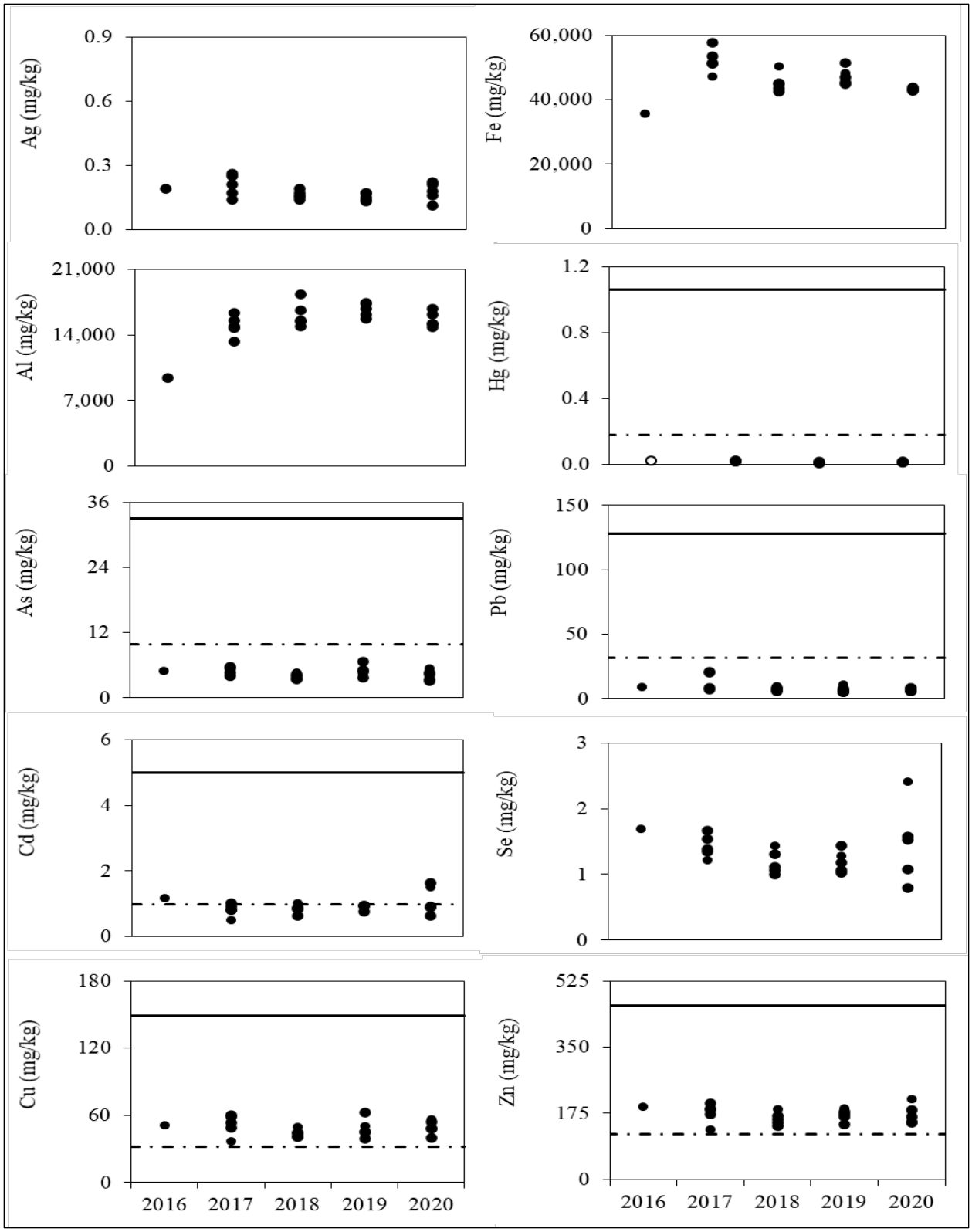


Figure 10.–Lower Glacier Creek sediment element concentrations.

Note: Element concentrations undetected (o) are presented at the method reporting limit. The dashed line represents the TEC and the solid line represents the PEC for freshwater sediments (Buchman 2008); guidelines are not published for Ag, Al, Fe, or Se.

MIDDLE GLACIER CREEK

We sampled Middle Glacier Creek on June 2, 2020, and measured basic water quality at 1610 hours (Table 7).

Table 7.–Middle Glacier Creek water quality data.

Sample Date	Temperature (°C)	Dissolved Oxygen (mg/L)	Conductivity (µS/cm)	Turbidity (NTU)	pH
06/02/20	3.44	13.3	246	23	8.14

Periphyton: Chlorophyll Density and Composition

The 2020 Middle Glacier Creek mean Chl-*a* density was 1.19 mg/m^2, within the range observed 2016–2019 (Table 8; Figure 11). As in previous years, the samples contained about 85% Chl-*a* and 15% Chl-*c*, and 1 sample contained Chl-*b* (Figure 12).

Table 8.–Middle Glacier Creek mean chlorophylls *a*, *b*, and *c* densities.

Sample Date	Chl-*a* (mg/m^2)	Chl-*b* (mg/m^2)	Chl-*c* (mg/m^2)
06/08/16	1.50	0.00	0.25
06/09/17	0.81	0.00	0.10
05/31/18	1.76	0.00	0.29
06/07/19	0.33	0.01	0.04
06/02/20	1.19	0.01	0.16

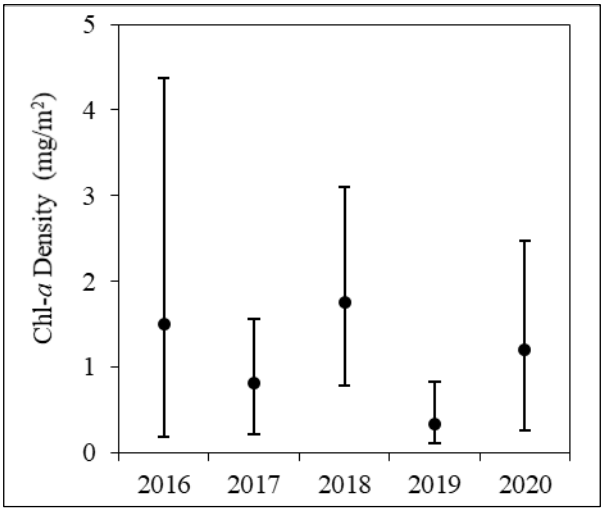


Figure 11.–Middle Glacier Creek chlorophyll *a* densities.

Note: Minimum, mean, and maximum values shown.

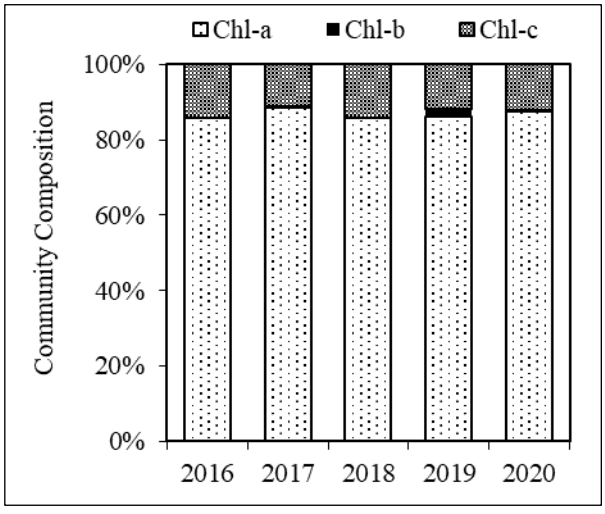


Figure 12.–Middle Glacier Creek mean proportions of chlorophylls *a*, *b*, and *c*.

Benthic Macroinvertebrate Density and Community Composition

Among the 2020 Middle Glacier Creek BMI samples, we identified 25 taxa and estimate mean density at 754 BMI/m^2, of which 24% were EPT insects (Table 9; Figures 13, 14). The dominant taxon was Diptera: Chironomidae, representing 69% of the samples, as in previous years.

Table 9.–Middle Glacier Creek benthic macroinvertebrate data summaries.

	06/08/16	06/09/17	05/31/18	06/07/19	06/02/20
Mean BMI density (per m^2)	2,299	593	504	215	754
Total BMI taxa	22	14	12	11	25
Number of EPT taxa	12	6	5	8	13
Proportion of EPT insects	13%	12%	9%	28%	24%
Proportion of Chironomidae insects	85%	82%	87%	68%	69%

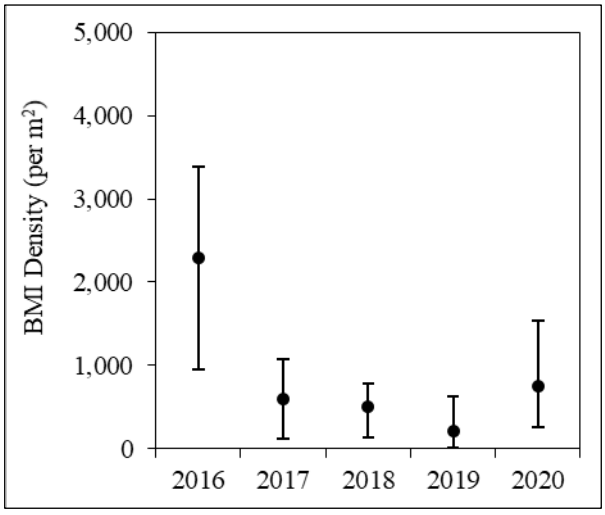


Figure 13.–Middle Glacier Creek benthic macroinvertebrate densities.

Note: Minimum, mean, and maximum values shown.

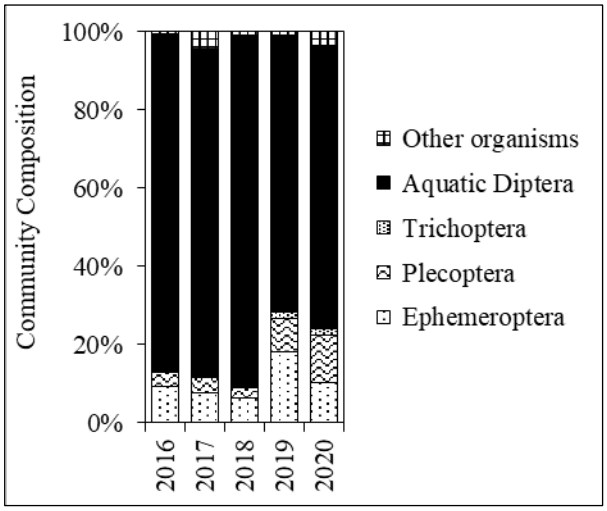


Figure 14.–Middle Glacier Creek mean benthic macroinvertebrate community compositions.

Resident Fish Condition and Element Concentrations

Of the 6 individual whole body Dolly Varden char (108–142 mm) samples we retained from Middle Glacier Creek in 2020, mean fish condition was 1.1. We did not capture other fish species while sampling. The 2020 whole body Dolly Varden char element concentrations generally were similar to concentrations observed in 2016–2019.

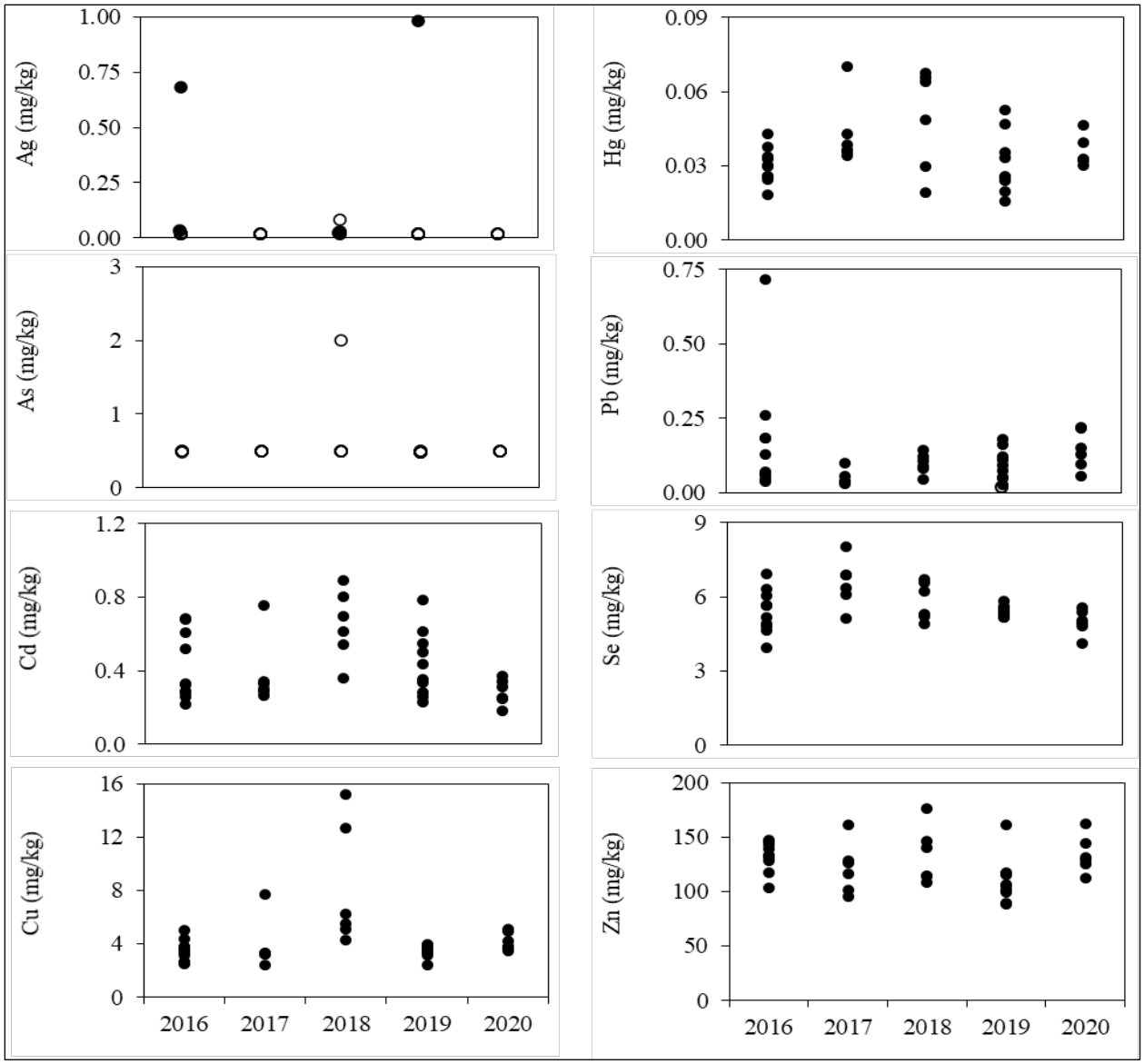


Figure 15.–Middle Glacier Creek whole body Dolly Varden char element concentrations.
Note: Element concentrations undetected (o) are presented at the method reporting limit.

Sediment Composition and Element Concentrations

The 2020 Middle Glacier Creek sediment samples included particle sizes less than 9.5 mm. Total organic carbon concentrations were less than 0.418%, and acid volatile sulfide was not detected. The predominant elements were Fe and Al, and the 2020 element concentrations generally were similar to the 2016–2019 results.

We evaluated the 2020 sediment sample element concentration data against the guidelines for freshwater sediments published in Buchman (2008), and similar to the 2016–2019 results we found Cd, Cu, and Zn concentrations near or above the TEC values, and As, Hg, and Pb concentrations below the TEC values (Figure 16).

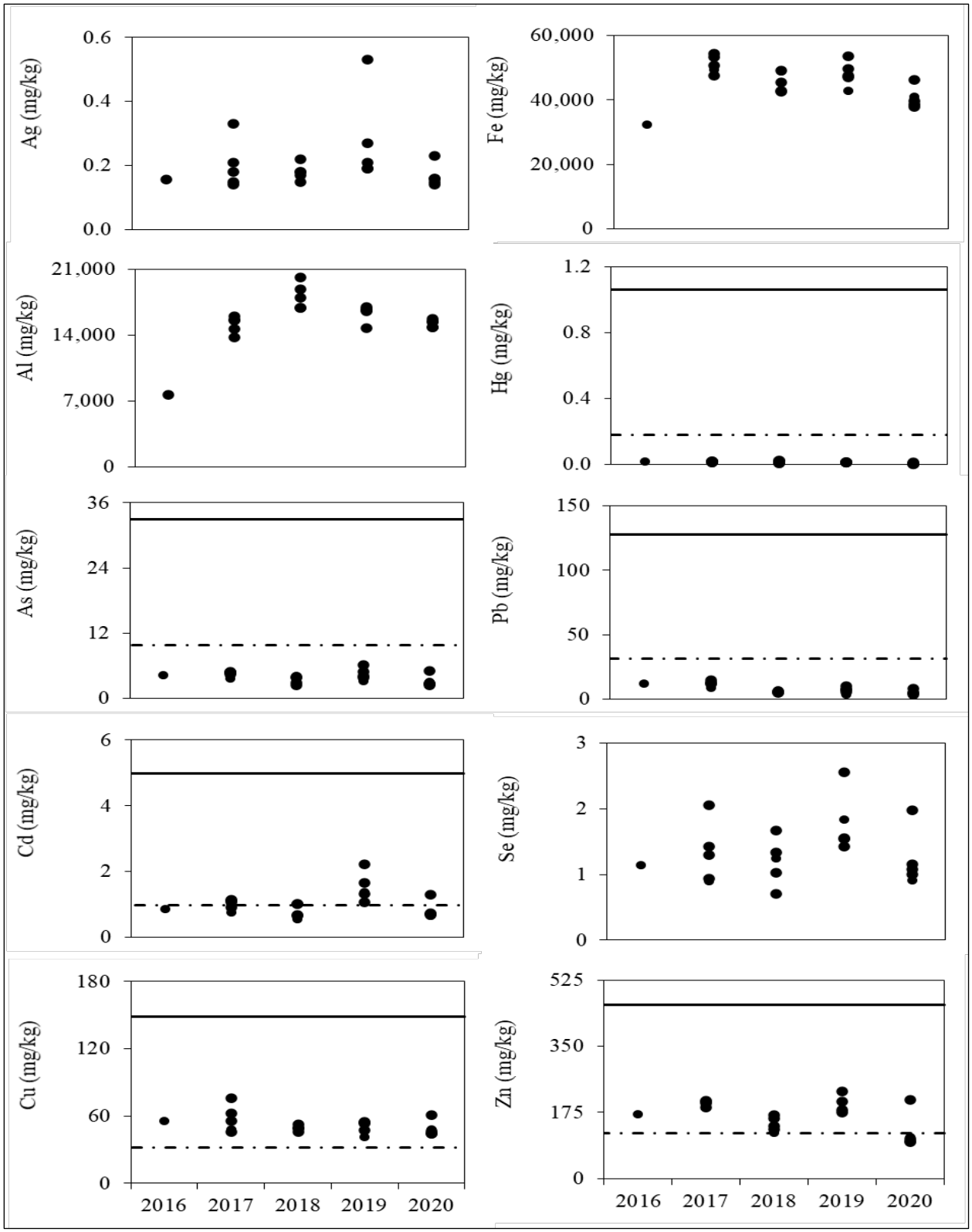


Figure 16.–Middle Glacier Creek sediment element concentrations.

Note: Element concentrations undetected (o) are presented at the method reporting limit. The dashed line represents the TEC and the solid line represents the PEC for freshwater sediments (Buchman 2008); guidelines are not published for Ag, Al, Fe, or Se.

COMPARISON AMONG SITES

Periphyton: Chlorophyll Density and Composition

The 2020 Lower Glacier Creek mean Chl-*a* density was greater than the 2020 Middle Glacier Creek mean density, and greater than observed 2016–2019 (Figure 17). The 2020 Middle Glacier Creek mean Chl-*a* density was within the range observed at the site 2016–2019. Most periphyton samples contained about 85% Chl-*a* and 15% Chl-*c* at both sites all years.

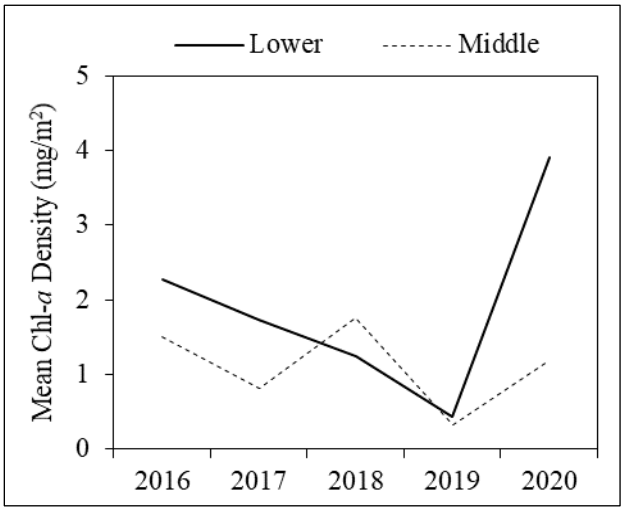


Figure 17.–Glacier Creek chlorophyll *a* densities.

Benthic Macroinvertebrate Density and Community Composition

In 2020, we documented greater BMI density and taxa richness at the Lower and Middle Glacier Creek sample sites than in 2018 and 2019 (Figures 18, 19). Mean BMI density and taxa richness followed similar trends at each site 2016–2020. Diptera: Chironomidae insects were the dominant taxon at both sites in 2020, as in most previous years.

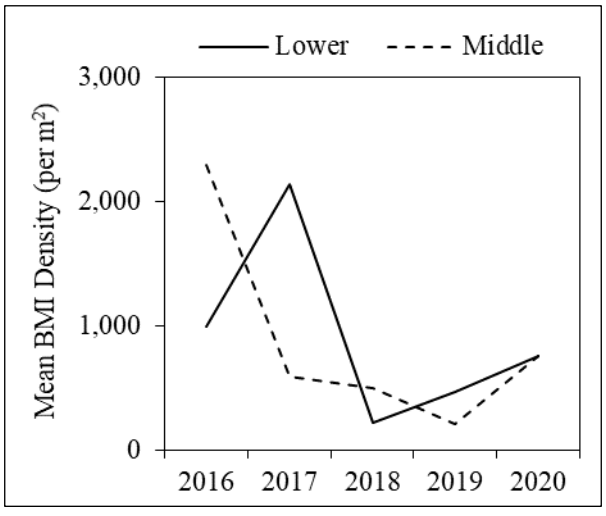


Figure 18.–Glacier Creek mean benthic macroinvertebrate densities.

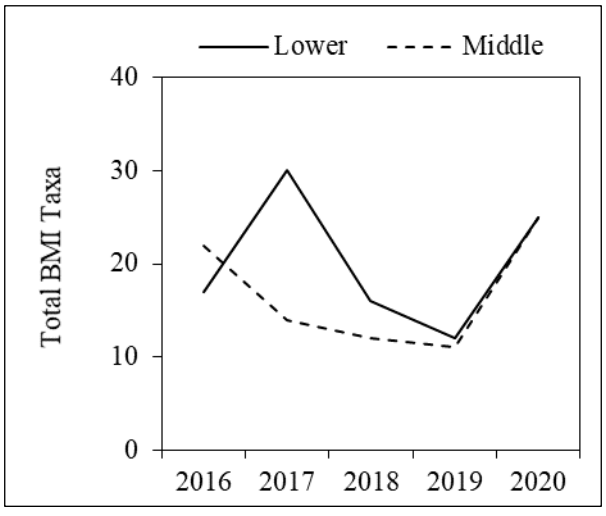


Figure 19.–Glacier Creek benthic macroinvertebrate taxa richness.

Resident Fish Condition and Element Concentrations

Mean fish condition among the 2020 Lower and Middle Glacier Creek Dolly Varden char samples was 1.1 at each site, similar to the 2016–2019 results and other Dolly Varden char condition data collected in Southeast Alaska (Kane 2020).

When we combined the 2016–2020 Dolly Varden char element concentration data by site, median element concentrations were greater among the Lower Glacier Creek samples, except median Ag and As concentrations were similar as those elements are often not detected (Figure 20). All concentrations were within the ranges observed in whole body Dolly Varden char samples collected from reference and exploration sites elsewhere in Alaska (Legere and Timothy 2016).

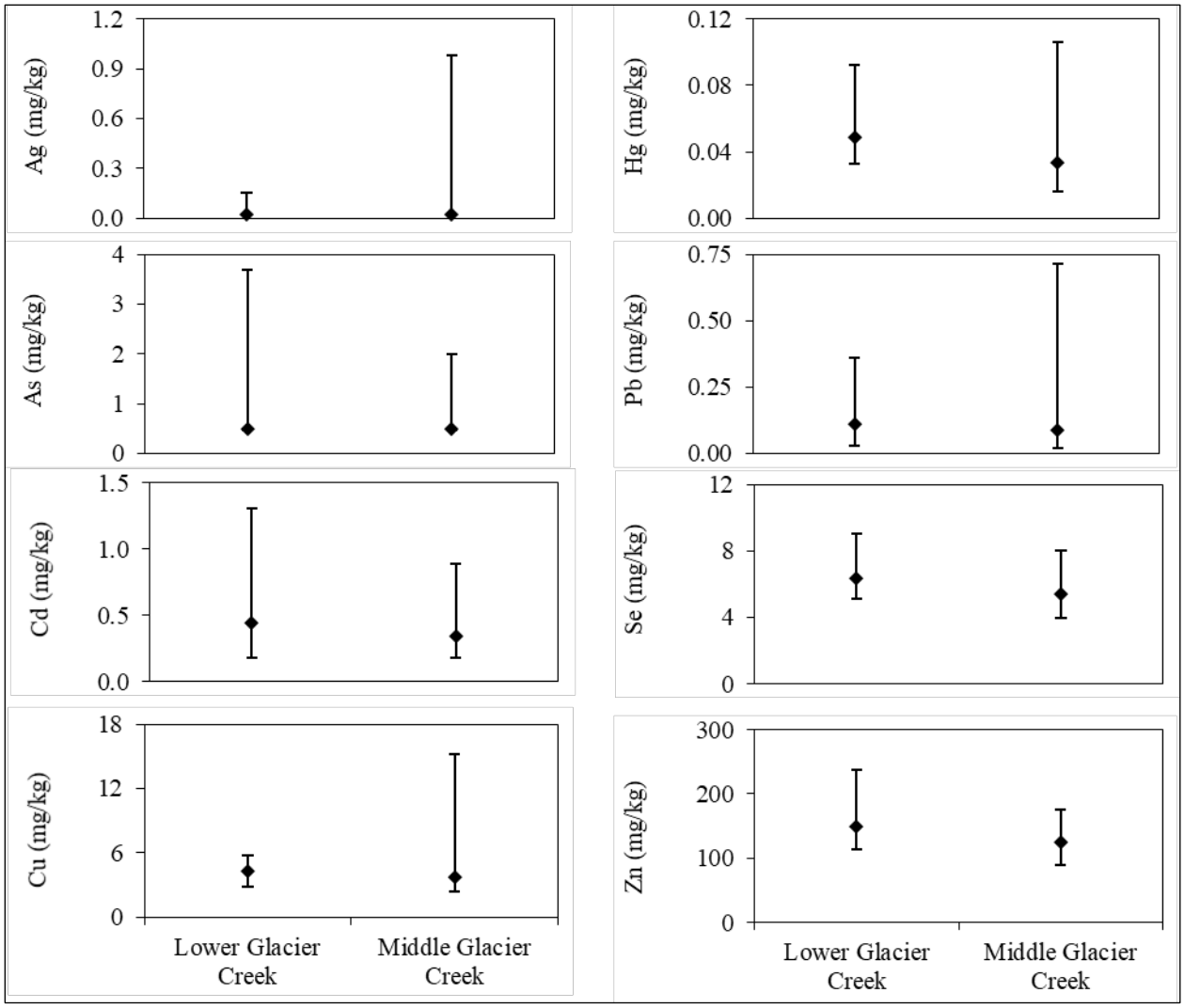


Figure 20.–Glacier Creek whole body Dolly Varden char element concentrations, 2016–2020.

Note: Median (♦), minimum, and maximum concentrations presented; element concentrations not detected are included at the method reporting limit.

Sediment Composition and Element Concentrations

The 2016–2020 Lower and Middle Glacier Creek sediment samples were largely composed of sand and silt; total organic carbon was less than 0.5% and acid volatile sulfide was not detected. When we combined the 2016–2020 sediment element concentration data by site, median element concentrations were generally similar among sites (Figure 21).

We evaluated the element concentration data against the guidelines for freshwater sediments published in Buchman (2008), and similar to the 2016–2019 results found Cd, Cu, and Zn concentrations near or above the TEC values, and As, Hg, and Pb concentrations below the TEC values at both sites (Figure 21). Guidelines are not published for Ag, Al, Fe, or Se.

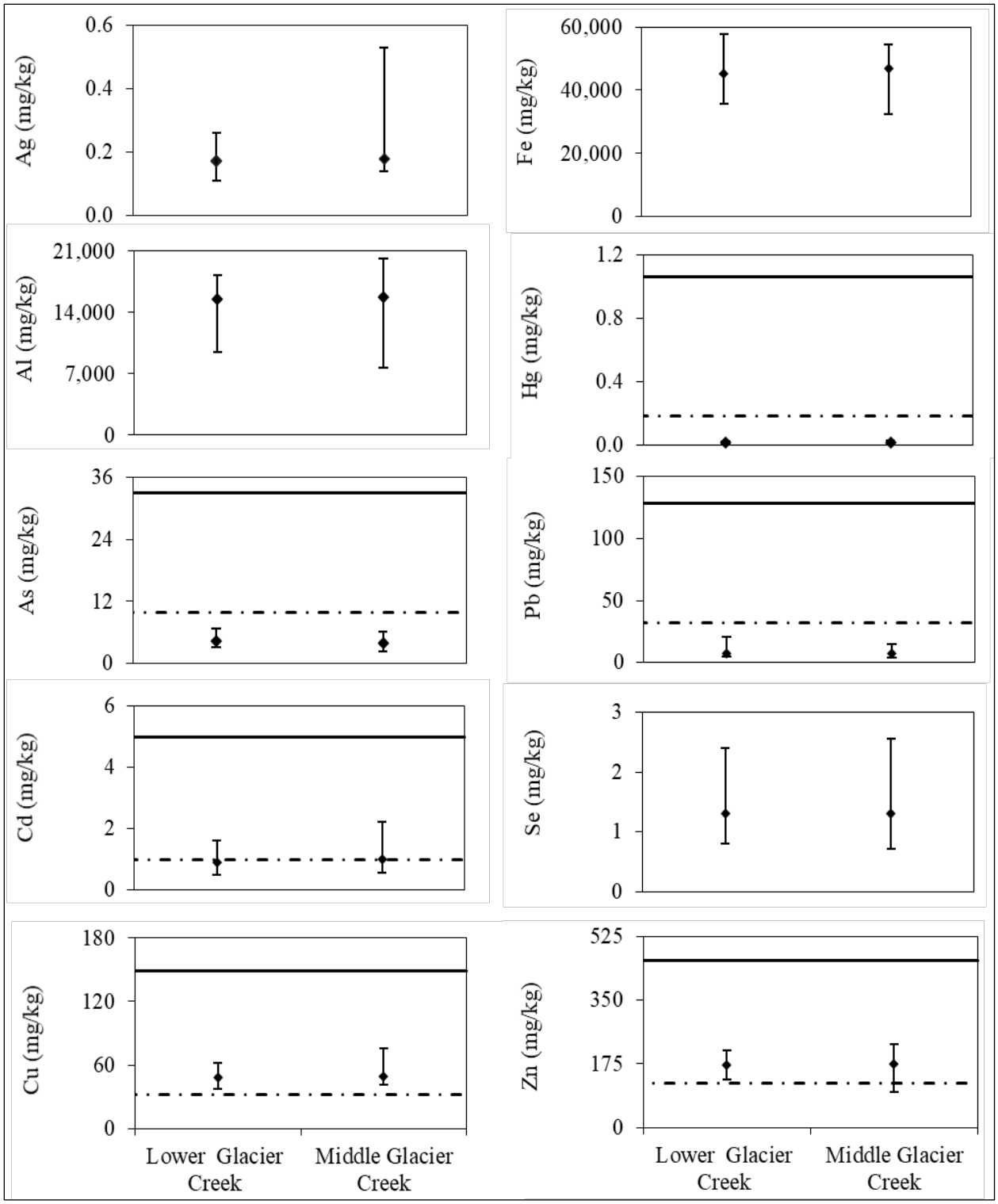


Figure 21.–Glacier Creek sediment element concentrations, 2016–2020.

Note: Median (♦), minimum, and maximum concentrations presented; element concentrations not detected are included at the at the method reporting limit.

Note: The dashed line represents the TEC and the solid line represents the PEC for freshwater sediments (Buchman 2008); guidelines are not published for Ag, Al, Fe, or Se.

REFERENCES CITED

APHA (American Public Health Association). 2012. Standard Methods for the examination of water and wastewater. Section 1020.H.2. 22nd Edition. American Public Health Association, Washington DC.

Anderson, R. O. and R. M. Neumann. 1996. Length, weight, and associated structural indices. [*In*] B. R. Murphy and D. W. Willis, editors. Fisheries Techniques. 2nd edition. American Fisheries Society, Bethesda, MD.

Barbour, M. T., J. Gerritsen, B. D. Snyder, and J. B. Stribling. 1999. Rapid bioassessment protocols for use in streams and wadeable rivers: periphyton, benthic macroinvertebrates and fish, 2nd edition. EPA 841-B-99-002. U. S. Environmental Protection Agency, Office of Water, Washington, D.C.

Buchman, M. F. 2008. NOAA screening quick reference tables, National Oceanic and Atmospheric Administration, Office of Response and Restoration Division, Report 08-1, Seattle, WA.

CNI. 2015. Palmer Exploration Project plan of operations. Prepared for the Bureau of Land Management, Alaska Department of Environmental Conservation, and Alaska Department of Natural Resources, Vancouver, BC.

DOI (U.S. Department of the Interior). 2016. Environmental Assessment for the Palmer Exploration Project. Case File AA-094088, U.S. Department of the Interior, Bureau of Land Management, Glennallen Field Office, Glennallen, AK.

Entrekin, S. A., J. B. Wallace, and S. L. Eggert. 2007. The response of Chironomidae (Diptera) to a long-term exclusion of terrestrial organic matter. Hydrobiologia 575(1):401-413.

Giefer, J., and B. Blossom. 2020. Catalog of waters important for spawning, rearing, or migration of anadromous fishes – Southeastern Region, effective June 1, 2020. Alaska Department of Fish and Game, Special Publication No. 20-04, Anchorage.

Kane, W. J. 2020. Aquatic studies at Kensington Gold Mine, 2019. Alaska Department of Fish and Game, Technical Report No. 20-04, Douglas, AK.

Kane, W. J. 2020. Aquatic biomonitoring at Greens Creek Mine, 2019. Alaska Department of Fish and Game, Technical Report No. 20-05, Douglas, AK.

Kanouse, K. M., and N. M. Legere. 2016. Glacier Creek aquatic studies, 2016. Alaska Department of Fish and Game, Technical Report No. 16-10, Douglas, AK.

Krull, D. 2019. Glacier Creek aquatic studies, 2019. Alaska Department of Fish and Game, Technical Report No. 19-12, Douglas, AK.

Legere, N. M. and K. M. Kanouse. 2017. Glacier Creek aquatic studies, 2017. Alaska Department of Fish and Game, Technical Report No. 17-11, Douglas, AK.

Legere, N. M. and K. M. Kanouse. 2018. Glacier Creek aquatic studies, 2018. Alaska Department of Fish and Game, Technical Report No. 18-09, Douglas, AK.

Legere, N. M. and J. Timothy. 2016. Tulsequah Chief acid mine drainage and Dolly Varden char metals concentrations. Alaska Department of Fish and Game, Technical Report No. 16-06, Douglas, AK.

Merritt, R. W. and K. W. Cummins, editors. 1996. An introduction to the aquatic insects of North America. 3rd edition. Kendall/Hunt Publishing Co., Dubuque, IA.

Paustian, S. 2010. Channel type user guide revision 2010. U.S. Department of Agriculture, Forest Service, R-10-TP-26.

Stewart, K. W. and M. W. Oswood. 2006. The stoneflies (Plecoptera) of Alaska and Western Canada. The Caddis Press, Columbus, OH.

Tetra Tech. 2013. Palmer VMS Project preliminary aquatic investigation. Prepared for Constantine North, Inc., Anchorage, AK.

Timothy, J. and K. M. Kanouse. 2014. Aquatic studies at Kensington Gold Mine, 2013. Alaska Department of Fish and Game, Technical Report No. 14-01, Douglas, AK.

REFERENCES CITED, CONTINUED

Tchounwou, P. B., C. G. Yedjou, A. K. Patlolla, D. J. Sutton. 2012. Heavy metal toxicity and the environment. Pages 133-164 [*In*] Experimentia Supplementum: Molecular, Clinical and Environmental Toxicology: Volume 3: Environmental Toxicology. Springer Basel.

USEPA. (U.S. Environmental Protection Agency). 1994. Method 200.8, Revision 5.4: Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma – Mass Spectrometry. U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Office of Research and Development, Cincinnati, OH.

USEPA. 1997. Method 446.0: In vitro determination of chlorophylls a, b, $c_1 + c_2$ and pheopigments in marine and freshwater algae by visible spectrophotometry (Revision 1.2). Adapted by Elizabeth J. Arar, U. S. Environmental Protection Agency, National Exposure Research Laboratory, Office of Research of Development, Cincinnati, OH.

USEPA. 1998. Method 6020A (SW-846) Revision 1: Inductively Coupled Plasma-Mass Spectrometry. U.S. Environmental Protection Agency, Washington, D.C.

USEPA. 2002. Method 1631 Revision E: Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry. U. S. Environmental Protection Agency, Office of Water, Washington, D.C.

APPENDIX A: WATER QUALITY DATA

Appendix A.1.–Lower Glacier Creek water quality data, 2016–2020.

Sample Date	Temperature (°C)	Dissolved Oxygen (mg/L)	Conductivity (µS/cm)	Turbidity (NTU)	pH
06/07/16	3.3	12.6	115	126	6[a]
06/08/17	6.5	13.6	129	306	8.32
05/30/18	5.8	10.8	161	17	8.15[b]
06/06/19	6.6	12.4	133.6	11	6.76[c]
06/03/20	5.74	12.02	233	17	7.85

[a] We used a colorpHast pH indicator strip with 0.5 unit sensitivity.
[b] Taken by Ms. Cairns on 6/2/2018.
[c] Taken by Ms. Cairns on 6/8/2019.

Appendix A.2.–Middle Glacier Creek water quality data, 2016–2020.

Sample Date	Temperature (°C)	Dissolved Oxygen (mg/L)	Conductivity (µS/cm)	Turbidity (NTU)	pH
06/08/16	3.1	14.1	129	57	6[a]
06/09/17	3.1	16.7	113	> 1000	8.38
05/31/18	4.1	11.3	182	16	ND
06/07/19	4.0	18.0	126	94	ND
06/02/20	3.44	13.3	246	23	8.14

[a] We used a colorpHast pH indicator strip with 0.5 unit sensitivity.

APPENDIX B: CHLOROPHYLL DATA

Appendix B.1.–Lower Glacier Creek chlorophylls *a*, *b*, and *c* densities, 2016–2020.

	06/07/16			06/08/17			05/30/18		
mg/m²	Chl-*a*	Chl-*b*	Chl-*c*	Chl-*a*	Chl-*b*	Chl-*c*	Chl-*a*	Chl-*b*	Chl-*c*
	3.35	0.00	0.47	1.50	0.00	0.17	0.21	0.00	0.08
	3.31	0.00	0.51	1.28	0.00	0.25	1.23	0.00	0.20
	2.56	0.00	0.45	2.89	0.00	0.30	3.31	0.00	0.51
	1.28	0.00	0.29	1.82	0.00	0.20	0.53	0.00	0.08
	3.10	0.00	0.38	1.92	0.00	0.25	0.53	0.00	0.07
	1.97	0.00	0.29	3.31	0.00	0.46	0.96	0.00	0.22
	0.53	0.00	0.11	1.92	0.00	0.24	3.10	0.00	0.53
	2.03	0.00	0.30	**0.19**	ND	ND	1.28	0.00	0.24
	3.52	0.00	0.63	1.39	0.00	0.21	0.43	0.15	0.27
	1.01	0.00	0.09	1.09	0.00	0.22	0.96	0.00	0.15
Mean	2.27	0.00	0.35	1.73	0.00	0.26	1.25	0.02	0.24
Minimum	0.53	0.00	0.09	0.19	0.00	0.17	0.21	0.00	0.07
Maximum	3.52	0.00	0.63	3.31	0.00	0.46	3.31	0.15	0.53

Note: Bold value is the spectrophotometer estimated detection limit, chlorophyll a not detected.

Appendix B.1.–Continued.

	06/06/19			06/03/20		
mg/m²	Chl-*a*	Chl-*b*	Chl-*c*	Chl-*a*	Chl-*b*	Chl-*c*
	0.43	0.00	0.03	5.23	0.00	0.58
	0.10	ND	ND	6.19	0.00	0.86
	0.53	0.00	0.00	3.66	0.00	0.52
	0.14	0.00	0.00	2.20	0.00	0.23
	0.22	0.05	0.00	1.06	0.00	0.09
	0.10	ND	ND	1.34	0.00	0.11
	0.11	0.01	0.05	1.06	0.00	0.09
	1.92	0.00	0.18	9.90	0.00	1.10
	0.64	0.00	0.01	1.65	0.00	0.20
	0.10	ND	ND	6.84	0.00	0.89
Mean	0.43	0.01	0.04	3.91	0.00	0.47
Minimum	0.10	0.00	0.00	1.06	0.00	0.09
Maximum	1.92	0.05	0.18	9.90	0.00	1.10

Note: Bold value is the spectrophotometer estimated detection limit, chlorophyll a not detected.

Appendix B.2.–Middle Glacier Creek chlorophylls *a*, *b*, and *c* densities, 2016–2020.

	06/08/16			06/09/17			05/31/18		
mg/m²	Chl-*a*	Chl-*b*	Chl-*c*	Chl-*a*	Chl-*b*	Chl-*c*	Chl-*a*	Chl-*b*	Chl-*c*
	1.82	0.00	0.30	0.96	0.00	0.15	1.50	0.00	0.20
	4.38	0.00	0.75	0.75	0.00	0.15	1.92	0.00	0.27
	0.96	0.00	0.10	1.38	0.00	0.08	2.24	0.00	0.41
	1.60	0.00	0.26	1.56	0.00	0.22	2.78	0.00	0.44
	0.19	ND	ND	0.43	0.00	0.00	3.10	0.00	0.51
	1.17	0.00	0.13	0.75	0.00	0.05	0.96	0.00	0.14
	0.96	0.00	0.15	0.50	0.00	0.03	0.78	0.00	0.16
	1.82	0.00	0.27	1.17	0.00	0.23	1.60	0.00	0.25
	0.28	0.00	0.00	0.21	0.02	0.10	1.82	0.00	0.35
	1.82	0.00	0.27	0.43	0.00	0.02	0.85	0.00	0.20
Mean	1.50	0.00	0.25	0.81	0.00	0.10	1.76	0.00	0.29
Minimum	0.19	0.00	0.00	0.21	0.00	0.00	0.78	0.00	0.14
Maximum	4.38	0.00	0.75	1.56	0.02	0.23	3.10	0.00	0.51

Note: Bold value is the spectrophotometer estimated detection limit, chlorophyll a not detected.

Appendix B.2.–Continued.

	06/07/19			06/02/20		
mg/m²	Chl-*a*	Chl-*b*	Chl-*c*	Chl-*a*	Chl-*b*	Chl-*c*
	0.83	0.00	0.05	**0.25**	ND	ND
	0.18	0.00	0.04	2.43	0.00	0.33
	0.55	0.00	0.02	1.70	0.00	0.17
	0.10	ND	ND	0.28	0.00	0.03
	0.21	0.00	0.02	0.73	0.00	0.07
	0.14	0.01	0.05	0.55	0.00	0.02
	0.18	0.06	0.11	0.96	0.00	0.10
	0.21	0.00	0.00	0.50	0.06	0.20
	0.53	0.00	0.02	2.48	0.00	0.32
	0.32	0.00	0.09	2.06	0.00	0.25
Mean	0.33	0.01	0.04	1.19	0.01	0.16
Minimum	0.10	0.00	0.00	0.25	0.00	0.02
Maximum	0.83	0.06	0.11	2.48	0.06	0.33

Note: Bold value is the spectrophotometer estimated detection limit, chlorophyll a not detected.

APPENDIX C: BENTHIC MACROINVERTEBRATE DATA

Appendix C.1.–Lower Glacier Creek benthic macroinvertebrate sample data, 2020.

				Sample Number						
Class or Subclass	Order	Family	Genus	1	2	3	4	5	6	**Total**
Insecta	Ephemeroptera	Baetidae	*Baetis*	3	3	14	4	4	14	**42**
		Heptageniidae	*Cinygmula*	0	0	0	0	2	0	**2**
			Epeorus	0	1	0	1	2	1	**5**
	Plecoptera	Capniidae	*Capnia*	0	0	0	0	1	1	**2**
		Chloroperlidae	*Suwallia*	2	3	1	0	4	2	**12**
			Sweltsa	0	0	0	1	0	1	**2**
		Nemouridae	*Zapada*	4	0	2	0	0	0	**6**
		Perlodidae	*Isoperla*	0	0	0	1	0	0	**1**
			Megarcys	1	0	0	0	0	1	**2**
		unidentified	unidentified	0	0	0	0	0	1	**1**
	Trichoptera	Rhyacophilidae	*Rhyacophila*	1	0	0	1	0	0	**2**
		Limnephilidae	unidentified	1	0	0	0	0	0	**1**
		unidentified	unidentified	0	0	0	0	0	1	**1**
	Diptera	Chironomidae	unidentified	24	24	41	61	39	123	**312**
		Limoniidae	*Gonomyodes*	0	0	3	1	0	0	**4**
		Simuliidae	*Prosimulium*	0	0	0	0	0	1	**1**
		Tipulidae	*Antocha*	0	0	0	1	0	0	**1**
			Rhabdomastix	0	0	1	0	0	0	**1**
			Tipula	0	0	0	1	1	0	**2**
		unidentified	unidentified	0	0	0	0	0	1	**1**
	Hemiptera	unidentified	unidentified	0	0	0	1	0	1	**2**
Arachnida	unidentified	unidentified	unidentified	0	0	0	0	0	2	**2**
Entognatha	Collembola	unidentified	unidentified	0	0	0	2	6	1	**9**
Nematoda	unidentified	unidentified	unidentified	2	0	0	0	0	0	**2**
Oligochaeta	unidentified	unidentified	unidentified	0	0	1	2	0	0	**3**
Ostracoda	unidentified	unidentified	unidentified	0	0	0	0	2	0	**2**
			Total	**38**	**31**	**63**	**77**	**61**	**151**	**421**

Appendix C.2.–Lower Glacier Creek benthic macroinvertebrate data summaries, 2016–2020.

	06/07/16	06/08/17	05/30/18	06/06/19	06/03/20
Total BMI taxa	17	30	16	12	25
Number of EPT taxa	9	13	10	5	12
Total counts					
Ephemeroptera	44	158	61	65	49
Plecoptera	13	41	22	12	26
Trichoptera	1	3	1	1	4
Aquatic Diptera	478	955	33	178	322
Other organisms	19	35	4	8	20
% Ephemeroptera	8%	13%	50%	25%	11.6%
% Plecoptera	2%	3%	18%	5%	6.2%
% Trichoptera	0.2%	0.3%	0.8%	0.4%	1.0%
% Aquatic Diptera	86%	80%	27%	67%	76.5%
% Other organisms	3%	3%	3%	3%	4.8%
% EPT	10%	17%	69%	30%	19%
% Chironomidae	85%	78%	26%	67%	74%
Total aquatic invertebrates	555	1,192	121	264	421
Total terrestrial invertebrates	17	18	13	17	4
Total invertebrates	572	1,210	134	281	425
% Sample aquatic	97.0%	98.5%	90.3%	94.0%	99.1%
% Sample terrestrial	3.0%	1.5%	0.0%	6.0%	0.9%
Total sample area (m^2)	0.558	0.558	0.558	0.558	0.558
Mean BMI density (per m^2)	995	2,136	217	473	754
±1 SD	373	1,015	151	148	463

Appendix C.3.–Middle Glacier Creek benthic macroinvertebrate sample data, 2020.

				Sample Number						
Class or Subclass	Order	Family	Genus	1	2	3	4	5	6	**Total**
Insecta	Ephemeroptera	Baetidae	*Baetis*	0	7	4	2	0	14	**27**
		Heptageniidae	*Cinygmula*	1	2	4	1	0	0	**8**
			Epeorus	0	0	0	0	3	1	**4**
			Rhithrogena	3	0	0	0	0	1	**4**
	Plecoptera	Capniidae	*Capnia*	1	1	1	1	4	1	**9**
		Chloroperlidae	*Suwallia*	1	0	2	8	0	0	**11**
		Nemouridae	*Nemoura*	0	0	1	0	0	0	**1**
			Podmosta	0	0	2	0	0	0	**2**
			Zapada	1	0	3	2	5	3	**14**
		Perlodidae	*Isoperla*	0	5	0	1	3	6	**15**
	Trichoptera	Hydropsychidae	*Arctopsyche*	1	0	0	0	0	0	**1**
		Limnephilidae	*Apatania*	0	0	0	0	0	2	**2**
		Rhyacophilidae	*Rhyacophila*	0	0	1	0	1	1	**3**
	Diptera	Blephariceridae	*Blepharicerca*	0	0	0	0	2	0	**2**
		Chironomidae	unidentified	14	24	114	18	55	64	**289**
		Empididae	*Clinocera*	0	0	0	0	0	1	**1**
		Limoniidae	*Gonomyodes*	0	2	6	2	1	1	**12**
		Simuliidae	*Prosimulium*	0	0	1	0	0	0	**1**
		Tipulidae	*Limonia*	1	0	0	0	0	0	**1**
	Hemiptera	unidentified	unidentified	0	0	1	0	0	0	**1**
Arachnida	unidentified	unidentified	unidentified	1	0	1	0	0	1	**3**
Entognatha	Collembola	unidentified	unidentified	0	0	0	0	1	0	**1**
Nematoda	unidentified	unidentified	unidentified	0	1	0	0	0	0	**1**
Oligochaeta	unidentified	unidentified	unidentified	0	2	1	0	3	1	**7**
Ostracoda	unidentified	unidentified	unidentified	0	0	1	0	1	0	**2**
			Total	**24**	**44**	**143**	**35**	**79**	**97**	**422**

Appendix C.4.–Middle Glacier Creek benthic macroinvertebrate data summaries, 2016–2020.

	06/08/16	06/09/17	05/31/18	06/07/19	06/02/20
Total BMI taxa	22	14	12	11	25
Number of EPT taxa	12	6	5	8	13
Total counts					
Ephemeroptera	119	25	18	22	43
Plecoptera	45	14	7	10	52
Trichoptera	4	1	0	2	6
Aquatic Diptera	1,107	276	254	85	306
Other organisms	8	15	2	1	14
% Ephemeroptera	9%	8%	6%	18%	10%
% Plecoptera	4%	4%	2%	8%	12%
% Trichoptera	0.3%	0.3%	0.0%	1.7%	1.4%
% Aquatic Diptera	86%	83%	90%	71%	73%
% Other organisms	1%	5%	0.7%	0.8%	3.3%
% EPT	13%	12%	9%	28%	24%
% Chironomidae	85%	82%	87%	68%	69%
Total aquatic invertebrates	1,283	331	281	120	421
Total terrestrial invertebrates	19	7	1	4	7
Total invertebrates	1,302	338	282	124	428
% Sample aquatic	98.5%	97.9%	99.6%	96.8%	98.4%
% Sample terrestrial	1.5%	2.1%	0.4%	3.2%	1.6%
Total sample area (m^2)	0.558	0.558	0.558	0.558	0.558
Mean BMI density (per m^2)	2,299	593	504	215	754
±1 SD	976	392	249	249	484

APPENDIX D: RESIDENT FISH DATA AND LABORATORY REPORT

Appendix D.1.–Lower Glacier Creek whole body Dolly Varden char element concentrations, 2016–2020.

Sample Date	Length (mm)	Weight (g)	Condition (K)	Ag (mg/kg)	As (mg/kg)	Cd (mg/kg)	Cu (mg/kg)	Hg (mg/kg)	Pb (mg/kg)	Se (mg/kg)	Zn (mg/kg)
06/07/16	108	12.7	1.0	<0.019	<0.48	0.429	3.55	0.0466	0.076	7.23	153
06/07/16	68	4.8	1.5	<0.020	<0.50	0.501	3.75	0.0330	0.182	7.60	173
06/07/16	112	17.7	1.3	0.025	<0.48	1.310	3.63	0.0567	0.230	5.48	145
06/07/16	105	15.9	1.4	<0.019	<0.48	0.585	3.23	0.0509	0.078	7.56	150
06/07/16	113	14.3	1.0	<0.020	0.50	0.420	3.42	0.0427	0.177	6.21	154
06/07/16	94	10.8	1.3	<0.019	0.52	0.441	4.35	0.0381	0.195	7.83	167
06/07/16	109	14.6	1.1	0.026	<0.50	1.250	5.20	0.0683	0.362	6.46	238
06/07/16	97	11.2	1.2	<0.019	<0.49	0.641	3.71	0.0401	0.172	6.11	154
06/08/16	93	9.5	1.2	<0.020	<0.49	0.960	3.32	0.0349	0.091	7.04	141
06/08/16	73	4.7	1.2	0.025	0.54	0.730	4.67	0.0353	0.360	6.31	168
06/08/17	133	29.1	1.2	0.023	<0.50	0.727	4.47	0.0599	0.109	6.00	184
06/08/17	113	15.7	1.1	<0.020	<0.50	0.426	3.69	0.0505	0.027	7.01	148
06/08/17	105	12.6	1.1	<0.020	<0.50	0.601	3.23	0.0523	0.038	7.16	134
06/08/17	90	9.2	1.3	0.038	<0.50	1.230	3.24	0.0473	0.088	8.33	123
06/08/17	106	12.8	1.1	<0.020	<0.50	0.606	4.06	0.0532	0.104	9.09	153
06/08/17	175	60.5	1.1	<0.020	<0.50	0.355	4.71	0.0924	0.119	6.90	162
06/08/17	75	5.7	1.4	<0.020	<0.50	0.429	4.77	0.0438	0.202	7.86	157
06/08/17	110	17.3	1.3	0.025	<0.50	0.736	4.35	0.0446	0.074	9.03	126
06/08/17	59, 118[a]	20.2	ND	<0.020	<0.50	0.472	4.20	0.0456	0.119	7.30	160
06/08/17	102, 70[a]	15.6	ND	<0.020	<0.50	0.865	4.55	0.0642	0.196	7.62	130
05/30/18	112	12.3	0.9	<0.020	<0.50	0.183	3.26	0.0511	0.042	5.14	114
05/30/18	66, 65[a]	4.7	ND	<0.034	<0.84	0.458	5.30	0.0467	0.098	5.90	142
05/30/18	109	15.1	1.2	<0.020	<0.50	0.257	4.34	0.0592	0.080	6.70	121
05/30/18	103	11.6	1.1	<0.020	<0.50	0.272	4.05	0.0426	0.108	7.04	132
05/30/18	78, 65[a]	7.0	ND	<0.020	<0.50	0.545	5.03	0.0589	0.136	6.19	182
05/30/18	97	7.8	0.9	<0.020	<0.50	0.558	5.04	0.0529	0.165	6.25	160
05/30/18	61, 63[a]	4.1	ND	<0.15	<3.7	0.710	5.29	0.0511	0.170	7.30	158
05/30/18	92	6.5	0.8	<0.020	<0.50	0.512	5.74	0.0545	0.207	5.47	175
05/30/18	81	4.5	0.8	<0.024	<0.59	0.440	4.43	0.0496	0.080	6.50	150
05/30/18	106	12.2	1.0	<0.020	<0.50	0.284	4.91	0.0530	0.087	5.76	149

[a] Composite sample of two fish.

Appendix D.1.–Continued.

Sample Date	Length (mm)	Weight (g)	Condition (K)	Ag (mg/kg)	As (mg/kg)	Cd (mg/kg)	Cu (mg/kg)	Hg (mg/kg)	Pb (mg/kg)	Se (mg/kg)	Zn (mg/kg)
06/06/19	122	22.9	1.3	<0.020	<0.50	0.237	4.07	0.0546	0.110	5.83	158
06/06/19	124	22.7	1.2	<0.019	<0.48	0.349	3.63	0.0440	0.082	5.87	117
06/06/19	155	42.5	1.1	<0.020	<0.50	0.514	5.79	0.0510	0.180	6.27	207
06/06/19	97	12.3	1.3	<0.020	<0.50	0.372	5.58	0.0341	0.137	7.32	156
06/06/19	121	20.8	1.2	<0.020	<0.49	0.353	2.87	0.0496	0.144	5.82	116
06/06/19	106	15.0	1.3	<0.019	<0.47	0.259	4.42	0.0540	0.168	6.95	134
06/06/19	105	13.6	1.2	<0.020	<0.49	0.300	3.37	0.0368	0.109	5.95	115
06/06/19	117	19.7	1.2	<0.020	<0.50	0.665	4.86	0.0428	0.206	6.02	150
06/06/19	141	27.1	1.0	<0.019	<0.48	0.440	4.87	0.0457	0.158	6.68	148
06/06/19	126	25.5	1.3	<0.020	<0.50	0.442	5.18	0.0549	0.129	5.69	188
06/03/20	115	14.8	1.0	<0.020	<0.49	0.223	4.15	0.0517	0.053	5.92	149
06/03/20	98	11.2	1.2	<0.020	<0.50	0.657	4.10	0.0412	0.051	5.55	134
06/03/20	110	15.4	1.2	<0.020	<0.50	0.29	4.03	0.0425	0.076	5.72	160
06/03/20	99	11.9	1.2	<0.020	<0.49	0.446	4.77	0.0455	0.178	6.75	132
06/03/20	123	19.9	1.1	<0.019	<0.49	0.467	4.91	0.0458	0.055	5.82	139
06/03/20	113	14.7	1.0	0.021	<0.49	1.29	5.81	0.0429	0.120	6.50	144
06/03/20	107	14.0	1.1	<0.020	<0.50	0.309	4.36	0.0412	0.069	5.95	141
06/03/20	113	15.8	1.1	<0.020	<0.50	0.312	5.49	0.0509	0.085	5.95	143
06/03/20	112	15.6	1.1	<0.020	<0.50	0.359	3.43	0.0369	0.045	7.10	150
06/03/20	122	18.3	1.0	<0.020	<0.50	0.286	4.62	0.0537	0.097	6.00	146

Appendix D.2.–Middle Glacier Creek whole body Dolly Varden char element concentrations, 2016–2020.

Sample Date	Length (mm)	Weight (g)	Condition (K)	Ag (mg/kg)	As (mg/kg)	Cd (mg/kg)	Cu (mg/kg)	Hg (mg/kg)	Pb (mg/kg)	Se (mg/kg)	Zn (mg/kg)
06/08/16	150	36.0	1.1	0.031	<0.48	0.605	3.37	0.0429	0.069	5.66	143
06/08/16	108	15.9	1.3	<0.020	<0.50	0.327	4.33	0.0337	0.183	6.91	147
06/08/16	123	26.5	1.4	<0.020	<0.50	0.683	3.83	0.0301	0.717	5.64	117
06/08/16	73	5.2	1.3	<0.020	<0.49	0.288	4.99	0.0260	0.128	3.94	128
06/08/16	180	66.7	1.1	<0.020	<0.50	0.329	3.11	0.0376	0.061	5.17	132
06/08/16	77	6.0	1.3	<0.020	<0.50	0.215	3.53	0.0259	0.259	4.80	146
06/08/16	83	7.8	1.4	<0.020	<0.50	0.280	3.75	0.0247	0.182	6.05	132
06/08/16	146	31.5	1.0	<0.020	<0.50	0.521	2.50	0.0299	0.062	4.90	103
06/08/16	83	7.0	1.2	<0.020	<0.50	0.678	2.56	0.0328	0.046	4.66	139
06/08/16	70	5.0	1.5	0.682	<0.50	0.257	2.63	0.0184	0.036	6.29	133
06/09/17	154	45.5	1.2	<0.020	<0.50	0.267	3.29	0.0364	0.036	5.14	116
06/09/17	130	24.3	1.1	<0.020	<0.50	0.333	3.23	0.0343	0.056	6.86	95
06/09/17	210	115.0	1.2	<0.020	<0.50	0.758	7.67	0.0701	0.031	6.34	161
06/09/17	141	34.7	1.2	<0.020	<0.50	0.291	3.33	0.0430	0.037	8.02	126
06/09/17	131	24.3	1.1	<0.020	<0.50	0.299	3.26	0.0385	0.100	6.10	128
06/09/17	90	7.4	1.0	<0.020	<0.50	0.343	2.40	0.0361	0.034	6.86	101
05/31/18	171	55.9	1.1	<0.020	<0.50	0.696	15.20	0.0641	0.080	6.56	176
05/31/18	138	28.3	1.1	<0.020	<0.50	0.541	6.22	0.0659	0.044	5.30	114
05/31/18	58, 57[a]	4.2	ND	<0.082	<2.0	0.357	4.25	0.0191	0.087	4.90	114
05/31/18	188	76.2	1.1	0.027	<0.50	0.889	12.70	0.0487	0.143	6.22	140
05/31/18	175	58.1	1.1	<0.020	<0.50	0.612	5.47	0.0296	0.107	5.20	108
05/31/18	100	11.2	1.1	0.029	<0.50	0.802	5.07	0.0676	0.122	6.72	146
06/07/19	65, 65[a]	8.3	ND	<0.020	<0.50	0.501	3.89	0.0157	0.053	5.81	117
06/07/19	72, 70[a]	10.2	ND	<0.020	<0.50	0.615	3.91	0.0241	0.073	5.30	101
06/07/19	141	36.9	1.3	<0.019	<0.48	0.354	3.16	0.0468	<0.019	5.46	116
06/07/19	185	88.4	1.4	<0.020	<0.49	0.785	3.42	0.1060	0.050	5.16	161
06/07/19	67, 69[a]	8.6	ND	<0.020	<0.50	0.438	3.55	0.0199	0.109	5.60	105
06/07/19	166	47.4	1.0	<0.019	<0.48	0.280	3.73	0.0528	0.091	5.47	115
06/07/19	87	8.7	1.3	<0.019	<0.48	0.231	2.39	0.0260	0.028	5.54	89.3
06/07/19	100	14.9	1.5	<0.020	<0.49	0.260	3.41	0.0356	0.163	5.43	99.8
06/07/19	75, 77[a]	11.6	ND	0.984	<0.48	0.337	3.94	0.0254	0.179	5.18	106
06/07/19	75, 75[a]	8.4	ND	<0.019	<0.48	0.547	3.68	0.0331	0.120	5.25	88.6

[a] Composite sample of two fish.

Appendix D.2.–Continued.

Sample Date	Length (mm)	Weight (g)	Condition (K)	Ag (mg/kg)	As (mg/kg)	Cd (mg/kg)	Cu (mg/kg)	Hg (mg/kg)	Pb (mg/kg)	Se (mg/kg)	Zn (mg/kg)
06/02/20	141	30.3	1.1	<0.019	<0.49	0.251	3.45	0.0465	0.054	5.38	162
06/02/20	142	35.4	1.2	<0.020	<0.50	0.182	3.73	0.0396	0.127	4.12	125
06/02/20	118	20.1	1.2	<0.020	<0.49	0.344	4.97	0.0327	0.219	5.04	131
06/02/20	108	14.4	1.1	<0.020	<0.49	0.373	5.07	0.0326	0.216	4.81	144
06/02/20	119	18.4	1.1	<0.020	<0.49	0.314	4.19	0.0302	0.094	5.55	112
06/02/20	111	14.6	1.1	<0.019	<0.49	0.249	3.79	0.0326	0.151	4.94	129

ALS Environmental
ALS Group USA, Corp
1317 South 13th Avenue
Kelso, WA 98626
T : +1 360 577 7222
F : +1 360 636 1068
www.alsglobal.com

October 20, 2020 **Analytical Report for Service Request No:** K2007937

Dylan Krull
Alaska Department of Fish and Game
Division of Habitat
802 3rd Street
P.O. Box 110024
Douglas, AK 99811-0024

RE: 2020 Palmer Project Biomonitoring

Dear Dylan,

Enclosed are the results of the sample(s) submitted to our laboratory September 10, 2020
For your reference, these analyses have been assigned our service request number **K2007937.**

Analyses were performed according to our laboratory's NELAP-approved quality assurance program. The test results meet requirements of the current NELAP standards, where applicable, and except as noted in the laboratory case narrative provided. For a specific list of NELAP-accredited analytes, refer to the certifications section at www.alsglobal.com. All results are intended to be considered in their entirety, and ALS Group USA Corp. dba ALS Environmental (ALS) is not responsible for use of less than the complete report. Results apply only to the items submitted to the laboratory for analysis and individual items (samples) analyzed, as listed in the report.

Please contact me if you have any questions. My extension is 3376. You may also contact me via email at Mark.Harris@alsglobal.com.

Respectfully submitted,

ALS Group USA, Corp. dba ALS Environmental

Mark Harris
Project Manager

ALS Environmental
ALS Group USA, Corp
1317 South 13th Avenue
Kelso, WA 98626
T : +1 360 577 7222
F : +1 360 636 1068
www.alsglobal.com

Table of Contents

Acronyms

ASTM	American Society for Testing and Materials
A2LA	American Association for Laboratory Accreditation
CARB	California Air Resources Board
CAS Number	Chemical Abstract Service registry Number
CFC	Chlorofluorocarbon
CFU	Colony-Forming Unit
DEC	Department of Environmental Conservation
DEQ	Department of Environmental Quality
DHS	Department of Health Services
DOE	Department of Ecology
DOH	Department of Health
EPA	U. S. Environmental Protection Agency
ELAP	Environmental Laboratory Accreditation Program
GC	Gas Chromatography
GC/MS	Gas Chromatography/Mass Spectrometry
LOD	Limit of Detection
LOQ	Limit of Quantitation
LUFT	Leaking Underground Fuel Tank
M	Modified
MCL	Maximum Contaminant Level is the highest permissible concentration of a substance allowed in drinking water as established by the USEPA.
MDL	Method Detection Limit
MPN	Most Probable Number
MRL	Method Reporting Limit
NA	Not Applicable
NC	Not Calculated
NCASI	National Council of the Paper Industry for Air and Stream Improvement
ND	Not Detected
NIOSH	National Institute for Occupational Safety and Health
PQL	Practical Quantitation Limit
RCRA	Resource Conservation and Recovery Act
SIM	Selected Ion Monitoring
TPH	Total Petroleum Hydrocarbons
tr	Trace level is the concentration of an analyte that is less than the PQL but greater than or equal to the MDL.

Inorganic Data Qualifiers

*	The result is an outlier. See case narrative.
#	The control limit criteria is not applicable. See case narrative.
B	The analyte was found in the associated method blank at a level that is significant relative to the sample result as defined by the DOD or NELAC standards.
E	The result is an estimate amount because the value exceeded the instrument calibration range.
J	The result is an estimated value.
U	The analyte was analyzed for, but was not detected ("Non-detect") at or above the MRL/MDL. *DOD-QSM 4.2 definition* : Analyte was not detected and is reported as less than the LOD or as defined by the project. The detection limit is adjusted for dilution.
i	The MRL/MDL or LOQ/LOD is elevated due to a matrix interference.
X	See case narrative.
Q	See case narrative. One or more quality control criteria was outside the limits.
H	The holding time for this test is immediately following sample collection. The samples were analyzed as soon as possible after receipt by the laboratory.

Metals Data Qualifiers

#	The control limit criteria is not applicable. See case narrative.
J	The result is an estimated value.
E	The percent difference for the serial dilution was greater than 10%, indicating a possible matrix interference in the sample.
M	The duplicate injection precision was not met.
N	The Matrix Spike sample recovery is not within control limits. See case narrative.
S	The reported value was determined by the Method of Standard Additions (MSA).
U	The analyte was analyzed for, but was not detected ("Non-detect") at or above the MRL/MDL. *DOD-QSM 4.2 definition* : Analyte was not detected and is reported as less than the LOD or as defined by the project. The detection limit is adjusted for dilution.
W	The post-digestion spike for furnace AA analysis is out of control limits, while sample absorbance is less than 50% of spike absorbance.
i	The MRL/MDL or LOQ/LOD is elevated due to a matrix interference.
X	See case narrative.
+	The correlation coefficient for the MSA is less than 0.995.
Q	See case narrative. One or more quality control criteria was outside the limits.

Organic Data Qualifiers

*	The result is an outlier. See case narrative.
#	The control limit criteria is not applicable. See case narrative.
A	A tentatively identified compound, a suspected aldol-condensation product.
B	The analyte was found in the associated method blank at a level that is significant relative to the sample result as defined by the DOD or NELAC standards.
C	The analyte was qualitatively confirmed using GC/MS techniques, pattern recognition, or by comparing to historical data.
D	The reported result is from a dilution.
E	The result is an estimated value.
J	The result is an estimated value.
N	The result is presumptive. The analyte was tentatively identified, but a confirmation analysis was not performed.
P	The GC or HPLC confirmation criteria was exceeded. The relative percent difference is greater than 40% between the two analytical results.
U	The analyte was analyzed for, but was not detected ("Non-detect") at or above the MRL/MDL. *DOD-QSM 4.2 definition* : Analyte was not detected and is reported as less than the LOD or as defined by the project. The detection limit is adjusted for dilution.
i	The MRL/MDL or LOQ/LOD is elevated due to a chromatographic interference.
X	See case narrative.
Q	See case narrative. One or more quality control criteria was outside the limits.

Additional Petroleum Hydrocarbon Specific Qualifiers

F	The chromatographic fingerprint of the sample matches the elution pattern of the calibration standard.
L	The chromatographic fingerprint of the sample resembles a petroleum product, but the elution pattern indicates the presence of a greater amount of lighter molecular weight constituents than the calibration standard.
H	The chromatographic fingerprint of the sample resembles a petroleum product, but the elution pattern indicates the presence of a greater amount of heavier molecular weight constituents than the calibration standard.
O	The chromatographic fingerprint of the sample resembles an oil, but does not match the calibration standard.
Y	The chromatographic fingerprint of the sample resembles a petroleum product eluting in approximately the correct carbon range, but the elution pattern does not match the calibration standard.
Z	The chromatographic fingerprint does not resemble a petroleum product.

ALS Group USA Corp. dba ALS Environmental (ALS) - Kelso
State Certifications, Accreditations, and Licenses

Agency	Web Site	Number
Alaska DEH	http://dec.alaska.gov/eh/lab/cs/csapproval.htm	UST-040
Arizona DHS	http://www.azdhs.gov/lab/license/env.htm	AZ0339
Arkansas - DEQ	http://www.adeq.state.ar.us/techsvs/labcert.htm	88-0637
California DHS (ELAP)	http://www.cdph.ca.gov/certlic/labs/Pages/ELAP.aspx	2795
DOD ELAP	http://www.denix.osd.mil/edqw/Accreditation/AccreditedLabs.cfm	L16-58-R4
Florida DOH	http://www.doh.state.fl.us/lab/EnvLabCert/WaterCert.htm	E87412
Hawaii DOH	http://health.hawaii.gov/	-
ISO 17025	http://www.pjlabs.com/	L16-57
Louisiana DEQ	http://www.deq.louisiana.gov/page/la-lab-accreditation	03016
Maine DHS	http://www.maine.gov/dhhs/	WA01276
Minnesota DOH	http://www.health.state.mn.us/accreditation	053-999-457
Nevada DEP	http://ndep.nv.gov/bsdw/labservice.htm	WA01276
New Jersey DEP	http://www.nj.gov/dep/enforcement/oqa.html	WA005
New York - DOH	https://www.wadsworth.org/regulatory/elap	12060
North Carolina DEQ	https://deq.nc.gov/about/divisions/water-resources/water-resources-data/water-sciences-home-page/laboratory-certification-branch/non-field-lab-certification	605
Oklahoma DEQ	http://www.deq.state.ok.us/CSDnew/labcert.htm	9801
Oregon – DEQ (NELAP)	http://public.health.oregon.gov/LaboratoryServices/EnvironmentalLaboratoryAccreditation/Pages/index.aspx	WA100010
South Carolina DHEC	http://www.scdhec.gov/environment/EnvironmentalLabCertification/	61002
Texas CEQ	http://www.tceq.texas.gov/field/qa/env_lab_accreditation.html	T104704427
Washington DOE	http://www.ecy.wa.gov/programs/eap/labs/lab-accreditation.html	C544
Wyoming (EPA Region 8)	https://www.epa.gov/region8-waterops/epa-region-8-certified-drinking-water-	-
Kelso Laboratory Website	www.alsglobal.com	NA

Analyses were performed according to our laboratory's NELAP-approved quality assurance program. A complete listing of specific NELAP-certified analytes, can be found in the certification section at www.ALSGlobal.com or at the accreditation bodies web site.
Please refer to the certification and/or accreditation body's web site if samples are submitted for compliance purposes. The states highlighted above, require the analysis be listed on the state certification if used for compliance purposes and if the method/anlayte is offered by that state.

Case Narrative

ALS Environmental—Kelso Laboratory
1317 South 13th Avenue, Kelso, WA 98626
Phone (360)577- 7222 Fax (360)636- 1068
www.alsglobal.com

ALS Environmental

Client: Alaska Department of Fish and Game
Project: 2020 Palmer Project Biomonitoring
Sample Matrix: Animal Tissue

Service Request: K2007937
Date Received: 09/10/2020

CASE NARRATIVE

All analyses were performed consistent with the quality assurance program of ALS Environmental. This report contains analytical results for samples for the Tier II level requested by the client.

Sample Receipt:

Sixteen animal tissue samples were received for analysis at ALS Environmental on 09/10/2020. Any discrepancies upon initial sample inspection are annotated on the sample receipt and preservation form included within this report. The samples were stored at minimum in accordance with the analytical method requirements.

Metals:

Method 6020A, 10/16/2020: Method Blanks KQ2015605-01 and KQ2015607-01 contained low levels of Copper above the Method Reporting Limit (MRL). The concentration of Copper in all of the associated samples was greater than ten times the amount found in the Method Blanks so not corrective action was required.

Approved by Noe D. Oan Date 10/20/2020

Chain of Custody

ALS Environmental—Kelso Laboratory
1317 South 13th Avenue, Kelso, WA 98626
Phone (360)577- 7222 Fax (360)636- 1068
www.alsglobal.com

CHAIN OF CUSTODY

ALS Environmental
1317 South 13th Ave., Kelso, WA 98626 | 360.577.7222 | 800.695.7222 | 360.636.1068 (fax)

SR# K2007937 PAGE 1 OF 2 COC#

PROJECT NAME: 2020 Palmer Project Biomonitoring
PROJECT NUMBER:
PROJECT MANAGER: Dylan Krull
COMPANY NAME: AK Dept. of Fish + Game
ADDRESS: 802 3rd St.
CITY/STATE/ZIP: Douglas, AK 99824
E-MAIL ADDRESS: dylan.krull@alaska.gov
PHONE #: 907-465-6160 FAX #:
PROJECT SIGNATURE:
SAMPLER'S SIGNATURE: D. Krull

SAMPLE I.D.	DATE	TIME	LAB I.D.	MATRIX	NUMBER OF CONTAINERS	Semivolatile Organics by GC/MS 625☐ 8270☐ 8270LL☐ SIM PAH☐	Volatile Organics 624☐ 8260☐ 8021☐ BTEX☐	Hydrocarbons (*see below) Gas☐ Diesel☐ Oil☐	Oil & Grease/TRPH 1664 HEM☐ 1664 SGT☐	PCBs Aroclors☐ Congeners☐	Pesticides/Herbicides 608☐ 8081☐ 8141☐ 8151☐	Chlorophenolics - 8151M Tri☐ Tetra☐ PCP☐	Metals, Total or Dissolved (See List below)	Cyanide☐ Hex-Chrom☐	(circle) pH, Cond., Cl, SO4, PO4, F, NO2, NO3, BOD, TSS, TDS, Turb.	(circle) NH3-N, COD, TKN, TOC, DOC, NO2+NO3, T-Phos	TOX 9020☐ AOX 1650☐ 506☐	Alkalinity☐ CO3☐ HCO3☐	Dioxins/Furans 1613☐ 8290☐	Dissolved Gases RSK 175☐ CO2☐ Methane☐ Ethane☐ Ethene☐				REMARKS
See attachment		1 of 1	for		16								X								X				
Whole body juvenile fish																									
individual samples																									

6020A
Hg - 1631E

REPORT REQUIREMENTS

___ I. Routine Report: Method Blank, Surrogate, as required
✓ II. Report Dup., MS, MSD as required
___ III. CLP Like Summary (no raw data)
___ IV. Data Validation Report
___ V. EDD

INVOICE INFORMATION

P.O. # Constantine
Bill To: Allegra Cairns
allegra@constantinemetals.com

TURNAROUND REQUIREMENTS

___ 24 hr. ___ 48 hr.
___ 5 day
✓ Standard (15 working days)
___ Provide FAX Results

Requested Report Date

Circle which metals are to be analyzed:

Total Metals: Al (As) Sb Ba Be B Ca (Cd) Co Cr (Cu) Fe (Pb) Mg Mn Mo Ni K (Ag) Na (Se) Sr Tl Sn V (Zn) (Hg)

Dissolved Metals: Al As Sb Ba Be B Ca Cd Co Cr Cu Fe Pb Mg Mn Mo Ni K Ag Na Se Sr Tl Sn V Zn Hg

*INDICATE STATE HYDROCARBON PROCEDURE: AK CA WI NORTHWEST OTHER: _____ (CIRCLE ONE)

SPECIAL INSTRUCTIONS/COMMENTS:

Please email report to Dylan and Allegra

☐ Sample Shipment contains USDA regulated soil samples (check box if applicable)

RELINQUISHED BY:	RECEIVED BY:	RELINQUISHED BY:	RECEIVED BY:
Signature: [signature]	Signature: [signature]	Signature	Signature
Date/Time: 9/8/20 0800	Date/Time: 9/10/20 1040	Date/Time	Date/Time
Printed Name: Bill Kuna	Printed Name: [illegible]	Printed Name	Printed Name
Firm: ADF+G	Firm: ALS	Firm	Firm

Project Name: 2020 Palmer Project Biomonitoring
Company Name: Alaska Department of Fish and Game
Project Manager: Dylan Krull
Contact Information: dylan.krull@alaska.gov; (907) 465-6160
Sample Type: Whole body Dolly Varden char
Analysis: EPA 6020A total metals and EPA1631E Hg, dry weight basis, report percent solids

Matrix	Sample Date	Sample Name	Sample ID	Analytes	Fork Length (mm)	Weight (g)
Whole Body	6/6/2020	Lower Glacier Creek DV Metals Fish #1	2020LGCDV1	Ag, As, Cd, Cu, Hg, Pb, Se, Zn	115	14.8
Whole Body	6/6/2020	Lower Glacier Creek DV Metals Fish #2	2020LGCDV2	Ag, As, Cd, Cu, Hg, Pb, Se, Zn	98	11.2
Whole Body	6/6/2020	Lower Glacier Creek DV Metals Fish #3	2020LGCDV3	Ag, As, Cd, Cu, Hg, Pb, Se, Zn	110	15.4
Whole Body	6/6/2020	Lower Glacier Creek DV Metals Fish #4	2020LGCDV4	Ag, As, Cd, Cu, Hg, Pb, Se, Zn	99	11.9
Whole Body	6/6/2020	Lower Glacier Creek DV Metals Fish #5	2020LGCDV5	Ag, As, Cd, Cu, Hg, Pb, Se, Zn	123	19.9
Whole Body	6/6/2020	Lower Glacier Creek DV Metals Fish #6	2020LGCDV6	Ag, As, Cd, Cu, Hg, Pb, Se, Zn	113	14.7
Whole Body	6/6/2020	Lower Glacier Creek DV Metals Fish #7	2020LGCDV7	Ag, As, Cd, Cu, Hg, Pb, Se, Zn	107	14.0
Whole Body	6/6/2020	Lower Glacier Creek DV Metals Fish #8	2020LGCDV8	Ag, As, Cd, Cu, Hg, Pb, Se, Zn	113	15.8
Whole Body	6/6/2020	Lower Glacier Creek DV Metals Fish #9	2020LGCDV9	Ag, As, Cd, Cu, Hg, Pb, Se, Zn	112	15.6
Whole Body	6/6/2020	Lower Glacier Creek DV Metals Fish #10	2020LGCDV10	Ag, As, Cd, Cu, Hg, Pb, Se, Zn	122	18.3
Whole Body	6/7/2020	Middle Glacier Creek DV Metals Fish #1	2020MGCDV1	Ag, As, Cd, Cu, Hg, Pb, Se, Zn	141	30.3
Whole Body	6/7/2020	Middle Glacier Creek DV Metals Fish #2	2020MGCDV2	Ag, As, Cd, Cu, Hg, Pb, Se, Zn	142	35.4
Whole Body	6/7/2020	Middle Glacier Creek DV Metals Fish #3	2020MGCDV3	Ag, As, Cd, Cu, Hg, Pb, Se, Zn	118	20.1
Whole Body	6/7/2020	Middle Glacier Creek DV Metals Fish #4	2020MGCDV4	Ag, As, Cd, Cu, Hg, Pb, Se, Zn	108	14.4
Whole Body	6/7/2020	Middle Glacier Creek DV Metals Fish #5	2020MGCDV5	Ag, As, Cd, Cu, Hg, Pb, Se, Zn	119	18.4
Whole Body	6/7/2020	Middle Glacier Creek DV Metals Fish #6	2020MGCDV6	Ag, As, Cd, Cu, Hg, Pb, Se, Zn	111	14.6

PM MH

Cooler Receipt and Preservation Form

Client Alaska Dept of Fish + Game Service Request K2007937

Received: 9/10/20 Opened: 9/10/20 By: [illegible] Unloaded: 9/10/20 By: [illegible]

1. Samples were received via? *USPS* *Fed Ex* (*UPS*) *DHL* *PDX* *Courier* *Hand Delivered*
2. Samples were received in: (circle) (*Cooler*) *Box* *Envelope* *Other* _____ *NA*
3. Were custody seals on coolers? NA (Y) N If yes, how many and where? 1 Front-
   If present, were custody seals intact? (Y) N If present, were they signed and dated? (Y) N
4. Was a Temperature Blank present in cooler? NA (Y) N If yes, notate the temperature in the appropriate column below:
   If no, take the temperature of a representative sample bottle contained within the cooler; notate in the column "Sample Temp":
5. Were samples received within the method specified temperature ranges? NA Y (N)
   If no, were they received on ice and same day as collected? If not, notate the cooler # below and notify the PM. NA Y (N)

If applicable, tissue samples were received: *Frozen* *Partially Thawed* *Thawed*

Temp Blank	Sample Temp	IR Gun	Cooler #/COC ID / NA	Out of temp indicate with "X"	PM Notified If out of temp	Tracking Number NA	Filed
18.6	—	IR02	2gr	X	X	3966 0398	

6. Packing material: *Inserts* (*Baggies*) (*Bubble Wrap*) *Gel Packs* *Wet Ice* *Dry Ice* *Sleeves* Melted gel packs
7. Were custody papers properly filled out (ink, signed, etc.)? NA (Y) N
8. Were samples received in good condition (unbroken) NA (Y) N
9. Were all sample labels complete (ie, analysis, preservation, etc.)? NA (Y) N
10. Did all sample labels and tags agree with custody papers? NA (Y) N
11. Were appropriate bottles/containers and volumes received for the tests indicated? NA (Y) N
12. Were the pH-preserved bottles (*see SMO GEN SOP*) received at the appropriate pH? *Indicate in the table below* (NA) Y N
13. Were VOA vials received without headspace? *Indicate in the table below.* (NA) Y N
14. Was C12/Res negative? (NA) Y N

Sample ID on Bottle	Sample ID on COC	Identified by:

Sample ID	Bottle Count Bottle Type	Head-space	Broke	pH	Reagent	Volume added	Reagent Lot Number	Initials	Time

Notes, Discrepancies, Resolutions: _____

Total Solids

ALS Environmental—Kelso Laboratory
1317 South 13th Avenue, Kelso, WA 98626
Phone (360)577-7222 Fax (360)636-1068
www.alsglobal.com

Analytical Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K2007937
Project:	2020 Palmer Project Biomonitoring	**Date Collected:**	06/06/20 - 06/07/20
Sample Matrix:	Animal Tissue	**Date Received:**	09/10/20
Analysis Method:	Freeze Dry	**Units:**	Percent
Prep Method:	None	**Basis:**	Wet

Total Solids

Sample Name	Lab Code	Result	MRL	MDL	Dil.	Date Analyzed	Q
Lower Glacier Creek DV Metals Fish #1	K2007937-001	**23.0**	-	-	1	10/12/20	
Lower Glacier Creek DV Metals Fish #2	K2007937-002	**23.3**	-	-	1	10/12/20	
Lower Glacier Creek DV Metals Fish #3	K2007937-003	**24.6**	-	-	1	10/12/20	
Lower Glacier Creek DV Metals Fish #4	K2007937-004	**25.3**	-	-	1	10/12/20	
Lower Glacier Creek DV Metals Fish #5	K2007937-005	**23.4**	-	-	1	10/12/20	
Lower Glacier Creek DV Metals Fish #6	K2007937-006	**23.4**	-	-	1	10/12/20	
Lower Glacier Creek DV Metals Fish #7	K2007937-007	**23.7**	-	-	1	10/12/20	
Lower Glacier Creek DV Metals Fish #8	K2007937-008	**25.4**	-	-	1	10/12/20	
Lower Glacier Creek DV Metals Fish #9	K2007937-009	**24.6**	-	-	1	10/12/20	
Lower Glacier Creek DV Metals Fish #10	K2007937-010	**23.0**	-	-	1	10/12/20	
Middle Glacier Creek DV Metals Fish #1	K2007937-011	**26.8**	-	-	1	10/12/20	
Middle Glacier Creek DV Metals Fish #2	K2007937-012	**28.0**	-	-	1	10/12/20	
Middle Glacier Creek DV Metals Fish #3	K2007937-013	**24.2**	-	-	1	10/12/20	
Middle Glacier Creek DV Metals Fish #4	K2007937-014	**23.5**	-	-	1	10/12/20	
Middle Glacier Creek DV Metals Fish #5	K2007937-015	**25.6**	-	-	1	10/12/20	
Middle Glacier Creek DV Metals Fish #6	K2007937-016	**24.8**	-	-	1	10/12/20	

Metals

ALS Environmental—Kelso Laboratory
1317 South 13th Avenue, Kelso, WA 98626
Phone (360)577-7222 Fax (360)636-1068
www.alsglobal.com

ALS Group USA, Corp.
dba ALS Environmental
Analytical Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K2007937
Project:	2020 Palmer Project Biomonitoring	**Date Collected:**	06/06-06/07/20
Sample Matrix:	Animal tissue	**Date Received:**	09/10/20

Mercury, Total

Prep Method:	METHOD	Units:	ng/g
Analysis Method:	1631E	Basis:	Dry
Test Notes:			

Sample Name	Lab Code	MRL	MDL	Dilution Factor	Date Extracted	Date Analyzed	Result	Result Notes
Lower Glacier Creek DV Metals Fish #1	K2007937-001	1.0	0.09	1	10/16/20	10/19/20	51.7	
Lower Glacier Creek DV Metals Fish #2	K2007937-002	1.0	0.09	1	10/16/20	10/19/20	41.2	
Lower Glacier Creek DV Metals Fish #3	K2007937-003	1.0	0.09	1	10/16/20	10/19/20	42.5	
Lower Glacier Creek DV Metals Fish #4	K2007937-004	1.0	0.09	1	10/16/20	10/19/20	45.5	
Lower Glacier Creek DV Metals Fish #5	K2007937-005	1.0	0.09	1	10/16/20	10/19/20	45.8	
Lower Glacier Creek DV Metals Fish #6	K2007937-006	1.0	0.09	1	10/16/20	10/19/20	42.9	
Lower Glacier Creek DV Metals Fish #7	K2007937-007	1.0	0.09	1	10/16/20	10/19/20	41.2	
Lower Glacier Creek DV Metals Fish #8	K2007937-008	1.0	0.09	1	10/16/20	10/19/20	50.9	
Lower Glacier Creek DV Metals Fish #9	K2007937-009	1.0	0.09	1	10/16/20	10/19/20	36.9	
Lower Glacier Creek DV Metals Fish #10	K2007937-010	1.0	0.09	1	10/16/20	10/19/20	53.7	
Middle Glacier Creek DV Metals Fish #1	K2007937-011	1.0	0.09	1	10/16/20	10/19/20	46.5	
Middle Glacier Creek DV Metals Fish #2	K2007937-012	1.0	0.09	1	10/16/20	10/19/20	39.6	
Middle Glacier Creek DV Metals Fish #3	K2007937-013	1.0	0.09	1	10/16/20	10/19/20	32.7	
Middle Glacier Creek DV Metals Fish #4	K2007937-014	1.0	0.09	1	10/16/20	10/19/20	32.6	
Middle Glacier Creek DV Metals Fish #5	K2007937-015	1.0	0.09	1	10/16/20	10/19/20	30.2	
Middle Glacier Creek DV Metals Fish #6	K2007937-016	1.0	0.09	1	10/16/20	10/19/20	32.6	
Method Blank 1	K2007937-MB1	1.0	0.09	1	10/16/20	10/19/20	ND	
Method Blank 2	K2007937-MB2	1.0	0.09	1	10/16/20	10/19/20	ND	
Method Blank 3	K2007937-MB3	1.0	0.09	1	10/16/20	10/19/20	0.13	J

ALS Group USA, Corp.
dba ALS Environmental
QA/QC Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K2007937
Project:	2020 Palmer Project Biomonitoring	**Date Collected:**	06/06/20
Sample Matrix:	Animal tissue	**Date Received:**	09/10/20
		Date Extracted:	10/16/20
		Date Analyzed:	10/19/20

Matrix Spike/Duplicate Matrix Spike Summary
Total Metals

Sample Name:	Lower Glacier Creek DV Metals Fish #5	Units:	ng/g
Lab Code:	K2007937-005MS, K2007937-005DMS	Basis:	Dry
Test Notes:			

Analyte	Prep Method	Analysis Method	MRL	Spike Level MS	Spike Level DMS	Sample Result	Spike Result MS	Spike Result DMS	Percent Recovery MS	Percent Recovery DMS	ALS Acceptance Limits	Relative Percent Difference	Result Notes
Mercury	METHOD	1631E	9.8	245	246	45.8	292	289	100	99	70-130	1	

ALS Group USA, Corp.
dba ALS Environmental
QA/QC Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K2007937
Project:	2020 Palmer Project Biomonitoring	**Date Collected:**	06/06/20
Sample Matrix:	Animal tissue	**Date Received:**	09/10/20
		Date Extracted:	10/16/20
		Date Analyzed:	10/19/20

Matrix Spike/Duplicate Matrix Spike Summary
Total Metals

Sample Name:	Lower Glacier Creek DV Metals Fish #10	Units:	ng/g
Lab Code:	K2007937-010MS, K2007937-010DMS	Basis:	Dry
Test Notes:			

Analyte	Prep Method	Analysis Method	MRL	Spike Level MS	Spike Level DMS	Sample Result	Spike Result MS	Spike Result DMS	Percent Recovery MS	Percent Recovery DMS	ALS Acceptance Limits	Relative Percent Difference	Result Notes
Mercury	METHOD	1631E	9.8	246	250	53.7	306	302	103	99	70-130	1	

ALS Group USA, Corp.
dba ALS Environmental
QA/QC Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K2007937
Project:	2020 Palmer Project Biomonitoring	**Date Collected:**	NA
LCS Matrix:	Water	**Date Received:**	NA
		Date Extracted:	NA
		Date Analyzed:	10/19/20

Ongoing Precision and Recovery (OPR) Sample Summary
Total Metals

Sample Name: Ongoing Precision and Recovery (Initial)

Units: ng/g
Basis: NA

Test Notes:

Analyte	Prep Method	Analysis Method	True Value	Result	Percent Recovery	ALS Percent Recovery Acceptance Limits	Result Notes
Mercury	METHOD	1631E	5.00	5.39	108	70-130	

ALS Group USA, Corp.
dba ALS Environmental
QA/QC Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K2007937
Project:	2020 Palmer Project Biomonitoring	**Date Collected:**	NA
LCS Matrix:	Water	**Date Received:**	NA
		Date Extracted:	NA
		Date Analyzed:	10/19/20

Ongoing Precision and Recovery (OPR) Sample Summary
Total Metals

Sample Name: Ongoing Precision and Recovery (Final)

Units: ng/g
Basis: NA

Test Notes:

Analyte	Prep Method	Analysis Method	True Value	Result	Percent Recovery	ALS Percent Recovery Acceptance Limits	Result Notes
Mercury	METHOD	1631E	5.00	5.07	101	70-130	

ALS Group USA, Corp.
dba ALS Environmental
QA/QC Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K2007937
Project:	2020 Palmer Project Biomonitoring	**Date Collected:**	NA
LCS Matrix:	Animal tissue	**Date Received:**	NA
		Date Extracted:	10/16/20
		Date Analyzed:	10/19/20

Quality Control Sample (QCS) Summary
Total Metals

Sample Name:	Quality Control Sample	Units:	ng/g
Lab Code:		Basis:	Dry
Test Notes:	Tort-3 Solids = 99.1%		

Source: TORT-3

Analyte	Prep Method	Analysis Method	True Value	Result	Percent Recovery	ALS Percent Recovery Acceptance Limits	Result Notes
Mercury	METHOD	1631E	292	286	98	70-130	

Analytical Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K2007937
Project:	2020 Palmer Project Biomonitoring	**Date Collected:**	06/06/20
Sample Matrix:	Animal Tissue	**Date Received:**	09/10/20 10:40
Sample Name:	Lower Glacier Creek DV Metals Fish #1	**Basis:**	Dry
Lab Code:	K2007937-001		

Total Metals

Analyte Name	Analysis Method	Result	Units	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
Arsenic	6020A	**0.18 J**	mg/Kg	0.49	0.02	5	10/16/20 19:40	10/15/20	
Cadmium	6020A	**0.223**	mg/Kg	0.020	0.004	5	10/16/20 19:40	10/15/20	
Copper	6020A	**4.15**	mg/Kg	0.098	0.030	5	10/16/20 19:40	10/15/20	
Lead	6020A	**0.053**	mg/Kg	0.020	0.003	5	10/16/20 19:40	10/15/20	
Selenium	6020A	**5.92**	mg/Kg	0.98	0.20	5	10/16/20 19:40	10/15/20	
Silver	6020A	ND U	mg/Kg	0.020	0.008	5	10/16/20 19:40	10/15/20	
Zinc	6020A	**149**	mg/Kg	0.49	0.08	5	10/16/20 19:40	10/15/20	

Analytical Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K2007937
Project:	2020 Palmer Project Biomonitoring	**Date Collected:**	06/06/20
Sample Matrix:	Animal Tissue	**Date Received:**	09/10/20 10:40
Sample Name:	Lower Glacier Creek DV Metals Fish #2	**Basis:**	Dry
Lab Code:	K2007937-002		

Total Metals

Analyte Name	Analysis Method	Result	Units	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
Arsenic	6020A	**0.21 J**	mg/Kg	0.50	0.02	5	10/16/20 19:42	10/15/20	
Cadmium	6020A	**0.657**	mg/Kg	0.020	0.004	5	10/16/20 19:42	10/15/20	
Copper	6020A	**4.10**	mg/Kg	0.10	0.03	5	10/16/20 19:42	10/15/20	
Lead	6020A	**0.051**	mg/Kg	0.020	0.003	5	10/16/20 19:42	10/15/20	
Selenium	6020A	**5.55**	mg/Kg	1.0	0.2	5	10/16/20 19:42	10/15/20	
Silver	6020A	**0.008 J**	mg/Kg	0.020	0.008	5	10/16/20 19:42	10/15/20	
Zinc	6020A	**134**	mg/Kg	0.50	0.08	5	10/16/20 19:42	10/15/20	

Analytical Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K2007937
Project:	2020 Palmer Project Biomonitoring	**Date Collected:**	06/06/20
Sample Matrix:	Animal Tissue	**Date Received:**	09/10/20 10:40
Sample Name:	Lower Glacier Creek DV Metals Fish #3	**Basis:**	Dry
Lab Code:	K2007937-003		

Total Metals

Analyte Name	Analysis Method	Result	Units	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
Arsenic	6020A	**0.20 J**	mg/Kg	0.50	0.02	5	10/16/20 19:45	10/15/20	
Cadmium	6020A	**0.290**	mg/Kg	0.020	0.004	5	10/16/20 19:45	10/15/20	
Copper	6020A	**4.03**	mg/Kg	0.099	0.030	5	10/16/20 19:45	10/15/20	
Lead	6020A	**0.076**	mg/Kg	0.020	0.003	5	10/16/20 19:45	10/15/20	
Selenium	6020A	**5.72**	mg/Kg	0.99	0.20	5	10/16/20 19:45	10/15/20	
Silver	6020A	ND U	mg/Kg	0.020	0.008	5	10/16/20 19:45	10/15/20	
Zinc	6020A	**160**	mg/Kg	0.50	0.08	5	10/16/20 19:45	10/15/20	

Analytical Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K2007937
Project:	2020 Palmer Project Biomonitoring	**Date Collected:**	06/06/20
Sample Matrix:	Animal Tissue	**Date Received:**	09/10/20 10:40
Sample Name:	Lower Glacier Creek DV Metals Fish #4	**Basis:**	Dry
Lab Code:	K2007937-004		

Total Metals

Analyte Name	Analysis Method	Result	Units	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
Arsenic	6020A	**0.35 J**	mg/Kg	0.49	0.02	5	10/16/20 19:47	10/15/20	
Cadmium	6020A	**0.446**	mg/Kg	0.020	0.004	5	10/16/20 19:47	10/15/20	
Copper	6020A	**4.77**	mg/Kg	0.098	0.029	5	10/16/20 19:47	10/15/20	
Lead	6020A	**0.178**	mg/Kg	0.020	0.003	5	10/16/20 19:47	10/15/20	
Selenium	6020A	**6.75**	mg/Kg	0.98	0.20	5	10/16/20 19:47	10/15/20	
Silver	6020A	**0.010 J**	mg/Kg	0.020	0.008	5	10/16/20 19:47	10/15/20	
Zinc	6020A	**132**	mg/Kg	0.49	0.08	5	10/16/20 19:47	10/15/20	

Analytical Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K2007937
Project:	2020 Palmer Project Biomonitoring	**Date Collected:**	06/06/20
Sample Matrix:	Animal Tissue	**Date Received:**	09/10/20 10:40
Sample Name:	Lower Glacier Creek DV Metals Fish #5	**Basis:**	Dry
Lab Code:	K2007937-005		

Total Metals

Analyte Name	Analysis Method	Result	Units	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
Arsenic	6020A	**0.17 J**	mg/Kg	0.49	0.02	5	10/16/20 19:50	10/15/20	
Cadmium	6020A	**0.467**	mg/Kg	0.019	0.004	5	10/16/20 19:50	10/15/20	
Copper	6020A	**4.91**	mg/Kg	0.097	0.029	5	10/16/20 19:50	10/15/20	
Lead	6020A	**0.055**	mg/Kg	0.019	0.003	5	10/16/20 19:50	10/15/20	
Selenium	6020A	**5.82**	mg/Kg	0.97	0.19	5	10/16/20 19:50	10/15/20	
Silver	6020A	**0.009 J**	mg/Kg	0.019	0.008	5	10/16/20 19:50	10/15/20	
Zinc	6020A	**139**	mg/Kg	0.49	0.08	5	10/16/20 19:50	10/15/20	

Analytical Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K2007937
Project:	2020 Palmer Project Biomonitoring	**Date Collected:**	06/06/20
Sample Matrix:	Animal Tissue	**Date Received:**	09/10/20 10:40
Sample Name:	Lower Glacier Creek DV Metals Fish #6	**Basis:**	Dry
Lab Code:	K2007937-006		

Total Metals

Analyte Name	Analysis Method	Result	Units	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
Arsenic	6020A	**0.38 J**	mg/Kg	0.49	0.02	5	10/16/20 19:57	10/15/20	
Cadmium	6020A	**1.29**	mg/Kg	0.020	0.004	5	10/16/20 19:57	10/15/20	
Copper	6020A	**5.81**	mg/Kg	0.099	0.030	5	10/16/20 19:57	10/15/20	
Lead	6020A	**0.120**	mg/Kg	0.020	0.003	5	10/16/20 19:57	10/15/20	
Selenium	6020A	**6.50**	mg/Kg	0.99	0.20	5	10/16/20 19:57	10/15/20	
Silver	6020A	**0.021**	mg/Kg	0.020	0.008	5	10/16/20 19:57	10/15/20	
Zinc	6020A	**144**	mg/Kg	0.49	0.08	5	10/16/20 19:57	10/15/20	

Analytical Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K2007937
Project:	2020 Palmer Project Biomonitoring	**Date Collected:**	06/06/20
Sample Matrix:	Animal Tissue	**Date Received:**	09/10/20 10:40
Sample Name:	Lower Glacier Creek DV Metals Fish #7	**Basis:**	Dry
Lab Code:	K2007937-007		

Total Metals

Analyte Name	Analysis Method	Result	Units	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
Arsenic	6020A	**0.19 J**	mg/Kg	0.50	0.02	5	10/16/20 19:59	10/15/20	
Cadmium	6020A	**0.309**	mg/Kg	0.020	0.004	5	10/16/20 19:59	10/15/20	
Copper	6020A	**4.36**	mg/Kg	0.099	0.030	5	10/16/20 19:59	10/15/20	
Lead	6020A	**0.069**	mg/Kg	0.020	0.003	5	10/16/20 19:59	10/15/20	
Selenium	6020A	**5.95**	mg/Kg	0.99	0.20	5	10/16/20 19:59	10/15/20	
Silver	6020A	**0.009 J**	mg/Kg	0.020	0.008	5	10/16/20 19:59	10/15/20	
Zinc	6020A	**141**	mg/Kg	0.50	0.08	5	10/16/20 19:59	10/15/20	

Analytical Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K2007937
Project:	2020 Palmer Project Biomonitoring	**Date Collected:**	06/06/20
Sample Matrix:	Animal Tissue	**Date Received:**	09/10/20 10:40
Sample Name:	Lower Glacier Creek DV Metals Fish #8	**Basis:**	Dry
Lab Code:	K2007937-008		

Total Metals

Analyte Name	Analysis Method	Result	Units	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
Arsenic	6020A	**0.20 J**	mg/Kg	0.50	0.02	5	10/16/20 20:02	10/15/20	
Cadmium	6020A	**0.312**	mg/Kg	0.020	0.004	5	10/16/20 20:02	10/15/20	
Copper	6020A	**5.49**	mg/Kg	0.099	0.030	5	10/16/20 20:02	10/15/20	
Lead	6020A	**0.085**	mg/Kg	0.020	0.003	5	10/16/20 20:02	10/15/20	
Selenium	6020A	**5.95**	mg/Kg	0.99	0.20	5	10/16/20 20:02	10/15/20	
Silver	6020A	**0.009 J**	mg/Kg	0.020	0.008	5	10/16/20 20:02	10/15/20	
Zinc	6020A	**143**	mg/Kg	0.50	0.08	5	10/16/20 20:02	10/15/20	

Analytical Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K2007937
Project:	2020 Palmer Project Biomonitoring	**Date Collected:**	06/06/20
Sample Matrix:	Animal Tissue	**Date Received:**	09/10/20 10:40
Sample Name:	Lower Glacier Creek DV Metals Fish #9	**Basis:**	Dry
Lab Code:	K2007937-009		

Total Metals

Analyte Name	Analysis Method	Result	Units	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
Arsenic	6020A	**0.19 J**	mg/Kg	0.50	0.02	5	10/16/20 20:04	10/15/20	
Cadmium	6020A	**0.359**	mg/Kg	0.020	0.004	5	10/16/20 20:04	10/15/20	
Copper	6020A	**3.43**	mg/Kg	0.10	0.03	5	10/16/20 20:04	10/15/20	
Lead	6020A	**0.045**	mg/Kg	0.020	0.003	5	10/16/20 20:04	10/15/20	
Selenium	6020A	**7.10**	mg/Kg	1.0	0.2	5	10/16/20 20:04	10/15/20	
Silver	6020A	ND U	mg/Kg	0.020	0.008	5	10/16/20 20:04	10/15/20	
Zinc	6020A	**150**	mg/Kg	0.50	0.08	5	10/16/20 20:04	10/15/20	

Analytical Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K2007937
Project:	2020 Palmer Project Biomonitoring	**Date Collected:**	06/06/20
Sample Matrix:	Animal Tissue	**Date Received:**	09/10/20 10:40
Sample Name:	Lower Glacier Creek DV Metals Fish #10	**Basis:**	Dry
Lab Code:	K2007937-010		

Total Metals

Analyte Name	Analysis Method	Result	Units	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
Arsenic	6020A	**0.17 J**	mg/Kg	0.50	0.02	5	10/16/20 20:07	10/15/20	
Cadmium	6020A	**0.286**	mg/Kg	0.020	0.004	5	10/16/20 20:07	10/15/20	
Copper	6020A	**4.62**	mg/Kg	0.10	0.03	5	10/16/20 20:07	10/15/20	
Lead	6020A	**0.097**	mg/Kg	0.020	0.003	5	10/16/20 20:07	10/15/20	
Selenium	6020A	**6.0**	mg/Kg	1.0	0.2	5	10/16/20 20:07	10/15/20	
Silver	6020A	ND U	mg/Kg	0.020	0.008	5	10/16/20 20:07	10/15/20	
Zinc	6020A	**146**	mg/Kg	0.50	0.08	5	10/16/20 20:07	10/15/20	

Analytical Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K2007937
Project:	2020 Palmer Project Biomonitoring	**Date Collected:**	06/07/20
Sample Matrix:	Animal Tissue	**Date Received:**	09/10/20 10:40
Sample Name:	Middle Glacier Creek DV Metals Fish #1	**Basis:**	Dry
Lab Code:	K2007937-011		

Total Metals

Analyte Name	Analysis Method	Result	Units	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
Arsenic	6020A	**0.16 J**	mg/Kg	0.49	0.02	5	10/16/20 20:09	10/15/20	
Cadmium	6020A	**0.251**	mg/Kg	0.019	0.004	5	10/16/20 20:09	10/15/20	
Copper	6020A	**3.45**	mg/Kg	0.097	0.029	5	10/16/20 20:09	10/15/20	
Lead	6020A	**0.054**	mg/Kg	0.019	0.003	5	10/16/20 20:09	10/15/20	
Selenium	6020A	**5.38**	mg/Kg	0.97	0.19	5	10/16/20 20:09	10/15/20	
Silver	6020A	ND U	mg/Kg	0.019	0.008	5	10/16/20 20:09	10/15/20	
Zinc	6020A	**162**	mg/Kg	0.49	0.08	5	10/16/20 20:09	10/15/20	

Analytical Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K2007937
Project:	2020 Palmer Project Biomonitoring	**Date Collected:**	06/07/20
Sample Matrix:	Animal Tissue	**Date Received:**	09/10/20 10:40
Sample Name:	Middle Glacier Creek DV Metals Fish #2	**Basis:**	Dry
Lab Code:	K2007937-012		

Total Metals

Analyte Name	Analysis Method	Result	Units	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
Arsenic	6020A	**0.19 J**	mg/Kg	0.50	0.02	5	10/16/20 20:12	10/15/20	
Cadmium	6020A	**0.182**	mg/Kg	0.020	0.004	5	10/16/20 20:12	10/15/20	
Copper	6020A	**3.73**	mg/Kg	0.099	0.030	5	10/16/20 20:12	10/15/20	
Lead	6020A	**0.127**	mg/Kg	0.020	0.003	5	10/16/20 20:12	10/15/20	
Selenium	6020A	**4.12**	mg/Kg	0.99	0.20	5	10/16/20 20:12	10/15/20	
Silver	6020A	**0.009 J**	mg/Kg	0.020	0.008	5	10/16/20 20:12	10/15/20	
Zinc	6020A	**125**	mg/Kg	0.50	0.08	5	10/16/20 20:12	10/15/20	

Analytical Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K2007937
Project:	2020 Palmer Project Biomonitoring	**Date Collected:**	06/07/20
Sample Matrix:	Animal Tissue	**Date Received:**	09/10/20 10:40
Sample Name:	Middle Glacier Creek DV Metals Fish #3	**Basis:**	Dry
Lab Code:	K2007937-013		

Total Metals

Analyte Name	Analysis Method	Result	Units	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
Arsenic	6020A	**0.21 J**	mg/Kg	0.49	0.02	5	10/16/20 20:14	10/15/20	
Cadmium	6020A	**0.344**	mg/Kg	0.020	0.004	5	10/16/20 20:14	10/15/20	
Copper	6020A	**4.97**	mg/Kg	0.098	0.030	5	10/16/20 20:14	10/15/20	
Lead	6020A	**0.219**	mg/Kg	0.020	0.003	5	10/16/20 20:14	10/15/20	
Selenium	6020A	**5.04**	mg/Kg	0.98	0.20	5	10/16/20 20:14	10/15/20	
Silver	6020A	**0.010 J**	mg/Kg	0.020	0.008	5	10/16/20 20:14	10/15/20	
Zinc	6020A	**131**	mg/Kg	0.49	0.08	5	10/16/20 20:14	10/15/20	

Analytical Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K2007937
Project:	2020 Palmer Project Biomonitoring	**Date Collected:**	06/07/20
Sample Matrix:	Animal Tissue	**Date Received:**	09/10/20 10:40
Sample Name:	Middle Glacier Creek DV Metals Fish #4	**Basis:**	Dry
Lab Code:	K2007937-014		

Total Metals

Analyte Name	Analysis Method	Result	Units	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
Arsenic	6020A	**0.24 J**	mg/Kg	0.49	0.02	5	10/16/20 16:58	10/15/20	
Cadmium	6020A	**0.385**	mg/Kg	0.020	0.004	5	10/16/20 16:58	10/15/20	
Copper	6020A	**5.10**	mg/Kg	0.098	0.029	5	10/16/20 16:58	10/15/20	
Lead	6020A	**0.212**	mg/Kg	0.020	0.003	5	10/16/20 16:58	10/15/20	
Selenium	6020A	**4.93**	mg/Kg	0.98	0.20	5	10/16/20 16:58	10/15/20	
Silver	6020A	**0.009 J**	mg/Kg	0.020	0.008	5	10/16/20 16:58	10/15/20	
Zinc	6020A	**146**	mg/Kg	0.49	0.08	5	10/16/20 16:58	10/15/20	

Analytical Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K2007937
Project:	2020 Palmer Project Biomonitoring	**Date Collected:**	06/07/20
Sample Matrix:	Animal Tissue	**Date Received:**	09/10/20 10:40
Sample Name:	Middle Glacier Creek DV Metals Fish #5	**Basis:**	Dry
Lab Code:	K2007937-015		

Total Metals

Analyte Name	Analysis Method	Result	Units	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
Arsenic	6020A	**0.18 J**	mg/Kg	0.49	0.02	5	10/16/20 17:16	10/15/20	
Cadmium	6020A	**0.314**	mg/Kg	0.020	0.004	5	10/16/20 17:16	10/15/20	
Copper	6020A	**4.19**	mg/Kg	0.098	0.029	5	10/16/20 17:16	10/15/20	
Lead	6020A	**0.094**	mg/Kg	0.020	0.003	5	10/16/20 17:16	10/15/20	
Selenium	6020A	**5.55**	mg/Kg	0.98	0.20	5	10/16/20 17:16	10/15/20	
Silver	6020A	ND U	mg/Kg	0.020	0.008	5	10/16/20 17:16	10/15/20	
Zinc	6020A	**112**	mg/Kg	0.49	0.08	5	10/16/20 17:16	10/15/20	

Analytical Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K2007937
Project:	2020 Palmer Project Biomonitoring	**Date Collected:**	06/07/20
Sample Matrix:	Animal Tissue	**Date Received:**	09/10/20 10:40
Sample Name:	Middle Glacier Creek DV Metals Fish #6	**Basis:**	Dry
Lab Code:	K2007937-016		

Total Metals

Analyte Name	Analysis Method	Result	Units	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
Arsenic	6020A	**0.17 J**	mg/Kg	0.49	0.02	5	10/16/20 17:18	10/15/20	
Cadmium	6020A	**0.249**	mg/Kg	0.019	0.004	5	10/16/20 17:18	10/15/20	
Copper	6020A	**3.79**	mg/Kg	0.097	0.029	5	10/16/20 17:18	10/15/20	
Lead	6020A	**0.151**	mg/Kg	0.019	0.003	5	10/16/20 17:18	10/15/20	
Selenium	6020A	**4.94**	mg/Kg	0.97	0.19	5	10/16/20 17:18	10/15/20	
Silver	6020A	ND U	mg/Kg	0.019	0.008	5	10/16/20 17:18	10/15/20	
Zinc	6020A	**129**	mg/Kg	0.49	0.08	5	10/16/20 17:18	10/15/20	

Analytical Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K2007937
Project:	2020 Palmer Project Biomonitoring	**Date Collected:**	NA
Sample Matrix:	Animal Tissue	**Date Received:**	NA
Sample Name:	Method Blank	**Basis:**	Dry
Lab Code:	KQ2015605-01		

Total Metals

Analyte Name	Analysis Method	Result	Units	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
Arsenic	6020A	ND U	mg/Kg	0.5	0.02	5	10/16/20 18:58	10/15/20	
Cadmium	6020A	ND U	mg/Kg	0.020	0.004	5	10/16/20 18:58	10/15/20	
Copper	6020A	**0.29**	mg/Kg	0.10	0.03	5	10/16/20 18:58	10/15/20	
Lead	6020A	ND U	mg/Kg	0.020	0.003	5	10/16/20 18:58	10/15/20	
Selenium	6020A	ND U	mg/Kg	1.0	0.2	5	10/16/20 18:58	10/15/20	
Silver	6020A	ND U	mg/Kg	0.020	0.008	5	10/16/20 18:58	10/15/20	
Zinc	6020A	ND U	mg/Kg	0.5	0.08	5	10/16/20 18:58	10/15/20	

Analytical Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K2007937
Project:	2020 Palmer Project Biomonitoring	**Date Collected:**	NA
Sample Matrix:	Animal Tissue	**Date Received:**	NA
Sample Name:	Method Blank	**Basis:**	Dry
Lab Code:	KQ2015607-01		

Total Metals

Analyte Name	Analysis Method	Result	Units	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
Arsenic	6020A	ND U	mg/Kg	0.5	0.02	5	10/16/20 16:46	10/15/20	
Cadmium	6020A	ND U	mg/Kg	0.020	0.004	5	10/16/20 16:46	10/15/20	
Copper	6020A	**0.10**	mg/Kg	0.10	0.03	5	10/16/20 16:46	10/15/20	
Lead	6020A	ND U	mg/Kg	0.020	0.003	5	10/16/20 16:46	10/15/20	
Selenium	6020A	ND U	mg/Kg	1.0	0.2	5	10/16/20 16:46	10/15/20	
Silver	6020A	ND U	mg/Kg	0.020	0.008	5	10/16/20 16:46	10/15/20	
Zinc	6020A	ND U	mg/Kg	0.5	0.08	5	10/16/20 16:46	10/15/20	

ALS Group USA, Corp.

dba ALS Environmental

QA/QC Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K2007937
Project	2020 Palmer Project Biomonitoring	**Date Collected:**	06/07/20
Sample Matrix:	Animal Tissue	**Date Received:**	09/10/20
		Date Analyzed:	10/16/20

Replicate Sample Summary
Total Metals

Sample Name:	Middle Glacier Creek DV Metals Fish #4	**Units:**	mg/Kg
Lab Code:	K2007937-014	**Basis:**	Dry

Analyte Name	Analysis Method	MRL	MDL	Sample Result	Duplicate Sample KQ2015607-05 Result	Average	RPD	RPD Limit
Arsenic	6020A	0.5	0.02	0.24 J	0.23 J	0.24	4	20
Cadmium	6020A	0.020	0.004	0.385	0.361	0.373	6	20
Copper	6020A	0.10	0.03	5.10	5.04	5.07	1	20
Lead	6020A	0.020	0.003	0.212	0.220	0.216	4	20
Selenium	6020A	1.0	0.2	4.93	4.68	4.81	5	20
Silver	6020A	0.020	0.008	0.009 J	0.008 J	0.009	12	20
Zinc	6020A	0.5	0.08	146	142	144	3	20

Results flagged with an asterisk (*) indicate values outside control criteria.

Results flagged with a pound (#) indicate the control criteria is not applicable.

Percent recoveries and relative percent differences (RPD) are determined by the software using values in the calculation which have not been rounded.

Printed 10/20/2020 3:49:28 PM Superset Reference:

Client:	Alaska Department of Fish and Game	**Service Request:**	K2007937
Project:	2020 Palmer Project Biomonitoring	**Date Collected:**	06/07/20
Sample Matrix:	Animal Tissue	**Date Received:**	09/10/20
		Date Analyzed:	10/16/20
		Date Extracted:	10/15/20

Matrix Spike Summary
Total Metals

Sample Name:	Middle Glacier Creek DV Metals Fish #4	**Units:**	mg/Kg
Lab Code:	K2007937-014	**Basis:**	Dry
Analysis Method:	6020A		
Prep Method:	PSEP Metals		

Matrix Spike
KQ2015607-06

Analyte Name	Sample Result	Result	Spike Amount	% Rec	% Rec Limits
Arsenic	0.24 J	16.0	16.3	97	75-125
Cadmium	0.385	4.95	4.90	93	75-125
Copper	5.10	26.8	24.5	89	75-125
Lead	0.212	44.3	49.0	90	75-125
Selenium	4.93	21.2	16.3	100	75-125
Silver	0.009 J	4.50	4.90	92	75-125
Zinc	146	190	49.0	89	75-125

Results flagged with an asterisk (*) indicate values outside control criteria.

Results flagged with a pound (#) indicate the control criteria is not applicable.

Percent recoveries and relative percent differences (RPD) are determined by the software using values in the calculation which have not been rounded.

Matrix Spike and Matrix Spike Duplicate Data is presented for information purposes only. The matrix may or may not be relevant to samples reported in this report. The laboratory evaluates system performance based on the LCS and LCSD control limits.

Client: Alaska Department of Fish and Game
Project: 2020 Palmer Project Biomonitoring
Sample Matrix: Animal Tissue

Service Request: K2007937
Date Analyzed: 10/16/20

Lab Control Sample Summary
Total Metals

Units:mg/Kg
Basis: Dry

Lab Control Sample
KQ2015605-02

Analyte Name	Analytical Method	Result	Spike Amount	% Rec	% Rec Limits
Arsenic	6020A	16.1	16.7	96	80-120
Cadmium	6020A	4.66	5.00	93	80-120
Copper	6020A	23.1	25.0	93	80-120
Lead	6020A	46.8	50.0	94	80-120
Selenium	6020A	17.4	16.7	104	80-120
Silver	6020A	4.75	5.00	95	80-120
Zinc	6020A	45.8	50.0	92	80-120

Client: Alaska Department of Fish and Game
Project: 2020 Palmer Project Biomonitoring
Sample Matrix: Animal Tissue

Service Request: K2007937
Date Analyzed: 10/16/20

Lab Control Sample Summary
Total Metals

Units:mg/Kg
Basis: Dry

Lab Control Sample
KQ2015607-02

Analyte Name	Analytical Method	Result	Spike Amount	% Rec	% Rec Limits
Arsenic	6020A	16.4	16.7	98	80-120
Cadmium	6020A	4.78	5.00	96	80-120
Copper	6020A	23.5	25.0	94	80-120
Lead	6020A	47.5	50.0	95	80-120
Selenium	6020A	16.6	16.7	100	80-120
Silver	6020A	4.80	5.00	96	80-120
Zinc	6020A	47.8	50.0	96	80-120

ALS Group USA, Corp.
dba ALS Environmental
QA/QC Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K2007937
Project:	2020 Palmer Project Biomonitoring	**Date Collected:**	NA
LCS Matrix:	Tissue	**Date Received:**	NA
		Date Extracted:	10/15/2020
		Date Analyzed:	10/16/2020

Standard Reference Material Summary
Total Metals

Sample Name:	Standard Reference Material	Units:	mg/Kg (ppm)
Lab Code:	KQ2015605-03	Basis:	Dry
Test Notes:	Dorm-4 Solids = 93.8%		

Source: N.R.C.C. Dorm-4

Analyte	Prep Method	Analysis Method	True Value	Result	Percent Recovery	Control Limits	Result Notes
Arsenic	PSEP Tissue	6020A	6.87	6.58	96	5.14 - 8.77	
Cadmium	PSEP Tissue	6020A	0.299	0.304	102	0.225 - 0.380	
Copper	PSEP Tissue	6020A	15.7	15.6	99	12.2 - 19.4	
Lead	PSEP Tissue	6020A	0.40	0.39	97	0.274 - 0.559	
Silver	PSEP Tissue	6020A	0.0252	0.0279	111	0.0162 - 0.0362	
Zinc	PSEP Tissue	6020A	51.6	50.9	99	39.0 - 65.3	

ALS Group USA, Corp.
dba ALS Environmental
QA/QC Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K2007937
Project:	2020 Palmer Project Biomonitoring	**Date Collected:**	NA
LCS Matrix:	Tissue	**Date Received:**	NA
		Date Extracted:	10/15/2020
		Date Analyzed:	10/16/2020

Standard Reference Material Summary
Total Metals

Sample Name:	Standard Reference Material	Units:	mg/Kg (ppm)
Lab Code:	KQ2015605-04	Basis:	Dry
Test Notes:	Tort-3 Solids = 97.4%		

Source: N.R.C.C. Tort-3

Analyte	Prep Method	Analysis Method	True Value	Result	Percent Recovery	Control Limits	Result Notes
Arsenic	PSEP Tissue	6020A	59.5	62.7	105	44.6-76.0	
Cadmium	PSEP Tissue	6020A	42.3	40.7	96	32.4-52.9	
Copper	PSEP Tissue	6020A	497	481	97	380-623	
Lead	PSEP Tissue	6020A	0.225	0.200	89	0.166-0.292	
Zinc	PSEP Tissue	6020A	136	131	96	104-170	

ALS Group USA, Corp.
dba ALS Environmental
QA/QC Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K2007937
Project:	2020 Palmer Project Biomonitoring	**Date Collected:**	NA
LCS Matrix:	Tissue	**Date Received:**	NA
		Date Extracted:	10/15/2020
		Date Analyzed:	10/16/2020

Standard Reference Material Summary
Total Metals

Sample Name:	Standard Reference Material	Units:	mg/Kg (ppm)
Lab Code:	KQ2015607-03	Basis:	Dry
Test Notes:	Dorm-4 Solids = 93.8%		

Source: N.R.C.C. Dorm-4

Analyte	Prep Method	Analysis Method	True Value	Result	Percent Recovery	Control Limits	Result Notes
Arsenic	PSEP Tissue	6020A	6.87	6.64	97	5.14 - 8.77	
Cadmium	PSEP Tissue	6020A	0.299	0.293	98	0.225 - 0.380	
Copper	PSEP Tissue	6020A	15.7	14.9	95	12.2 - 19.4	
Lead	PSEP Tissue	6020A	0.40	0.37	92	0.274 - 0.559	
Silver	PSEP Tissue	6020A	0.0252	0.0251	100	0.0162 - 0.0362	
Zinc	PSEP Tissue	6020A	51.6	49.8	97	39.0 - 65.3	

ALS Group USA, Corp.
dba ALS Environmental
QA/QC Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K2007937
Project:	2020 Palmer Project Biomonitoring	**Date Collected:**	NA
LCS Matrix:	Tissue	**Date Received:**	NA
		Date Extracted:	10/15/2020
		Date Analyzed:	10/16/2020

Standard Reference Material Summary
Total Metals

Sample Name:	Standard Reference Material	Units:	mg/Kg (ppm)
Lab Code:	KQ2015607-04	Basis:	Dry
Test Notes:	Tort-3 Solids = 97.4%		

Source: N.R.C.C. Tort-3

Analyte	Prep Method	Analysis Method	True Value	Result	Percent Recovery	Control Limits	Result Notes
Arsenic	PSEP Tissue	6020A	59.5	61.2	103	44.6-76.0	
Cadmium	PSEP Tissue	6020A	42.3	39.1	92	32.4-52.9	
Copper	PSEP Tissue	6020A	497	456	92	380-623	
Lead	PSEP Tissue	6020A	0.225	0.192	85	0.166-0.292	
Zinc	PSEP Tissue	6020A	136	125	92	104-170	

APPENDIX E: SEDIMENT DATA AND LABORATORY REPORT

Appendix E.1.–Lower Glacier Creek sediment compositions, 2016–2020.

	Particle Size Data						
Sample Date	% Clay	% Silt	% Sand	% Course Material (> 2 mm)	% Total Solids	% Total Organic Carbon	Acid Volatile Sulfide (mg/kg)
06/07/16	4.0	29.2	66.8	0.0	78.6	0.274	ND
06/09/17	2.0	26.7	71.1	0.3	82.3	<0.16	<0.20
06/09/17	1.6	39.3	59.0	0.1	73.3	<0.17	<0.20
06/09/17	0.7	18.4	81.0	0.0	73.9	0.20	<0.20
06/09/17	1.3	27.8	70.3	0.6	77.8	0.25	<0.20
06/09/17	0.4	3.2	95.6	0.6	76.3	<0.16	<0.20
05/30/18	1.2	14.0	84.7	0.1	74.7	0.25	<0.20
05/30/18	1.9	44.3	50.1	3.7	77.7	0.29	0.63
05/30/18	2.0	41.8	56.2	0.0	78.0	<0.27	<0.20
05/30/18	1.1	9.6	85.0	4.3	79.1	<0.20	<0.20
05/30/18	1.4	16.1	81.9	4.3	78.6	<0.20	<0.20
06/06/19	0.29	10.14	89.3	0.0	83.10	0.29	<0.20
06/07/19	0.25	6.83	92.6	0.0	78.20	0.25	<0.20
06/08/19	0.25	8.49	91.2	0.0	74.60	0.250	<0.20
06/09/19	0.31	17.90	81.4	0.0	75.70	0.310	<0.20
06/10/19	0.32	8.51	91.0	0.0	80.10	0.320	<0.20
06/03/20	1.79	29.84	68.36	0.0	77.9	0.498	<0.20
06/03/20	2.35	31.3	64.96	1.38	72.40	0.336	<0.20
06/03/20	1.48	20.59	77.93	0.0	79.60	0.444	<0.20
06/03/20	1.97	24.2	73.78	0.07	83.10	0.203	<0.20
06/03/20	1.77	28.87	69.1	0.07	77.80	0.370	<0.20

Appendix E.2.–Lower Glacier Creek sediment element concentrations, 2016–2020.

Sample	Concentration (mg/kg dry weight)									
Date	Ag	Al	As	Cd	Cu	Fe	Hg	Pb	Se	Zn
06/07/16	0.19	9,460	4.98	1.17	51.1	35,700	<0.020	9.06	1.69	193
06/09/17	0.14	15,500	3.91	0.510	37.0	47,300	0.0120	7.90	1.22	133
06/09/17	0.25	16,300	5.68	0.910	58.5	57,800	0.0194	20.6	1.35	202
06/09/17	0.26	14,700	5.49	1.01	53.6	51,100	0.0204	8.49	1.67	186
06/09/17	0.21	14,900	4.66	0.821	60.1	53,600	0.0144	20.1	1.39	173
06/09/17	0.17	13,300	3.94	0.818	48.9	51,400	0.0135	7.03	1.54	186
05/30/18	0.19	18,300	4.65	1.02	49.3	50,400	0.0125	9.84	1.44	185
05/30/18	0.14	16,600	4.08	0.880	44.4	42,600	0.0079	5.88	1.07	150
05/30/18	0.17	14,900	3.60	0.858	44.1	43,600	0.0119	6.58	1.31	160
05/30/18	0.16	15,400	4.27	0.835	41.6	45,100	0.0142	8.11	1.12	168
05/30/18	0.15	15,500	3.46	0.639	40.7	44,900	0.0092	7.53	1.00	141
06/06/19	0.17	17,300	4.32	0.95	50.4	48,400	0.0172	10.9	1.28	189
06/06/19	0.17	16,800	6.70	0.950	62.4	51,400	0.0131	6.23	1.43	173
06/06/19	0.13	17,400	5.15	0.937	39.3	46,900	0.0174	7.50	1.18	179
06/06/19	0.15	16,200	3.68	0.934	45.3	45,400	0.0156	5.23	1.06	166
06/06/19	0.14	15,700	4.72	0.771	45.2	44,900	0.0111	4.99	1.03	146
06/03/20	0.22	15,200	5.44	1.52	56.3	43,200	0.0125	7.14	2.41	213
06/03/20	0.16	16,200	3.35	0.904	48.0	42,800	0.0109	6.08	1.08	166
06/03/20	0.18	16,800	4.33	1.63	48.4	43,700	0.0164	8.49	1.58	184
06/03/20	0.11	14,800	3.14	0.64	40.1	43,400	0.0103	5.98	0.8	152
06/03/20	0.21	15,200	4.61	0.924	54.3	43,000	0.0097	7.57	1.52	150

Appendix E.3.–Middle Glacier Creek sediment compositions, 2016–2020.

	Particle Size Data						
Sample Date	% Clay	% Silt	% Sand	% Course Material (> 2 mm)	% Total Solids	% Total Organic Carbon	Acid Volatile Sulfide (mg/kg)
06/08/16	4.1	31.2	64.8	0.0	80.5	0.491	ND
06/09/17	0.7	11.1	84.0	4.3	82.5	<0.16	<0.20
06/09/17	0.6	16.1	80.8	2.5	80.3	<0.17	<0.20
06/09/17	1.2	28.4	70.4	0.1	76.1	<0.19	0.30
06/09/17	2.3	48.5	49.2	0.0	74.8	0.27	<0.20
06/09/17	2.6	45.5	51.9	0.0	74.7	<0.19	<0.20
05/31/18	1.6	33.8	63.5	1.2	83.8	<0.28	0.40
05/31/18	1.7	26.5	71.5	0.4	80.1	<0.29	<0.20
05/31/18	1.2	10.7	74.6	13.5	77.7	<0.25	<0.20
05/31/18	1.6	25.9	71.9	0.6	75.0	<0.27	<0.20
05/31/18	1.6	15.7	80.8	1.9	71.4	0.37	<0.20
06/06/19	0.49	10.58	84.2	4.68	83.4	0.44	<0.20
06/06/19	1.51	21.39	77.1	0.00	84.1	0.30	<0.20
06/06/19	0.52	9.97	89.5	0.00	82.9	0.37	<0.20
06/06/19	1.14	25.86	73.0	0.00	78.6	0.58	<0.20
06/06/19	0.56	13.64	85.8	0.00	76.2	0.56	<0.20
06/02/20	2.33	39.96	57.09	0.62	75.6	0.26	<0.20
06/02/20	2.37	35.95	61.67	0.0	73.0	0.36	<0.20
06/02/20	2.6	37.46	59.93	0.0	80.3	0.40	<0.20
06/02/20	2.84	42.5	54.3	0.36	71.6	0.42	<0.20
06/02/20	2.7	36.99	60.3	0.00	78.3	0.31	<0.20

Appendix E.4.–Middle Glacier Creek sediment element concentrations, 2016–2020.

Sample	Concentration (mg/kg dry weight)									
Date	Ag	Al	As	Cd	Cu	Fe	Hg	Pb	Se	Zn
06/08/16	0.16	7,650	4.33	0.871	55.8	32,400	<0.020	12.0	1.14	170
06/09/17	0.14	15,700	3.68	0.758	48.1	49,400	0.0094	8.67	0.90	190
06/09/17	0.15	13,800	4.76	0.902	45.5	53,400	0.0179	14.8	0.93	203
06/09/17	0.33	14,700	4.88	1.11	75.6	54,500	0.0161	12.5	2.05	189
06/09/17	0.18	16,000	4.47	1.14	55.7	47,500	0.0210	12.3	1.30	205
06/09/17	0.21	15,600	4.73	1.07	62.1	50,800	0.0181	11.9	1.42	199
05/31/18	0.18	18,000	4.17	0.564	47.4	49,000	0.0072	6.89	1.25	122
05/31/18	0.22	16,900	3.95	1.03	49.6	45,400	0.0260	5.48	1.67	167
05/31/18	0.18	20,200	2.80	0.675	49.1	49,200	0.0079	5.49	1.03	139
05/31/18	0.15	18,900	2.48	0.645	45.6	42,500	0.0093	5.24	0.71	129
05/31/18	0.17	16,900	3.74	1.02	52.8	43,000	0.0118	5.99	1.34	160
06/07/19	0.19	14,800	3.20	1.38	41.6	43,000	0.0133	3.76	1.83	189
06/07/19	0.19	16,600	4.97	1.07	53.5	53,600	0.0140	7.40	1.54	174
06/07/19	0.21	16,800	3.74	1.33	54.2	49,800	0.0128	5.45	1.43	230
06/07/19	0.53	16,700	4.19	2.22	47.6	47,500	0.015	10.4	1.55	181
06/07/19	0.27	17,000	6.14	1.67	54.6	47,000	0.015	7.45	2.56	204
06/02/20	0.14	14,900	3.10	0.646	48.2	41,000	0.0122	5.04	0.91	110
06/02/20	0.15	14,900	2.36	0.687	44.5	37,800	0.0060	4.69	1.00	97
06/02/20	0.16	15,500	2.71	0.726	44.4	38,800	0.0072	5.24	1.15	106
06/02/20	0.23	15,400	4.99	1.300	60.7	46,400	0.0137	8.36	1.97	208
06/02/20	0.16	15,800	2.66	0.716	46.5	39,600	0.0058	3.84	1.08	99

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **VA20A7841**	Page	: 1 of 6
Client	: **Constantine North Inc.**	Laboratory	: Vancouver - Environmental
Contact	: Aris Morfopoulos	Account Manager	: Carla Fuginski
Address	: Suite 320 - 800 West Pender St. Vancouver BC Canada V6C 2V6	Address	: 8081 Lougheed Highway Burnaby BC Canada V5A 1W9
Telephone	: 604 629 2348	Telephone	: +1 604 253 4188
Project	: Stream Sediments	Date Samples Received	: 05-Jun-2020 15:20
PO	: ----	Date Analysis Commenced	: 09-Jun-2020
C-O-C number	: ----	Issue Date	: 25-Jun-2020 12:52
Sampler	: Dylan Krell		
Site	: Sediment Analysis		
Quote number	: Q62329		
No. of samples received	: 10		
No. of samples analysed	: 10		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QC Interpretive report to assist with Quality Review and Sample Receipt Notification (SRN).

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is conducted in accordance with US FDA 21 CFR Part 11.

Signatories	*Position*	*Laboratory Department*
Brieanna Allen	Department Manager - Organics	Organics, Burnaby, British Columbia
Cristina Alexandre	Supervisor - Metals ICP Instrumentation	Metals, Burnaby, British Columbia
Dee Lee	Analyst	Metals, Burnaby, British Columbia
Hedy Lai	Team Leader - Inorganics	Inorganics, Saskatoon, Saskatchewan
Jon Fisher	Department Manager - Inorganics	Inorganics, Waterloo, Ontario
Nancy Cruse	Laboratory _ Supervisor	Inorganics, Saskatoon, Saskatchewan
Xihua Yao	Laboratory Analyst	Inorganics, Saskatoon, Saskatchewan

General Comments

The analytical methods used by ALS are developed using internationally recognized reference methods (where available), such as those published by US EPA, APHA Standard Methods, ASTM, ISO, Environment Canada, BC MOE, and Ontario MOE. Refer to the ALS Quality Control Interpretive report (QCI) for applicable references and methodology summaries. Reference methods may incorporate modifications to improve performance.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Please refer to Quality Control Interpretive report (QCI) for information regarding Holding Time compliance.

Key : CAS Number: Chemical Abstracts Services number is a unique identifier assigned to discrete substances
LOR: Limit of Reporting (detection limit).

Unit	*Description*
-	No Unit
%	percent
mg/kg	milligrams per kilogram
pH units	pH units

<: less than.

>: greater than.

Surrogate: An analyte that is similar in behavior to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED on SRN or QCI Report, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical results in reports identified as "Preliminary Report" are considered authorized for use.

Analytical Results

Sub-Matrix: **Soil**
(Matrix: **Soil/Solid**)

Analyte	CAS Number	Method	LOR	Unit	Client sample ID	2020 LGCS1	2020 LGCS2	2020 LGCS3	2020 LGCS4	2020 LGCS5
					Client sampling date / time	03-Jun-2020	03-Jun-2020	03-Jun-2020	03-Jun-2020	03-Jun-2020
						VA20A7841-001	VA20A7841-002	VA20A7841-003	VA20A7841-004	VA20A7841-005
						Result	Result	Result	Result	Result
Physical Tests										
loss on ignition @ 550°C	----	E205D	1.0	%		1.4	1.4	1.5	1.1	1.5
moisture	----	E144	0.25	%		22.1	27.6	20.4	16.9	22.2
pH (1:2 soil:water)	----	E108	0.10	pH units		8.35	8.54	8.48	8.61	8.55
ash content @ 550°C	----	E205D	1.0	%		98.6	98.6	98.5	98.9	98.5
Particle Size										
grain size curve	----	E185A	-	-		See Attached	See Attached	See Attached	See Attached	See Attached
Organic / Inorganic Carbon										
carbon, total [TC]	----	E351	0.050	%		1.34	1.21	1.42	1.01	1.43
carbon, inorganic [IC]	----	E354	0.050	%		0.842	0.874	0.976	0.807	1.06
carbon, inorganic [IC], (as CaCO3 equivalent)	----	E354	0.40	%		7.02	7.28	8.14	6.72	8.84
carbon, total organic [TOC]	----	EC356	0.050	%		0.498	0.336	0.444	0.203	0.370
Inorganic Parameters										
sulfides, acid volatile	----	E401	0.20	mg/kg		<0.20	<0.20	<0.20	<0.20	<0.20
Metals										
aluminum	7429-90-5	E440	50	mg/kg		15200	16200	16800	14800	15200
antimony	7440-36-0	E440	0.10	mg/kg		0.53	0.34	1.02	0.28	0.39
arsenic	7440-38-2	E440	0.10	mg/kg		5.44	3.35	4.33	3.14	4.61
barium	7440-39-3	E440	0.50	mg/kg		134	144	134	93.9	118
beryllium	7440-41-7	E440	0.10	mg/kg		0.20	0.18	0.20	0.19	0.17
bismuth	7440-69-9	E440	0.20	mg/kg		<0.20	<0.20	<0.20	<0.20	<0.20
boron	7440-42-8	E440	5.0	mg/kg		<5.0	<5.0	<5.0	<5.0	<5.0
cadmium	7440-43-9	E440	0.020	mg/kg		1.52	0.904	1.63	0.640	0.924
calcium	7440-70-2	E440	50	mg/kg		38800	38200	41700	27400	35700
chromium	7440-47-3	E440	0.50	mg/kg		42.3	34.5	39.6	26.3	35.3
cobalt	7440-48-4	E440	0.10	mg/kg		23.8	22.6	21.6	20.9	22.2
copper	7440-50-8	E440	0.50	mg/kg		56.3	48.0	48.4	40.1	54.3
iron	7439-89-6	E440	50	mg/kg		43200	42800	43700	43400	43000
lead	7439-92-1	E440	0.50	mg/kg		7.14	6.08	8.49	5.98	7.57
lithium	7439-93-2	E440	2.0	mg/kg		7.0	6.6	7.4	6.2	6.1
magnesium	7439-95-4	E440	20	mg/kg		12400	12700	13300	12400	11500

Analytical Results

Sub-Matrix: **Soil**
(Matrix: **Soil/Solid**)

Analyte	CAS Number	Method	LOR	Unit	Client sample ID	2020 LGCS1	2020 LGCS2	2020 LGCS3	2020 LGCS4	2020 LGCS5
					Client sampling date / time	03-Jun-2020	03-Jun-2020	03-Jun-2020	03-Jun-2020	03-Jun-2020
						VA20A7841-001	VA20A7841-002	VA20A7841-003	VA20A7841-004	VA20A7841-005
						Result	Result	Result	Result	Result
Metals										
manganese	7439-96-5	E440	1.0	mg/kg		869	844	890	786	766
mercury	7439-97-6	E510	0.0050	mg/kg		0.0125	0.0109	0.0164	0.0103	0.0097
molybdenum	7439-98-7	E440	0.10	mg/kg		3.45	1.89	2.65	1.22	2.26
nickel	7440-02-0	E440	0.50	mg/kg		39.2	28.5	32.8	20.4	29.5
phosphorus	7723-14-0	E440	50	mg/kg		971	981	968	914	923
potassium	7440-09-7	E440	100	mg/kg		1230	1420	1430	1190	1190
selenium	7782-49-2	E440	0.20	mg/kg		2.41	1.08	1.58	0.80	1.52
silver	7440-22-4	E440	0.10	mg/kg		0.22	0.16	0.18	0.11	0.21
sodium	7440-23-5	E440	50	mg/kg		148	167	186	139	155
strontium	7440-24-6	E440	0.50	mg/kg		88.8	89.1	98.0	68.5	85.4
sulfur	7704-34-9	E440	1000	mg/kg		2400	2400	1900	2600	3000
thallium	7440-28-0	E440	0.050	mg/kg		0.103	0.100	0.106	0.064	0.084
tin	7440-31-5	E440	2.0	mg/kg		<2.0	<2.0	<2.0	<2.0	<2.0
titanium	7440-32-6	E440	1.0	mg/kg		1030	1280	1430	1320	1230
tungsten	7440-33-7	E440	0.50	mg/kg		<0.50	<0.50	<0.50	<0.50	<0.50
uranium	7440-61-1	E440	0.050	mg/kg		0.497	0.354	0.465	0.281	0.393
vanadium	7440-62-2	E440	0.20	mg/kg		92.0	101	101	103	95.4
zinc	7440-66-6	E440	2.0	mg/kg		213	166	184	152	150
zirconium	7440-67-7	E440	1.0	mg/kg		1.0	<1.0	1.0	<1.0	<1.0

Please refer to the General Comments section for an explanation of any qualifiers detected.

Analytical Results

Sub-Matrix: **Soil**
(Matrix: **Soil/Solid**)

Analyte	CAS Number	Method	LOR	Unit	Client sample ID	2020 MGCS1	2020 MGCS2	2020 MGCS3	2020 MGCS4	2020 MGCS5
					Client sampling date / time	02-Jun-2020	02-Jun-2020	02-Jun-2020	02-Jun-2020	02-Jun-2020
						VA20A7841-006	VA20A7841-007	VA20A7841-008	VA20A7841-009	VA20A7841-010
						Result	Result	Result	Result	Result
Physical Tests										
loss on ignition @ 550°C	---	E205D	1.0	%		1.3	1.4	1.5	1.4	1.2
moisture	---	E144	0.25	%		24.4	27.0	19.7	28.4	21.7
pH (1:2 soil:water)	---	E108	0.10	pH units		8.50	8.55	8.49	8.35	8.53
ash content @ 550°C	---	E205D	1.0	%		98.7	98.6	98.5	98.6	98.8
Particle Size										
grain size curve	---	E185A	-	-		See Attached	See Attached	See Attached	See Attached	See Attached
Organic / Inorganic Carbon										
carbon, total [TC]	---	E351	0.050	%		1.63	1.71	1.52	1.09	1.74
carbon, inorganic [IC]	---	E354	0.050	%		1.37	1.35	1.12	0.672	1.43
carbon, inorganic [IC], (as CaCO3 equivalent)	---	E354	0.40	%		11.4	11.3	9.33	5.60	11.9
carbon, total organic [TOC]	---	EC356	0.050	%		0.260	0.360	0.400	0.418	0.310
Inorganic Parameters										
sulfides, acid volatile	---	E401	0.20	mg/kg		<0.20	<0.20	<0.20	<0.20	<0.20
Metals										
aluminum	7429-90-5	E440	50	mg/kg		14900	14900	15500	15400	15800
antimony	7440-36-0	E440	0.10	mg/kg		0.26	0.24	0.28	0.51	0.29
arsenic	7440-38-2	E440	0.10	mg/kg		3.10	2.36	2.71	4.99	2.66
barium	7440-39-3	E440	0.50	mg/kg		98.0	103	117	141	127
beryllium	7440-41-7	E440	0.10	mg/kg		0.18	0.16	0.17	0.19	0.16
bismuth	7440-69-9	E440	0.20	mg/kg		<0.20	<0.20	<0.20	<0.20	<0.20
boron	7440-42-8	E440	5.0	mg/kg		<5.0	<5.0	<5.0	<5.0	<5.0
cadmium	7440-43-9	E440	0.020	mg/kg		0.646	0.687	0.726	1.30	0.716
calcium	7440-70-2	E440	50	mg/kg		44400	47400	47400	33400	51400
chromium	7440-47-3	E440	0.50	mg/kg		34.0	39.8	43.3	38.2	41.9
cobalt	7440-48-4	E440	0.10	mg/kg		21.9	20.2	21.4	24.7	21.1
copper	7440-50-8	E440	0.50	mg/kg		48.2	44.5	44.4	60.7	46.5
iron	7439-89-6	E440	50	mg/kg		41000	37800	38800	46400	39600
lead	7439-92-1	E440	0.50	mg/kg		5.04	4.69	5.24	8.36	3.84
lithium	7439-93-2	E440	2.0	mg/kg		6.2	6.2	6.5	6.7	6.3
magnesium	7439-95-4	E440	20	mg/kg		11600	11500	12000	12300	11800

Analytical Results

Sub-Matrix: **Soil**
(Matrix: **Soil/Solid**)

Analyte	CAS Number	Method	LOR	Unit	Client sample ID	2020 MGCS1	2020 MGCS2	2020 MGCS3	2020 MGCS4	2020 MGCS5
					Client sampling date / time	02-Jun-2020	02-Jun-2020	02-Jun-2020	02-Jun-2020	02-Jun-2020
						VA20A7841-006	VA20A7841-007	VA20A7841-008	VA20A7841-009	VA20A7841-010
						Result	Result	Result	Result	Result
Metals										
manganese	7439-96-5	E440	1.0	mg/kg		822	829	889	826	824
mercury	7439-97-6	E510	0.0050	mg/kg		0.0122	0.0060	0.0072	0.0137	0.0058
molybdenum	7439-98-7	E440	0.10	mg/kg		1.69	1.90	2.09	2.96	2.13
nickel	7440-02-0	E440	0.50	mg/kg		28.7	32.0	34.1	33.9	34.0
phosphorus	7723-14-0	E440	50	mg/kg		926	862	970	987	945
potassium	7440-09-7	E440	100	mg/kg		1550	1570	1640	1380	1620
selenium	7782-49-2	E440	0.20	mg/kg		0.91	1.00	1.15	1.97	1.08
silver	7440-22-4	E440	0.10	mg/kg		0.14	0.15	0.16	0.23	0.16
sodium	7440-23-5	E440	50	mg/kg		169	189	188	176	198
strontium	7440-24-6	E440	0.50	mg/kg		95.7	103	109	79.8	114
sulfur	7704-34-9	E440	1000	mg/kg		2200	1500	1400	3300	1400
thallium	7440-28-0	E440	0.050	mg/kg		0.108	0.105	0.120	0.104	0.114
tin	7440-31-5	E440	2.0	mg/kg		<2.0	<2.0	<2.0	<2.0	<2.0
titanium	7440-32-6	E440	1.0	mg/kg		1080	1030	972	1050	1080
tungsten	7440-33-7	E440	0.50	mg/kg		<0.50	<0.50	<0.50	<0.50	<0.50
uranium	7440-61-1	E440	0.050	mg/kg		0.437	0.341	0.390	0.400	0.373
vanadium	7440-62-2	E440	0.20	mg/kg		92.1	85.3	87.8	98.4	88.1
zinc	7440-66-6	E440	2.0	mg/kg		110	97.0	106	208	99.0
zirconium	7440-67-7	E440	1.0	mg/kg		<1.0	<1.0	<1.0	<1.0	<1.0

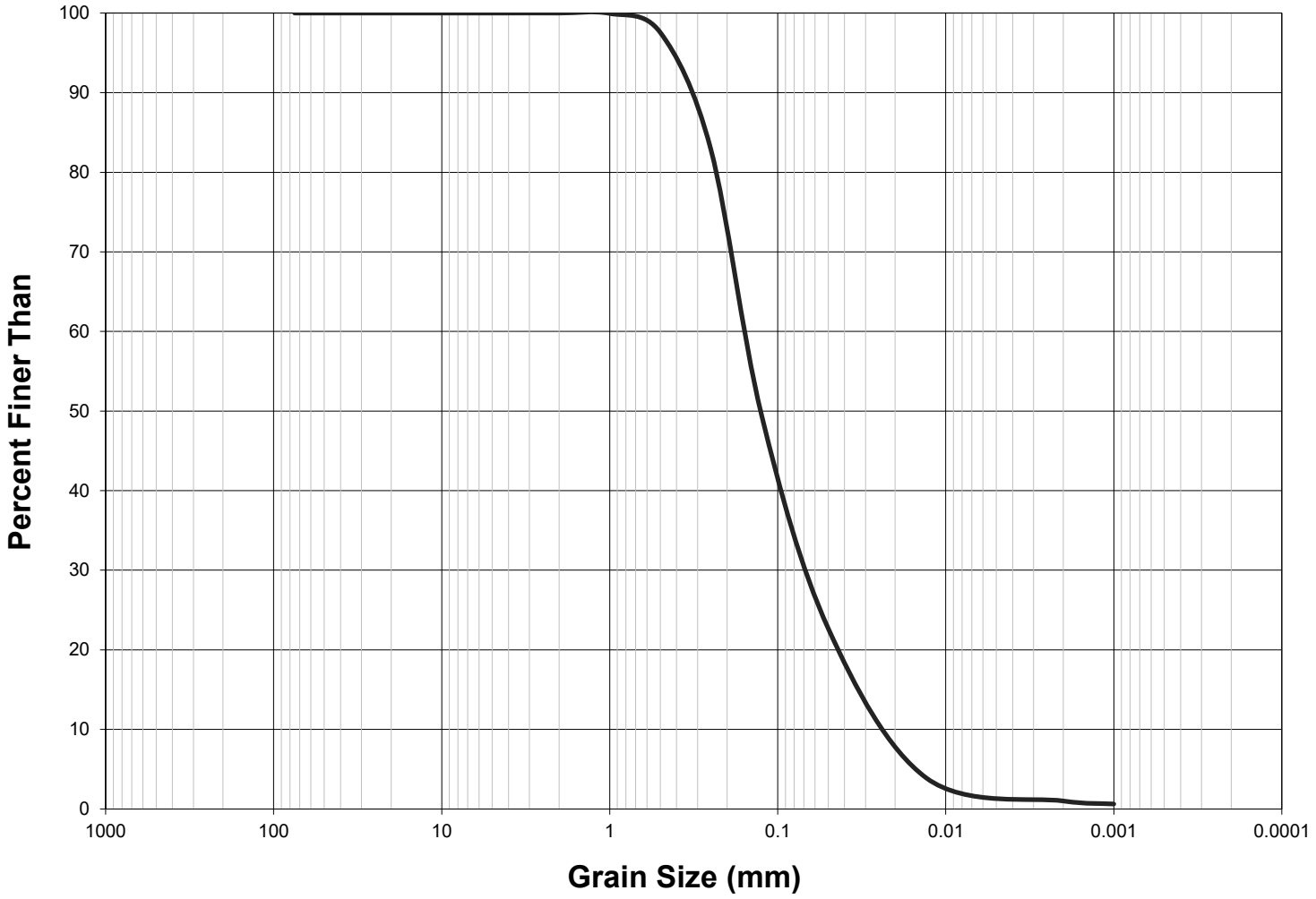
Please refer to the General Comments section for an explanation of any qualifiers detected.

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES
Environmental Division

819-58th Street, Saskatoon, SK S7K 6X5

Client Name: CONI100
Project:
Sample ID: 2020 LGCS1
Lab ID: VA20A7841001

Particle Size Distribution Curve



Particle Size Distribution

Range (mm)	Wt. (%)
> 19	0.00
19 - 9.5	0.00
9.5 - 4.75	0.00
4.75 - 2	0.00
2 - 0.85	0.77
0.85 - 0.425	6.08
0.425 - 0.25	10.29
0.25 - 0.106	40.11
0.106 - 0.075	11.11

Particle Size Distribution

Range (mm)	Wt. (%)
0.075 - 0.074	0.36
0.074 - 0.005	29.48
0.005 - 0.001	1.16
<0.001	0.63

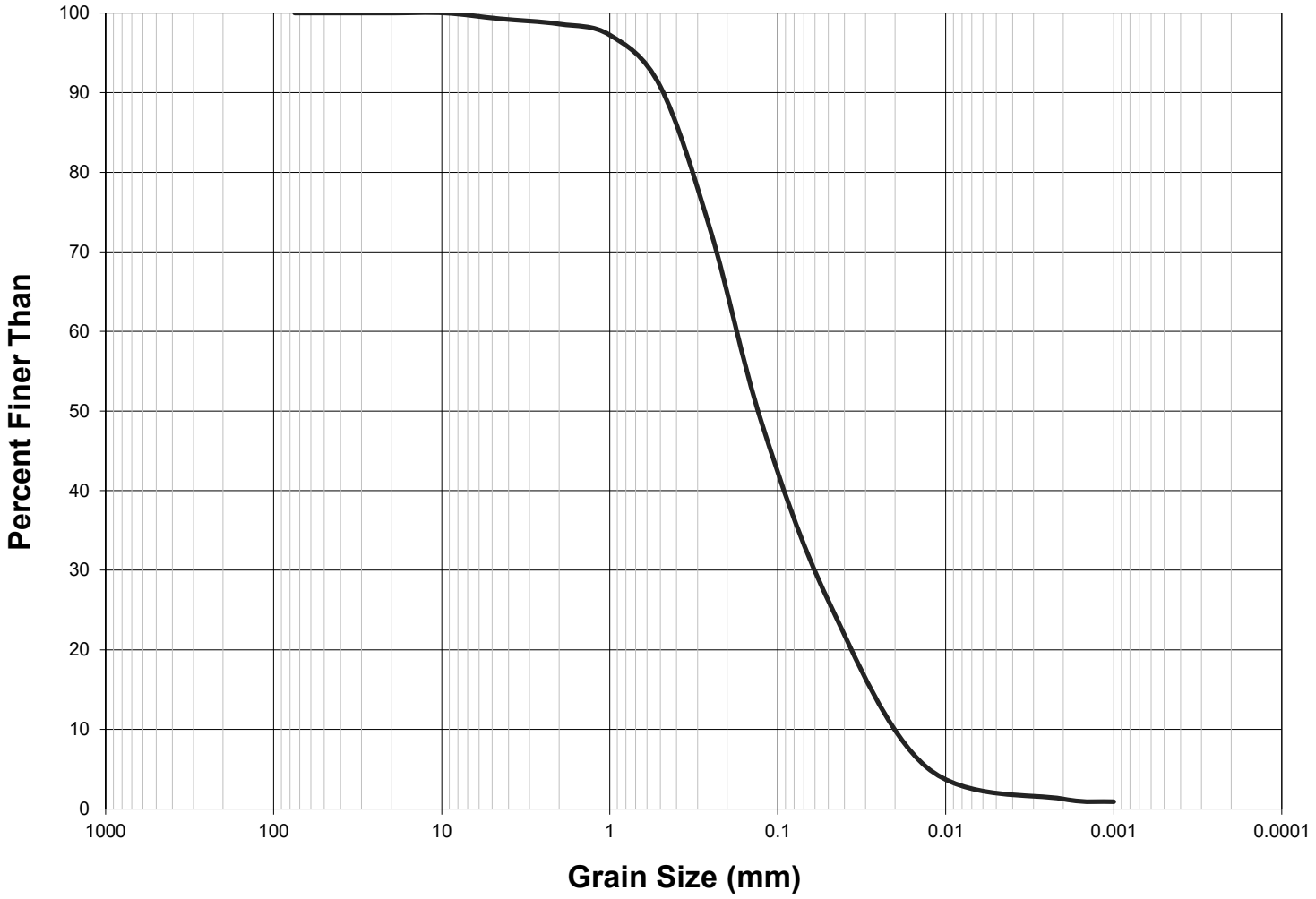
Method Reference: Can. Soc. Soil Sci. (1993) Method 47.2

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES
Environmental Division

819-58th Street, Saskatoon, SK S7K 6X5

Client Name: CONI100
Project:
Sample ID: 2020 LGCS2
Lab ID: VA20A7841002

Particle Size Distribution Curve



Particle Size Distribution

Range (mm)	Wt. (%)
> 19	0.00
19 - 9.5	0.00
9.5 - 4.75	0.69
4.75 - 2	0.69
2 - 0.85	3.32
0.85 - 0.425	10.00
0.425 - 0.25	12.77
0.25 - 0.106	29.60
0.106 - 0.075	9.27

Particle Size Distribution

Range (mm)	Wt. (%)
0.075 - 0.074	0.30
0.074 - 0.005	31.00
0.005 - 0.001	1.43
<0.001	0.92

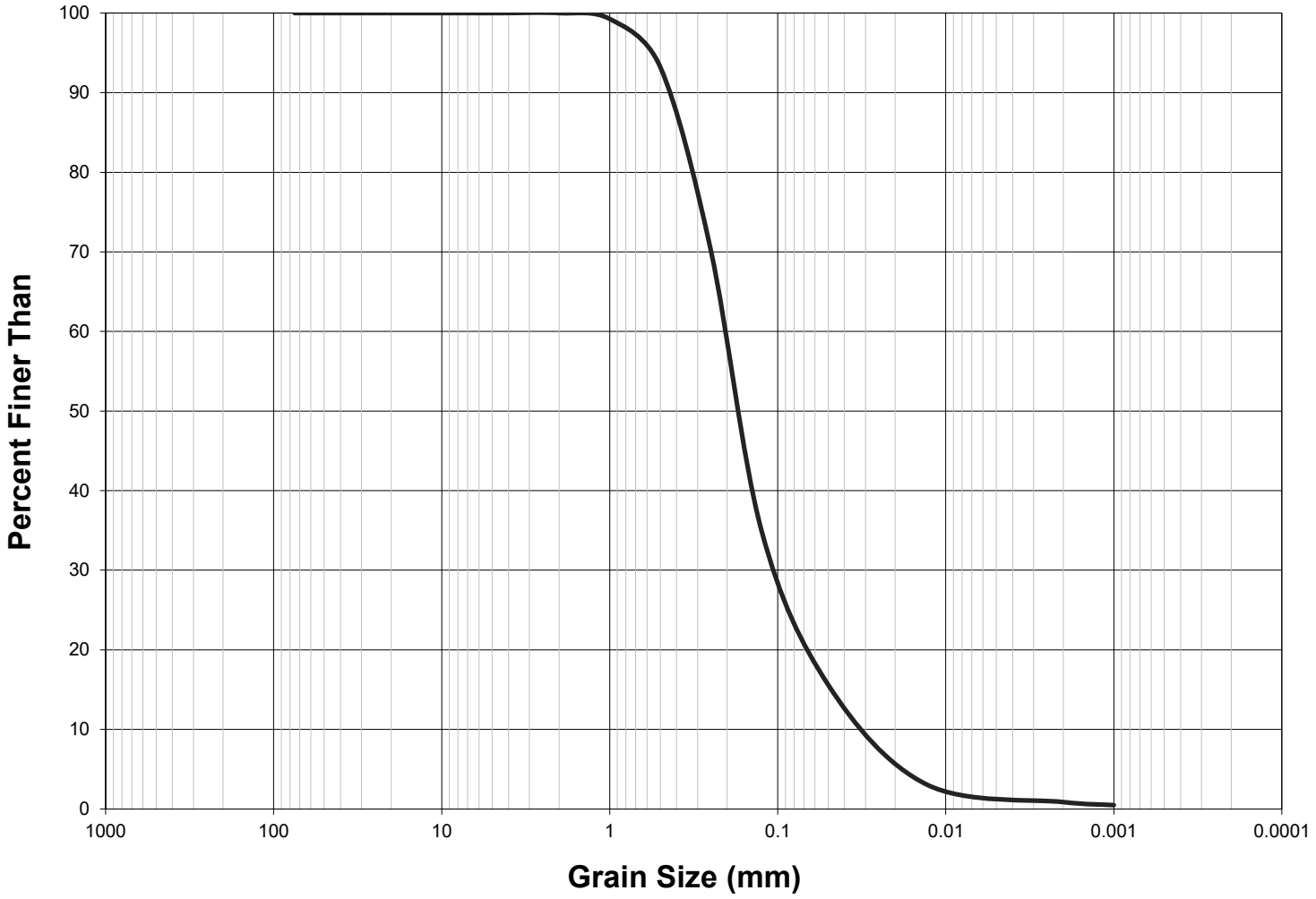
Method Reference: Can. Soc. Soil Sci. (1993) Method 47.2

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES
Environmental Division

819-58th Street, Saskatoon, SK S7K 6X5

Client Name: CONI100
Project:
Sample ID: 2020 LGCS3
Lab ID: VA20A7841003

Particle Size Distribution Curve



Particle Size Distribution

Range (mm)	Wt. (%)
> 19	0.00
19 - 9.5	0.00
9.5 - 4.75	0.00
4.75 - 2	0.00
2 - 0.85	2.55
0.85 - 0.425	11.14
0.425 - 0.25	16.14
0.25 - 0.106	40.07
0.106 - 0.075	8.03

Particle Size Distribution

Range (mm)	Wt. (%)
0.075 - 0.074	0.26
0.074 - 0.005	20.33
0.005 - 0.001	0.99
<0.001	0.49

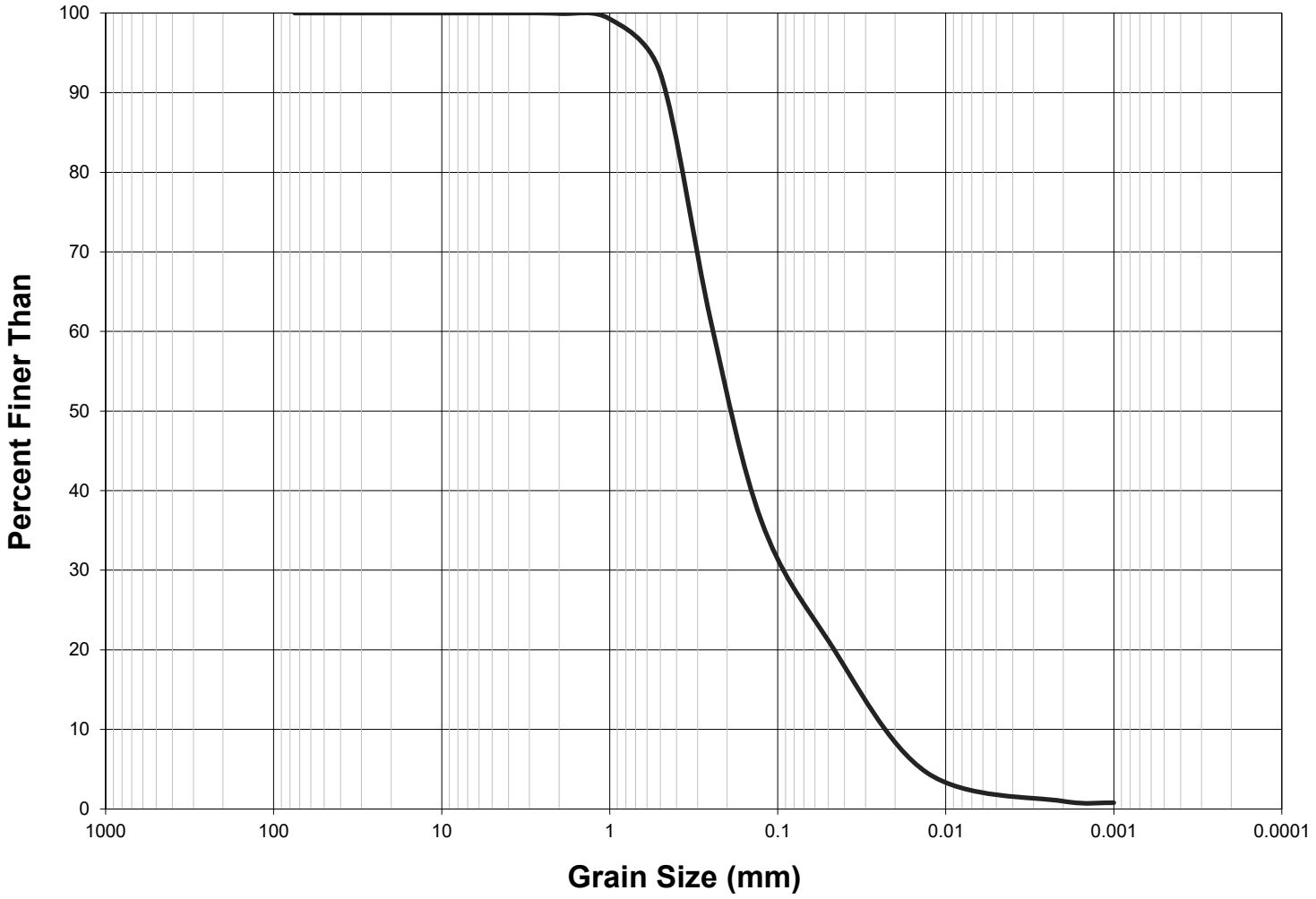
Method Reference: Can. Soc. Soil Sci. (1993) Method 47.2

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES
Environmental Division

819-58th Street, Saskatoon, SK S7K 6X5

Client Name: CONI100
Project:
Sample ID: 2020 LGCS4
Lab ID: VA20A7841004

Particle Size Distribution Curve



Particle Size Distribution

Range (mm)	Wt. (%)
> 19	0.00
19 - 9.5	0.00
9.5 - 4.75	0.00
4.75 - 2	0.07
2 - 0.85	2.71
0.85 - 0.425	14.12
0.425 - 0.25	21.84
0.25 - 0.106	28.90
0.106 - 0.075	6.21

Particle Size Distribution

Range (mm)	Wt. (%)
0.075 - 0.074	0.20
0.074 - 0.005	24.00
0.005 - 0.001	1.18
<0.001	0.79

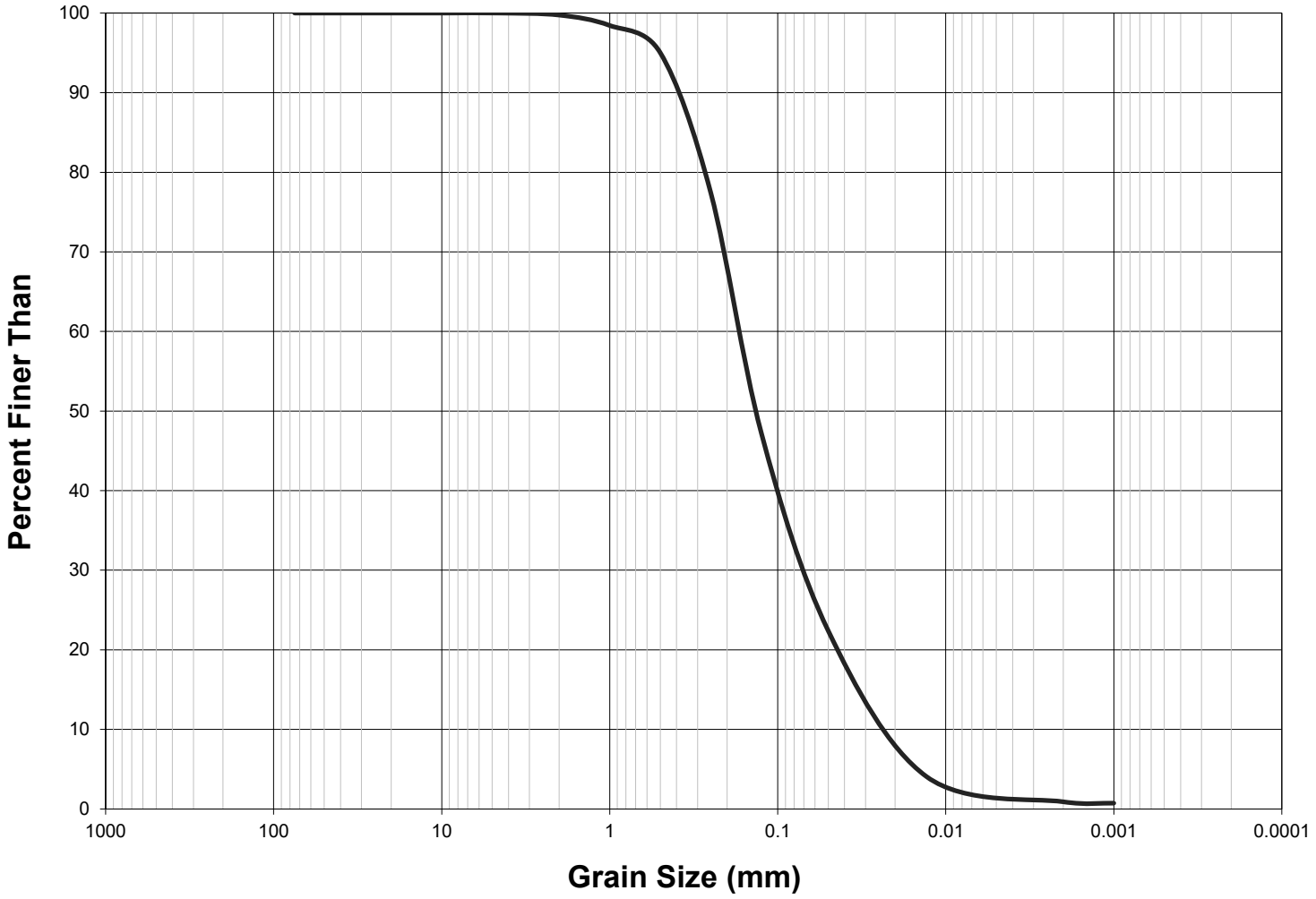
Method Reference: Can. Soc. Soil Sci. (1993) Method 47.2

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES
Environmental Division

819-58th Street, Saskatoon, SK S7K 6X5

Client Name: CONI100
Project:
Sample ID: 2020 LGCS5
Lab ID: VA20A7841005

Particle Size Distribution Curve



Particle Size Distribution

Range (mm)	Wt. (%)
> 19	0.00
19 - 9.5	0.00
9.5 - 4.75	0.00
4.75 - 2	0.25
2 - 0.85	2.34
0.85 - 0.425	7.69
0.425 - 0.25	12.34
0.25 - 0.106	36.47
0.106 - 0.075	10.26

Particle Size Distribution

Range (mm)	Wt. (%)
0.075 - 0.074	0.33
0.074 - 0.005	28.54
0.005 - 0.001	1.03
<0.001	0.74

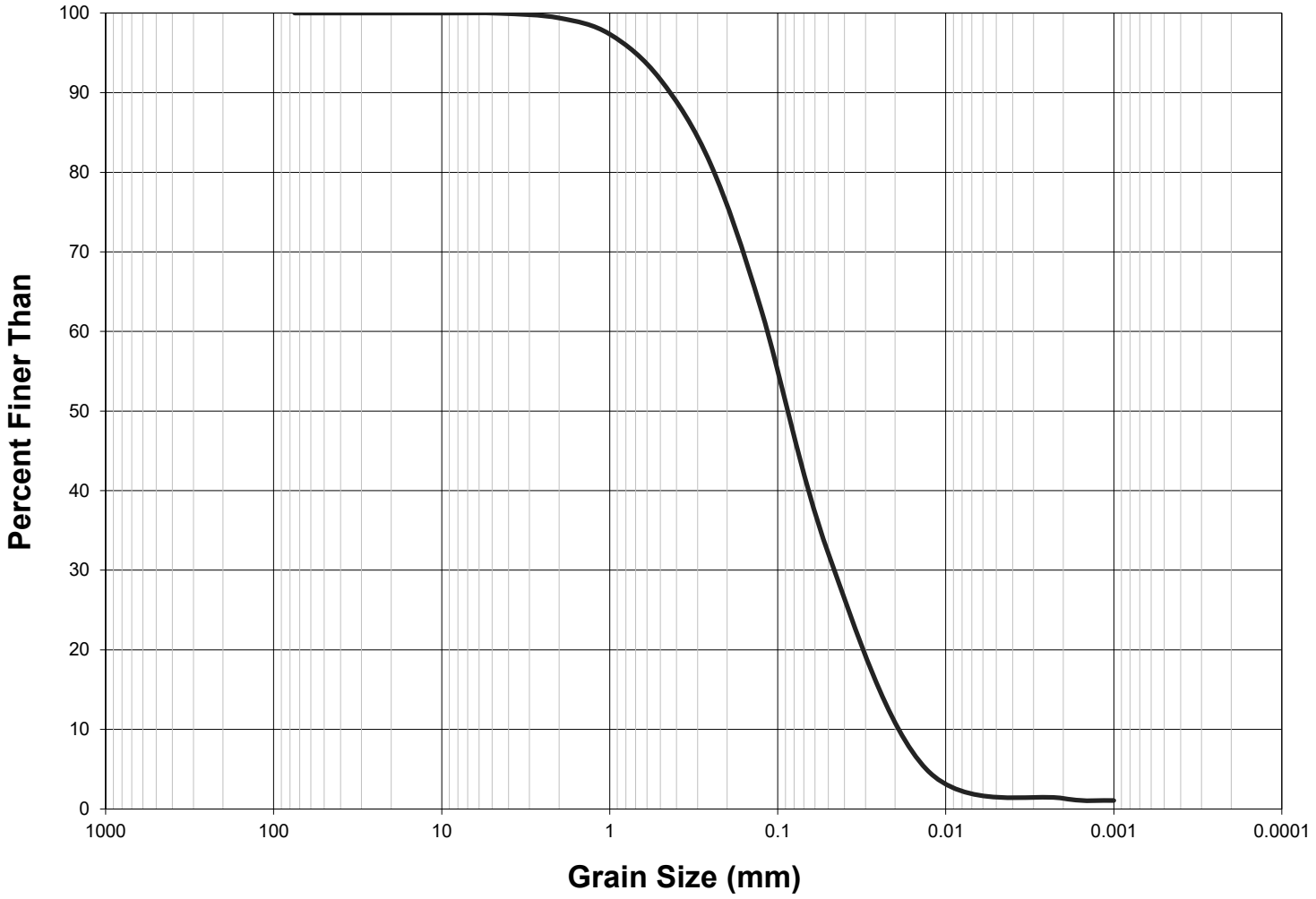
Method Reference: Can. Soc. Soil Sci. (1993) Method 47.2

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES
Environmental Division

819-58th Street, Saskatoon, SK S7K 6X5

Client Name: CONI100
Project:
Sample ID: 2020 MGCS1
Lab ID: VA20A7841006

Particle Size Distribution Curve



Particle Size Distribution

Range (mm)	Wt. (%)
> 19	0.00
19 - 9.5	0.00
9.5 - 4.75	0.04
4.75 - 2	0.58
2 - 0.85	3.74
0.85 - 0.425	7.19
0.425 - 0.25	7.50
0.25 - 0.106	26.05
0.106 - 0.075	12.61

Particle Size Distribution

Range (mm)	Wt. (%)
0.075 - 0.074	0.41
0.074 - 0.005	39.55
0.005 - 0.001	1.26
<0.001	1.07

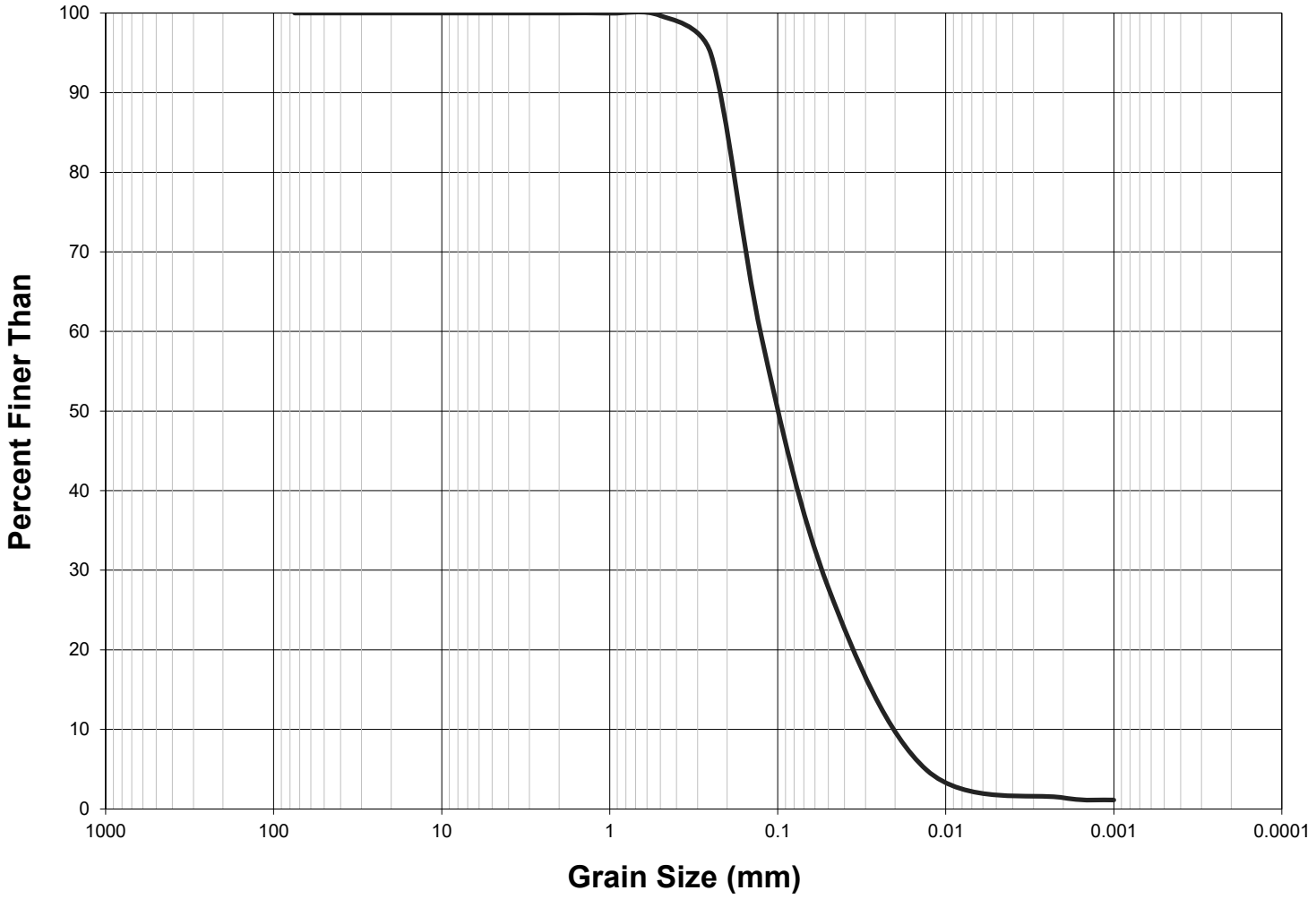
Method Reference: Can. Soc. Soil Sci. (1993) Method 47.2

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES
Environmental Division

819-58th Street, Saskatoon, SK S7K 6X5

Client Name: CONI100
Project:
Sample ID: 2020 MGCS2
Lab ID: VA20A7841007

Particle Size Distribution Curve



Particle Size Distribution

Range (mm)	Wt. (%)
> 19	0.00
19 - 9.5	0.00
9.5 - 4.75	0.00
4.75 - 2	0.00
2 - 0.85	0.11
0.85 - 0.425	1.65
0.425 - 0.25	3.35
0.25 - 0.106	43.53
0.106 - 0.075	13.03

Particle Size Distribution

Range (mm)	Wt. (%)
0.075 - 0.074	0.42
0.074 - 0.005	35.53
0.005 - 0.001	1.24
<0.001	1.13

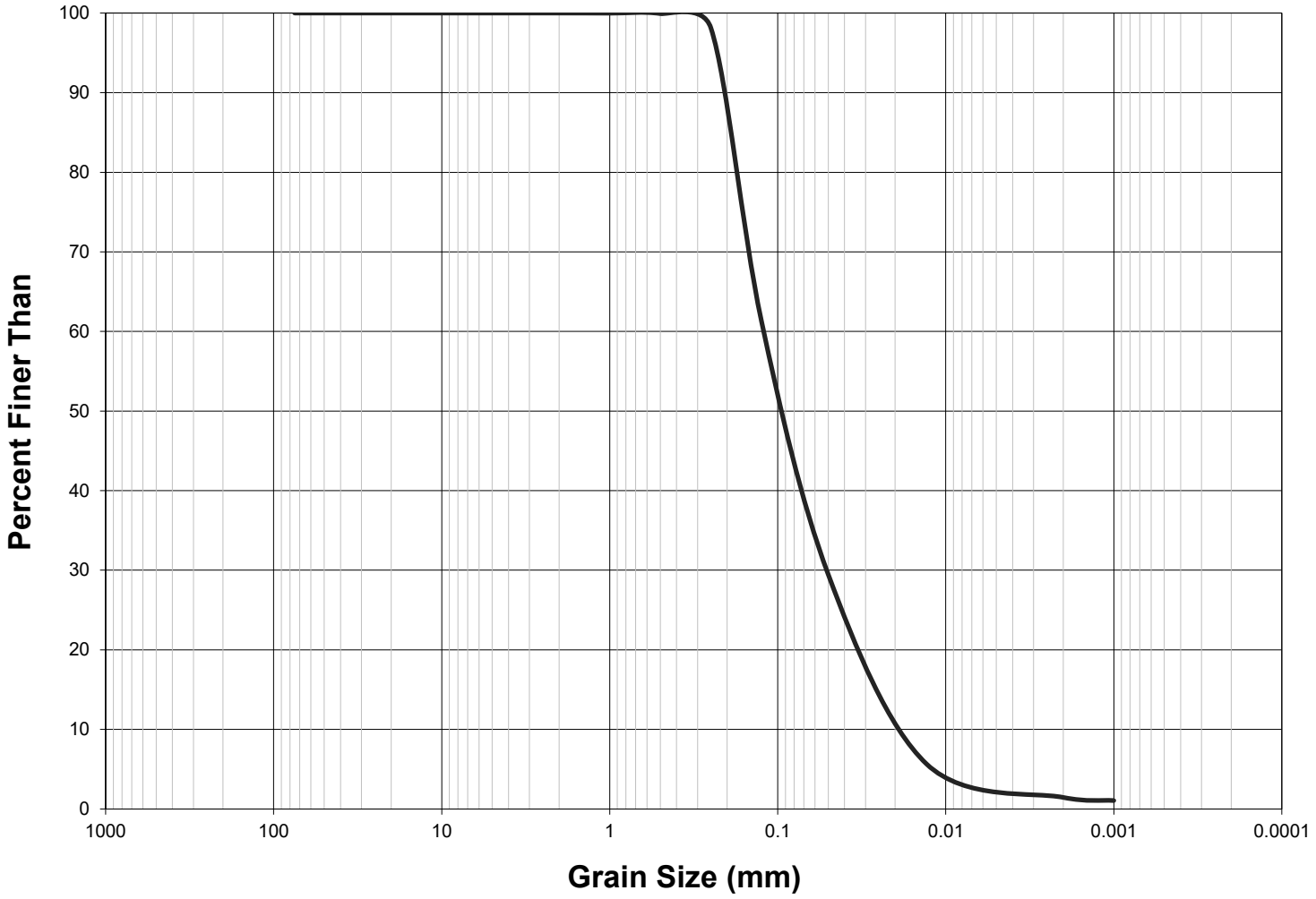
Method Reference: Can. Soc. Soil Sci. (1993) Method 47.2

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES
Environmental Division

819-58th Street, Saskatoon, SK S7K 6X5

Client Name: CONI100
Project:
Sample ID: 2020 MGCS3
Lab ID: VA20A7841008

Particle Size Distribution Curve



Particle Size Distribution

Range (mm)	Wt. (%)
> 19	0.00
19 - 9.5	0.00
9.5 - 4.75	0.00
4.75 - 2	0.00
2 - 0.85	0.03
0.85 - 0.425	0.58
0.425 - 0.25	1.26
0.25 - 0.106	44.89
0.106 - 0.075	13.17

Particle Size Distribution

Range (mm)	Wt. (%)
0.075 - 0.074	0.42
0.074 - 0.005	37.04
0.005 - 0.001	1.53
<0.001	1.07

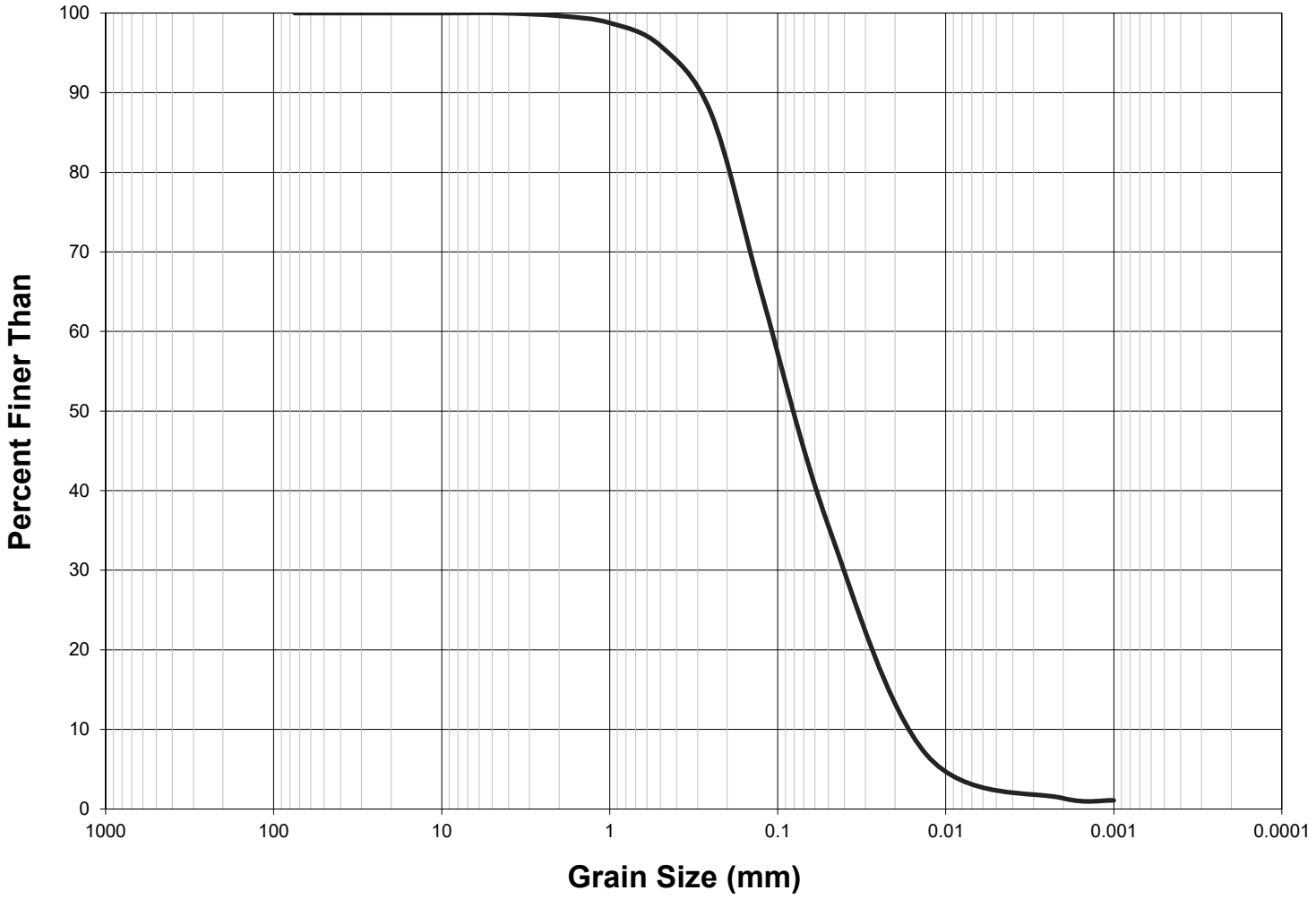
Method Reference: Can. Soc. Soil Sci. (1993) Method 47.2

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES
Environmental Division

819-58th Street, Saskatoon, SK S7K 6X5

Client Name: CONI100
Project:
Sample ID: 2020 MGCS4
Lab ID: VA20A7841009

Particle Size Distribution Curve



Particle Size Distribution

Range (mm)	Wt. (%)
> 19	0.00
19 - 9.5	0.00
9.5 - 4.75	0.00
4.75 - 2	0.36
2 - 0.85	1.74
0.85 - 0.425	4.53
0.425 - 0.25	5.90
0.25 - 0.106	30.06
0.106 - 0.075	12.07

Particle Size Distribution

Range (mm)	Wt. (%)
0.075 - 0.074	0.39
0.074 - 0.005	42.11
0.005 - 0.001	1.76
<0.001	1.08

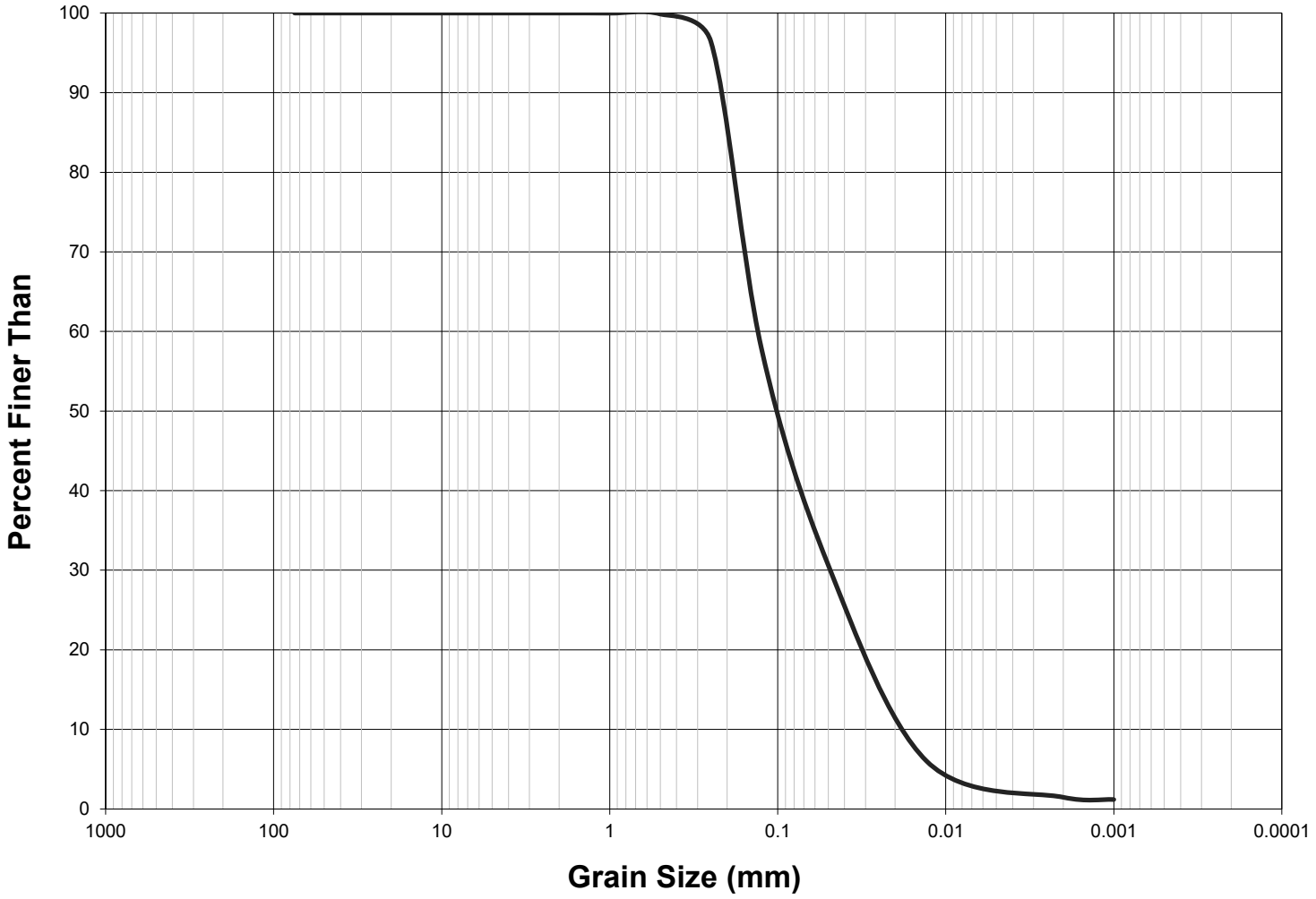
Method Reference: Can. Soc. Soil Sci. (1993) Method 47.2

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES
Environmental Division

819-58th Street, Saskatoon, SK S7K 6X5

Client Name: CONI100
Project:
Sample ID: 2020 MGCS5
Lab ID: VA20A7841010

Particle Size Distribution Curve



Particle Size Distribution

Range (mm)	Wt. (%)
> 19	0.00
19 - 9.5	0.00
9.5 - 4.75	0.00
4.75 - 2	0.00
2 - 0.85	0.05
0.85 - 0.425	1.11
0.425 - 0.25	2.42
0.25 - 0.106	45.46
0.106 - 0.075	11.26
	60.29

Particle Size Distribution

Range (mm)	Wt. (%)
0.075 - 0.074	0.36
0.074 - 0.005	36.63
0.005 - 0.001	1.53
<0.001	1.19
	39.71

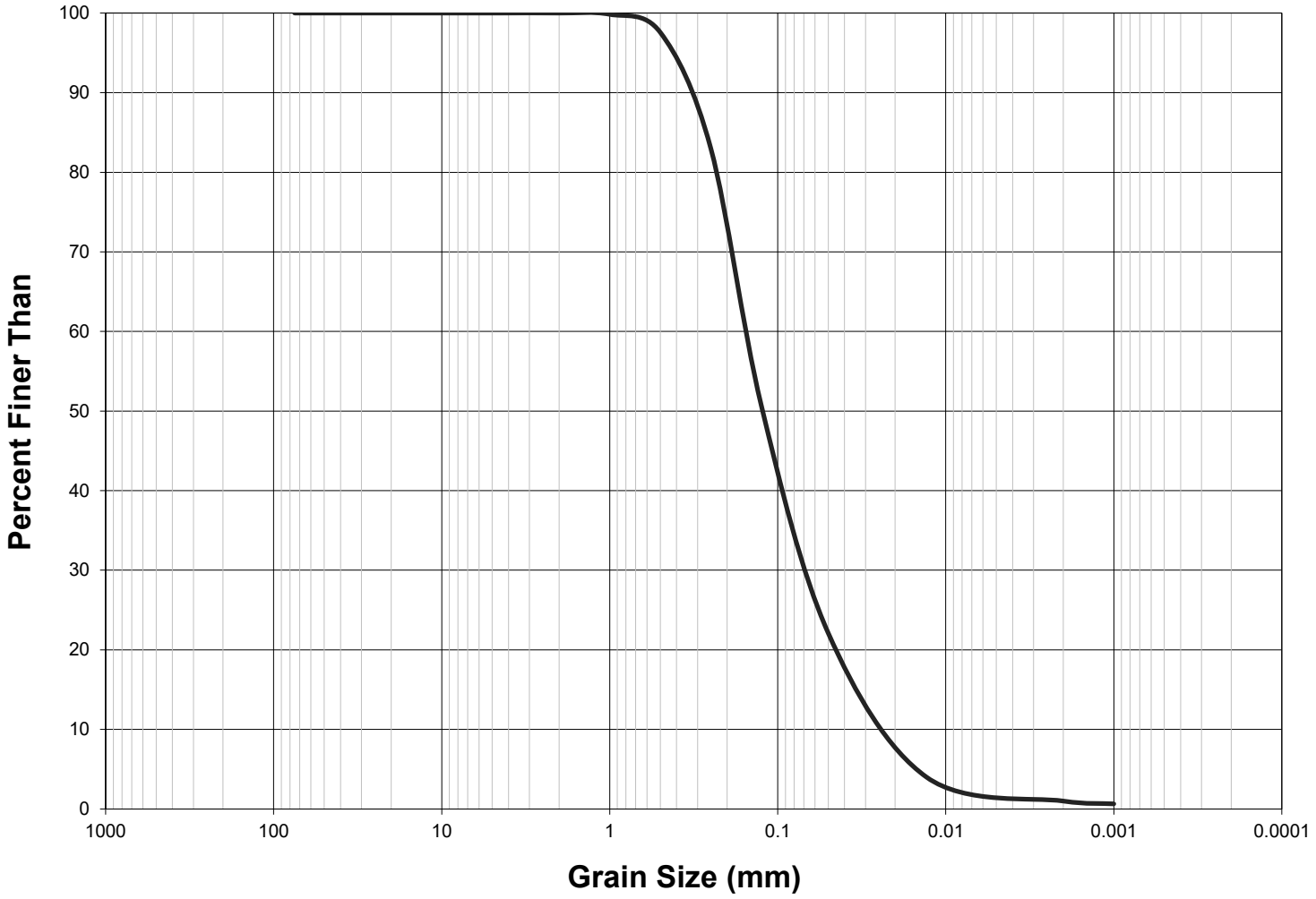
Method Reference: Can. Soc. Soil Sci. (1993) Method 47.2

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES
Environmental Division

819-58th Street, Saskatoon, SK S7K 6X5

Client Name: 0
Project:
Sample ID: 0
Lab ID: QC-MRG2-51657003

Particle Size Distribution Curve



Particle Size Distribution

Range (mm)	Wt. (%)
> 19	0.00
19 - 9.5	0.00
9.5 - 4.75	0.00
4.75 - 2	0.00
2 - 0.85	0.84
0.85 - 0.425	5.97
0.425 - 0.25	10.22
0.25 - 0.106	39.57
0.106 - 0.075	11.80

Particle Size Distribution

Range (mm)	Wt. (%)
0.075 - 0.074	0.38
0.074 - 0.005	29.40
0.005 - 0.001	1.17
<0.001	0.65

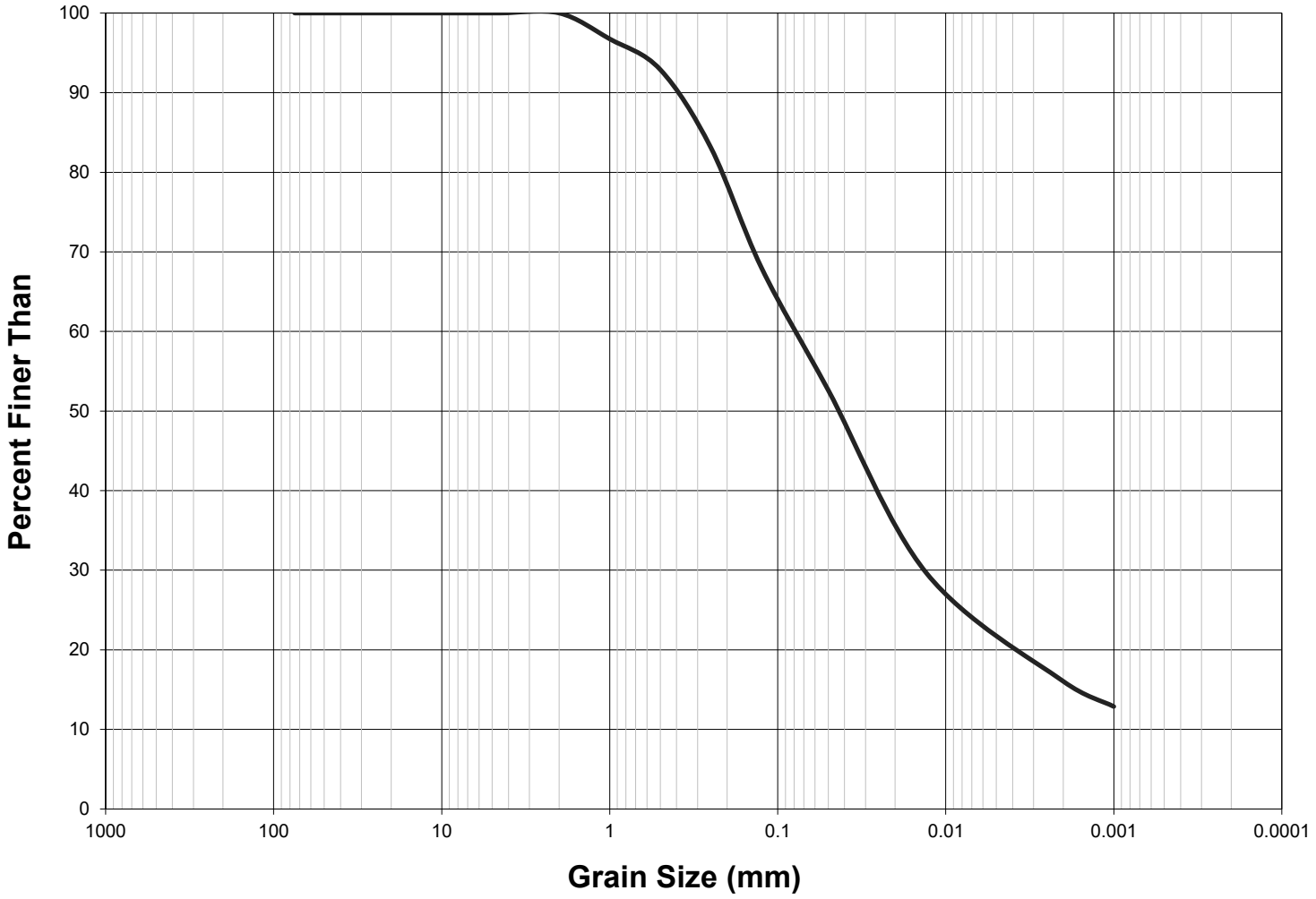
Method Reference: Can. Soc. Soil Sci. (1993) Method 47.2

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES
Environmental Division

819-58th Street, Saskatoon, SK S7K 6X5

Client Name: 0
Project:
Sample ID: 0
Lab ID: QC-MRG3-51657001

Particle Size Distribution Curve



Particle Size Distribution

Range (mm)	Wt. (%)
> 19	0.00
19 - 9.5	0.00
9.5 - 4.75	0.00
4.75 - 2	0.00
2 - 0.85	4.41
0.85 - 0.425	5.64
0.425 - 0.25	6.86
0.25 - 0.106	18.99
0.106 - 0.075	6.36

Particle Size Distribution

Range (mm)	Wt. (%)
0.075 - 0.074	0.21
0.074 - 0.005	37.79
0.005 - 0.001	6.87
<0.001	12.88

Method Reference: Can. Soc. Soil Sci. (1993) Method 47.2

ALS Environmental

QUALITY CONTROL REPORT

Work Order	: **VA20A7841**	Page	: 1 of 10
Client	: Constantine North Inc.	Laboratory	: Vancouver - Environmental
Contact	: Aris Morfopoulos	Account Manager	: Carla Fuginski
Address	: Suite 320 - 800 West Pender St. Vancouver BC Canada V6C 2V6	Address	: 8081 Lougheed Highway Burnaby, British Columbia Canada V5A 1W9
Telephone	: 604 629 2348	Telephone	: +1 604 253 4188
Project	: Stream Sediments	Date Samples Received	: 05-Jun-2020 15:20
PO	: ----	Date Analysis Commenced	: 09-Jun-2020
C-O-C number	: ----	Issue Date	: 25-Jun-2020 12:52
Sampler	: Dylan Krell		
Site	: Sediment Analysis		
Quote number	: Q62329		
No. of samples received	: 10		
No. of samples analysed	: 10		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits
- Reference Material (RM) Report; Recovery and Acceptance Limits
- Method Blank (MB) Report; Recovery and Acceptance Limits
- Laboratory Control Sample (LCS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is conducted in accordance with US FDA 21 CFR Part 11.

Signatories	*Position*	*Laboratory Department*
Brieanna Allen	Department Manager - Organics	Organics, Burnaby, British Columbia
Cristina Alexandre	Supervisor - Metals ICP Instrumentation	Metals, Burnaby, British Columbia
Dee Lee	Analyst	Metals, Burnaby, British Columbia
Hedy Lai	Team Leader - Inorganics	Inorganics, Saskatoon, Saskatchewan
Jon Fisher	Department Manager - Inorganics	Inorganics, Waterloo, Ontario
Nancy Cruse	Laboratory _ Supervisor	Inorganics, Saskatoon, Saskatchewan
Xihua Yao	Laboratory Analyst	Inorganics, Saskatoon, Saskatchewan

General Comments

The ALS Quality Control (QC) report is optionally provided to ALS clients upon request. ALS test methods include comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against predetermined Data Quality Objectives (DQOs) to provide confidence in the accuracy of associated test results. This report contains detailed results for all QC results applicable to this sample submission. Please refer to the ALS Quality Control Interpretation report (QCI) for applicable method references and methodology summaries.

Key :

Anonymous = Refers to samples which are not part of this work order, but which formed part of the QC process lot.
CAS Number = Chemical Abstracts Services number is a unique identifier assigned to discrete substances.
DQO = Data Quality Objective.
LOR = Limit of Reporting (detection limit).
RPD = Relative Percentage Difference
# = Indicates a QC result that did not meet the ALS DQO.

Laboratory Duplicate (DUP) Report

A Laboratory Duplicate (DUP) is a randomly selected intralaboratory replicate sample. Laboratory Duplicates provide information regarding method precision and sample heterogeneity. ALS DQOs for Laboratory Duplicates are expressed as test-specific limits for Relative Percent Difference (RPD), or as an absolute difference limit of 2 times the LOR for low concentration duplicates within ~ 4-10 times the LOR (cut-off is test specific).

Sub-Matrix: **Soil/Solid**

					Laboratory Duplicate (DUP) Report						
Laboratory sample ID	*Client sample ID*	*Analyte*	*CAS Number*	*Method*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD(%) or Difference*	*Duplicate Limits*	*Qualifier*
Physical Tests (QC Lot: 47541)											
VA20A7841-001	2020 LGCS1	pH (1:2 soil:water)	----	E108	0.10	pH units	8.35	8.35	0.00%	5%	----
Physical Tests (QC Lot: 47542)											
VA20A7689-003	Anonymous	moisture	----	E144	0.25	%	17.6	18.2	3.16%	20%	----
Physical Tests (QC Lot: 48472)											
VA20A7841-001	2020 LGCS1	loss on ignition @ 550°C	----	E205D	1.0	%	1.4	1.4	0.001	Diff <2x LOR	----
Organic / Inorganic Carbon (QC Lot: 48349)											
VA20A7372-009	Anonymous	carbon, total [TC]	----	E351	0.050	%	1.29	1.30	0.559%	20%	----
Organic / Inorganic Carbon (QC Lot: 48351)											
VA20A7372-009	Anonymous	carbon, inorganic [IC]	----	E354	0.050	%	0.082	0.080	0.002	Diff <2x LOR	----
Inorganic Parameters (QC Lot: 48749)											
VA20A7841-001	2020 LGCS1	sulfides, acid volatile	----	E401	0.20	mg/kg	<0.20	<0.20	0	Diff <2x LOR	----
Metals (QC Lot: 47536)											
VA20A7390-008	Anonymous	aluminum	7429-90-5	E440	50	mg/kg	22800	23400	2.67%	40%	----
		antimony	7440-36-0	E440	0.10	mg/kg	0.28	0.31	0.03	Diff <2x LOR	----
		arsenic	7440-38-2	E440	0.10	mg/kg	5.97	6.45	7.67%	30%	----
		barium	7440-39-3	E440	0.50	mg/kg	92.6	96.5	4.23%	40%	----
		beryllium	7440-41-7	E440	0.10	mg/kg	0.39	0.40	0.02	Diff <2x LOR	----
		bismuth	7440-69-9	E440	0.20	mg/kg	<0.20	<0.20	0	Diff <2x LOR	----
		boron	7440-42-8	E440	5.0	mg/kg	5.2	5.4	0.2	Diff <2x LOR	----
		cadmium	7440-43-9	E440	0.020	mg/kg	0.082	0.083	0.002	Diff <2x LOR	----
		calcium	7440-70-2	E440	50	mg/kg	7020	7360	4.70%	30%	----
		chromium	7440-47-3	E440	0.50	mg/kg	42.3	45.8	7.80%	30%	----
		cobalt	7440-48-4	E440	0.10	mg/kg	13.4	14.2	5.68%	30%	----
		copper	7440-50-8	E440	0.50	mg/kg	41.4	43.7	5.52%	30%	----
		iron	7439-89-6	E440	50	mg/kg	31900	33600	5.18%	30%	----
		lead	7439-92-1	E440	0.50	mg/kg	8.41	8.72	3.58%	40%	----
		lithium	7439-93-2	E440	2.0	mg/kg	16.8	18.0	6.67%	30%	----
		magnesium	7439-95-4	E440	20	mg/kg	9000	9420	4.67%	30%	----
		manganese	7439-96-5	E440	1.0	mg/kg	609	632	3.68%	30%	----
		molybdenum	7439-98-7	E440	0.10	mg/kg	0.26	0.29	0.03	Diff <2x LOR	----
		nickel	7440-02-0	E440	0.50	mg/kg	38.9	41.7	6.99%	30%	----

Sub-Matrix: **Soil/Solid**

					Laboratory Duplicate (DUP) Report						
Laboratory sample ID	*Client sample ID*	*Analyte*	*CAS Number*	*Method*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD(%) or Difference*	*Duplicate Limits*	*Qualifier*
Metals (QC Lot: 47536) - continued											
VA20A7390-008	Anonymous	phosphorus	7723-14-0	E440	50	mg/kg	625	644	3.06%	30%	----
		potassium	7440-09-7	E440	100	mg/kg	1360	1410	3.35%	40%	----
		selenium	7782-49-2	E440	0.20	mg/kg	<0.20	<0.20	0	Diff <2x LOR	----
		silver	7440-22-4	E440	0.10	mg/kg	0.11	0.12	0.005	Diff <2x LOR	----
		sodium	7440-23-5	E440	50	mg/kg	532	530	0.392%	40%	----
		strontium	7440-24-6	E440	0.50	mg/kg	50.9	49.5	2.72%	40%	----
		sulfur	7704-34-9	E440	1000	mg/kg	<1000	<1000	0	Diff <2x LOR	----
		thallium	7440-28-0	E440	0.050	mg/kg	0.080	0.095	0.014	Diff <2x LOR	----
		tin	7440-31-5	E440	2.0	mg/kg	<2.0	<2.0	0	Diff <2x LOR	----
		titanium	7440-32-6	E440	1.0	mg/kg	1180	1190	0.648%	40%	----
		tungsten	7440-33-7	E440	0.50	mg/kg	<0.50	<0.50	0	Diff <2x LOR	----
		uranium	7440-61-1	E440	0.050	mg/kg	0.420	0.459	8.83%	30%	----
		vanadium	7440-62-2	E440	0.20	mg/kg	78.1	82.6	5.64%	30%	----
		zinc	7440-66-6	E440	2.0	mg/kg	68.7	71.5	3.98%	30%	----
		zirconium	7440-67-7	E440	1.0	mg/kg	4.6	4.9	0.2	Diff <2x LOR	----
Metals (QC Lot: 47537)											
VA20A7841-001	2020 LGCS1	mercury	7439-97-6	E510	0.0050	mg/kg	0.0125	0.0159	0.0034	Diff <2x LOR	----

Method Blank (MB) Report

A Method Blank is an analyte-free matrix that undergoes sample processing identical to that carried out for test samples. Method Blank results are used to monitor and control for potential contamination from the laboratory environment and reagents. For most tests, the DQO for Method Blanks is for the result to be < LOR.

Sub-Matrix: **Soil/Solid**

Analyte	CAS Number	Method	LOR	Unit	Result	Qualifier
Physical Tests (QCLot: 47542)						
moisture	---	E144	0.25	%	<0.25	---
Organic / Inorganic Carbon (QCLot: 48349)						
carbon, total [TC]	---	E351	0.05	%	<0.050	---
Organic / Inorganic Carbon (QCLot: 48351)						
carbon, inorganic [IC]	---	E354	0.05	%	<0.050	---
Inorganic Parameters (QCLot: 48749)						
sulfides, acid volatile	---	E401	0.2	mg/kg	<0.20	---
Metals (QCLot: 47536)						
aluminum	7429-90-5	E440	50	mg/kg	<50	---
antimony	7440-36-0	E440	0.1	mg/kg	<0.10	---
arsenic	7440-38-2	E440	0.1	mg/kg	<0.10	---
barium	7440-39-3	E440	0.5	mg/kg	<0.50	---
beryllium	7440-41-7	E440	0.1	mg/kg	<0.10	---
bismuth	7440-69-9	E440	0.2	mg/kg	<0.20	---
boron	7440-42-8	E440	5	mg/kg	<5.0	---
cadmium	7440-43-9	E440	0.02	mg/kg	<0.020	---
calcium	7440-70-2	E440	50	mg/kg	<50	---
chromium	7440-47-3	E440	0.5	mg/kg	<0.50	---
cobalt	7440-48-4	E440	0.1	mg/kg	<0.10	---
copper	7440-50-8	E440	0.5	mg/kg	<0.50	---
iron	7439-89-6	E440	50	mg/kg	<50	---
lead	7439-92-1	E440	0.5	mg/kg	<0.50	---
lithium	7439-93-2	E440	2	mg/kg	<2.0	---
magnesium	7439-95-4	E440	20	mg/kg	<20	---
manganese	7439-96-5	E440	1	mg/kg	<1.0	---
molybdenum	7439-98-7	E440	0.1	mg/kg	<0.10	---
nickel	7440-02-0	E440	0.5	mg/kg	<0.50	---
phosphorus	7723-14-0	E440	50	mg/kg	<50	---
potassium	7440-09-7	E440	100	mg/kg	<100	---
selenium	7782-49-2	E440	0.2	mg/kg	<0.20	---
silver	7440-22-4	E440	0.1	mg/kg	<0.10	---
sodium	7440-23-5	E440	50	mg/kg	<50	---
strontium	7440-24-6	E440	0.5	mg/kg	<0.50	---

Sub-Matrix: **Soil/Solid**

Analyte	CAS Number	Method	LOR	Unit	Result	Qualifier
Metals (QCLot: 47536) - continued						
sulfur	7704-34-9	E440	1000	mg/kg	<1000	----
thallium	7440-28-0	E440	0.05	mg/kg	<0.050	----
tin	7440-31-5	E440	2	mg/kg	<2.0	----
titanium	7440-32-6	E440	1	mg/kg	<1.0	----
tungsten	7440-33-7	E440	0.5	mg/kg	<0.50	----
uranium	7440-61-1	E440	0.05	mg/kg	<0.050	----
vanadium	7440-62-2	E440	0.2	mg/kg	<0.20	----
zinc	7440-66-6	E440	2	mg/kg	<2.0	----
zirconium	7440-67-7	E440	1	mg/kg	<1.0	----
Metals (QCLot: 47537)						
mercury	7439-97-6	E510	0.005	mg/kg	<0.0050	----

Laboratory Control Sample (LCS) Report

A Laboratory Control Sample (LCS) is an analyte-free matrix that has been fortified (spiked) with test analytes at known concentration and processed in an identical manner to test samples. LCS results are expressed as percent recovery, and are used to monitor and control test method accuracy and precision, independent of test sample matrix.

Sub-Matrix: **Soil/Solid**

					Laboratory Control Sample (LCS) Report				
					Spike	Recovery (%)	Recovery Limits (%)		
Analyte	CAS Number	Method	LOR	Unit	Concentration	LCS	Low	High	Qualifier
Physical Tests (QCLot: 47541)									
pH (1:2 soil:water)	----	E108	----	pH units	7 pH units	100	95.0	105	----
Physical Tests (QCLot: 47542)									
moisture	----	E144	0.25	%	50 %	99.6	90.0	110	----
Organic / Inorganic Carbon (QCLot: 48349)									
carbon, total [TC]	----	E351	0.05	%	48 %	101	80.0	120	----
Organic / Inorganic Carbon (QCLot: 48351)									
carbon, inorganic [IC]	----	E354	0.05	%	0.5 %	97.4	80.0	120	----
Inorganic Parameters (QCLot: 48749)									
sulfides, acid volatile	----	E401	0.2	mg/kg	2.252 mg/kg	92.4	70.0	130	----
Metals (QCLot: 47536)									
aluminum	7429-90-5	E440	50	mg/kg	200 mg/kg	112	80.0	120	----
antimony	7440-36-0	E440	0.1	mg/kg	100 mg/kg	114	80.0	120	----
arsenic	7440-38-2	E440	0.1	mg/kg	100 mg/kg	110	80.0	120	----
barium	7440-39-3	E440	0.5	mg/kg	25 mg/kg	104	80.0	120	----
beryllium	7440-41-7	E440	0.1	mg/kg	10 mg/kg	99.1	80.0	120	----
bismuth	7440-69-9	E440	0.2	mg/kg	100 mg/kg	118	80.0	120	----
boron	7440-42-8	E440	5	mg/kg	100 mg/kg	102	80.0	120	----
cadmium	7440-43-9	E440	0.02	mg/kg	10 mg/kg	107	80.0	120	----
calcium	7440-70-2	E440	50	mg/kg	5000 mg/kg	105	80.0	120	----
chromium	7440-47-3	E440	0.5	mg/kg	25 mg/kg	108	80.0	120	----
cobalt	7440-48-4	E440	0.1	mg/kg	25 mg/kg	107	80.0	120	----
copper	7440-50-8	E440	0.5	mg/kg	25 mg/kg	109	80.0	120	----
iron	7439-89-6	E440	50	mg/kg	100 mg/kg	107	80.0	120	----
lead	7439-92-1	E440	0.5	mg/kg	50 mg/kg	113	80.0	120	----
lithium	7439-93-2	E440	2	mg/kg	25 mg/kg	97.8	80.0	120	----
magnesium	7439-95-4	E440	20	mg/kg	5000 mg/kg	114	80.0	120	----
manganese	7439-96-5	E440	1	mg/kg	25 mg/kg	114	80.0	120	----
molybdenum	7439-98-7	E440	0.1	mg/kg	25 mg/kg	105	80.0	120	----
nickel	7440-02-0	E440	0.5	mg/kg	50 mg/kg	107	80.0	120	----
phosphorus	7723-14-0	E440	50	mg/kg	1000 mg/kg	115	80.0	120	----
potassium	7440-09-7	E440	100	mg/kg	5000 mg/kg	118	80.0	120	----

Sub-Matrix: **Soil/Solid**

					Laboratory Control Sample (LCS) Report				
					Spike	Recovery (%)	Recovery Limits (%)		
Analyte	CAS Number	Method	LOR	Unit	Concentration	LCS	Low	High	Qualifier
Metals (QCLot: 47536) - continued									
selenium	7782-49-2	E440	0.2	mg/kg	100 mg/kg	108	80.0	120	----
silver	7440-22-4	E440	0.1	mg/kg	10 mg/kg	103	80.0	120	----
sodium	7440-23-5	E440	50	mg/kg	5000 mg/kg	113	80.0	120	----
strontium	7440-24-6	E440	0.5	mg/kg	25 mg/kg	114	80.0	120	----
sulfur	7704-34-9	E440	1000	mg/kg	5000 mg/kg	109	80.0	120	----
thallium	7440-28-0	E440	0.05	mg/kg	100 mg/kg	115	80.0	120	----
tin	7440-31-5	E440	2	mg/kg	50 mg/kg	109	80.0	120	----
titanium	7440-32-6	E440	1	mg/kg	25 mg/kg	109	80.0	120	----
tungsten	7440-33-7	E440	0.5	mg/kg	10 mg/kg	113	80.0	120	----
uranium	7440-61-1	E440	0.05	mg/kg	0.5 mg/kg	112	80.0	120	----
vanadium	7440-62-2	E440	0.2	mg/kg	50 mg/kg	111	80.0	120	----
zinc	7440-66-6	E440	2	mg/kg	50 mg/kg	113	80.0	120	----
zirconium	7440-67-7	E440	1	mg/kg	10 mg/kg	102	80.0	120	----
Metals (QCLot: 47537)									
mercury	7439-97-6	E510	0.005	mg/kg	0.1 mg/kg	109	80.0	120	----

Reference Material (RM) Report

A Reference Material (RM) is a homogenous material with known and well-established analyte concentrations. RMs are processed in an identical manner to test samples, and are used to monitor and control the accuracy and precision of a test method for a typical sample matrix. RM results are expressed as percent recovery of the target analyte concentration. RM targets may be certified target concentrations provided by the RM supplier, or may be ALS long-term mean values (for empirical test methods).

Sub-Matrix: **Soil/Solid**

					Reference Material (RM) Report				
					RM Target	Recovery (%)	Recovery Limits (%)		
Laboratory sample ID	Reference Material ID	Analyte	CAS Number	Method	Concentration	RM	Low	High	Qualifier
Physical Tests (QCLot: 48472)									
QC-48472-002	RM	loss on ignition @ 550°C	----	E205D	7.1 %	89.0	80.0	120	----
Organic / Inorganic Carbon (QCLot: 48349)									
QC-48349-003	RM	carbon, total [TC]	----	E351	1.4 %	98.4	80.0	120	----
Organic / Inorganic Carbon (QCLot: 48351)									
QC-48351-003	RM	carbon, inorganic [IC]	----	E354	0.383 %	97.2	80.0	120	----
Metals (QCLot: 47536)									
QC-47536-003	TILL-2	aluminum	7429-90-5	E440	29384 mg/kg	105	70.0	130	----
QC-47536-003	TILL-2	antimony	7440-36-0	E440	0.484 mg/kg	107	70.0	130	----
QC-47536-003	TILL-2	arsenic	7440-38-2	E440	24.1 mg/kg	108	70.0	130	----
QC-47536-003	TILL-2	barium	7440-39-3	E440	102 mg/kg	98.3	70.0	130	----
QC-47536-003	TILL-2	beryllium	7440-41-7	E440	1.6 mg/kg	91.4	70.0	130	----
QC-47536-003	TILL-2	bismuth	7440-69-9	E440	5 mg/kg	111	70.0	130	----
QC-47536-003	TILL-2	cadmium	7440-43-9	E440	0.34 mg/kg	107	70.0	130	----
QC-47536-003	TILL-2	calcium	7440-70-2	E440	1663 mg/kg	103	70.0	130	----
QC-47536-003	TILL-2	chromium	7440-47-3	E440	36.8 mg/kg	106	70.0	130	----
QC-47536-003	TILL-2	cobalt	7440-48-4	E440	13 mg/kg	105	70.0	130	----
QC-47536-003	TILL-2	copper	7440-50-8	E440	145.8 mg/kg	107	70.0	130	----
QC-47536-003	TILL-2	iron	7439-89-6	E440	33232 mg/kg	102	70.0	130	----
QC-47536-003	TILL-2	lead	7439-92-1	E440	22.4 mg/kg	106	70.0	130	----
QC-47536-003	TILL-2	lithium	7439-93-2	E440	35.5 mg/kg	94.7	70.0	130	----
QC-47536-003	TILL-2	magnesium	7439-95-4	E440	7350 mg/kg	100	70.0	130	----
QC-47536-003	TILL-2	manganese	7439-96-5	E440	652 mg/kg	106	70.0	130	----
QC-47536-003	TILL-2	molybdenum	7439-98-7	E440	13.1 mg/kg	98.2	70.0	130	----
QC-47536-003	TILL-2	nickel	7440-02-0	E440	30.9 mg/kg	106	70.0	130	----
QC-47536-003	TILL-2	phosphorus	7723-14-0	E440	568 mg/kg	106	70.0	130	----
QC-47536-003	TILL-2	potassium	7440-09-7	E440	3670 mg/kg	108	70.0	130	----
QC-47536-003	TILL-2	silver	7440-22-4	E440	0.268 mg/kg	103	50.0	150	----
QC-47536-003	TILL-2	sodium	7440-23-5	E440	307 mg/kg	98.5	70.0	130	----
QC-47536-003	TILL-2	strontium	7440-24-6	E440	15.1 mg/kg	106	70.0	130	----

Sub-Matrix: **Soil/Solid**

					Reference Material (RM) Report				
					RM Target	Recovery (%)	Recovery Limits (%)		
Laboratory sample ID	Reference Material ID	Analyte	CAS Number	Method	Concentration	RM	Low	High	Qualifier
Metals (QCLot: 47536) - continued									
QC-47536-003	TILL-2	thallium	7440-28-0	E440	0.376 mg/kg	102	50.0	150	----
QC-47536-003	TILL-2	titanium	7440-32-6	E440	1109 mg/kg	106	70.0	130	----
QC-47536-003	TILL-2	uranium	7440-61-1	E440	3.29 mg/kg	109	70.0	130	----
QC-47536-003	TILL-2	vanadium	7440-62-2	E440	43.9 mg/kg	105	70.0	130	----
QC-47536-003	TILL-2	zinc	7440-66-6	E440	112.1 mg/kg	111	70.0	130	----
Metals (QCLot: 47537)									
QC-47537-003	TILL-2	mercury	7439-97-6	E510	0.062 mg/kg	106	70.0	130	----

QUALITY CONTROL INTERPRETIVE REPORT

Work Order	: **VA20A7841**	Page	: 1 of 16
Client	: **Constantine North Inc.**	Laboratory	: Vancouver - Environmental
Contact	: Aris Morfopoulos	Account Manager	: Carla Fuginski
Address	: Suite 320 - 800 West Pender St. Vancouver BC Canada V6C 2V6	Address	: 8081 Lougheed Highway Burnaby, British Columbia Canada V5A 1W9
Telephone	: 604 629 2348	Telephone	: +1 604 253 4188
Project	: Stream Sediments	Date Samples Received	: 05-Jun-2020 15:20
PO	: ----	Issue Date	: 25-Jun-2020 12:52
C-O-C number	: ----		
Sampler	: Dylan Krell		
Site	: Sediment Analysis		
Quote number	: Q62329		
No. of samples received	: 10		
No. of samples analysed	: 10		

This report is automatically generated by the ALS LIMS (Laboratory Information Management System) through evaluation of Quality Control (QC) results and other QA parameters associated with this submission, and is intended to facilitate rapid data validation by auditors or reviewers. The report highlights any exceptions and outliers to ALS Data Quality Objectives, provides holding time details and exceptions, summarizes QC sample frequencies, and lists applicable methodology references and summaries.

Key

Anonymous: Refers to samples which are not part of this work order, but which formed part of the QC process lot.
CAS Number: Chemical Abstracts Services number is a unique identifier assigned to discrete substances.
DQO: Data Quality Objective.
LOR: Limit of Reporting (detection limit).
RPD: Relative Percent Difference.

Summary of Outliers

Outliers : Quality Control Samples

- No Method Blank value outliers occur.
- No Duplicate outliers occur.
- No Laboratory Control Sample (LCS) outliers occur
- No Matrix Spike outliers occur.
- No Test sample Surrogate recovery outliers exist.

Outliers: Reference Material (RM) Samples

- No Reference Material (RM) Sample outliers occur.

Outliers : Analysis Holding Time Compliance (Breaches)

- No Analysis Holding Time Outliers exist.

Outliers : Frequency of Quality Control Samples

- No Quality Control Sample Frequency Outliers occur.

Analysis Holding Time Compliance

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times, which are selected to meet known provincial and /or federal requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by organizations such as CCME, US EPA, APHA Standard Methods, ASTM, or Environment Canada (where available). Dates and holding times reported below represent the first dates of extraction or analysis. If subsequent tests or dilutions exceeded holding times, qualifiers are added (refer to COA).

If samples are identified below as having been analyzed or extracted outside of recommended holding times, measurement uncertainties may be increased, and this should be taken into consideration when interpreting results.

Where actual sampling date is not provided on the chain of custody, the date of receipt with time at 15:00 is used for calculation purposes.

Where only the sample date without time is provided on the chain of custody, the sampling date at 15:00 is used for calculation purposes.

Matrix: **Soil/Solid**

Evaluation: × = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group / Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times Rec	Holding Times Actual	Eval	Analysis Date	Holding Times Rec	Holding Times Actual	Eval
Inorganic Parameters : Acid Volatile Sulfide in Soil by Colourimetry										
Glass soil jar/Teflon lined cap										
2020 LGCS1	E401	03-Jun-2020	12-Jun-2020	14 days	8 days	✓	12-Jun-2020	5 days	0 days	✓
Inorganic Parameters : Acid Volatile Sulfide in Soil by Colourimetry										
Glass soil jar/Teflon lined cap										
2020 LGCS2	E401	03-Jun-2020	12-Jun-2020	14 days	8 days	✓	12-Jun-2020	5 days	0 days	✓
Inorganic Parameters : Acid Volatile Sulfide in Soil by Colourimetry										
Glass soil jar/Teflon lined cap										
2020 LGCS3	E401	03-Jun-2020	12-Jun-2020	14 days	8 days	✓	12-Jun-2020	5 days	0 days	✓
Inorganic Parameters : Acid Volatile Sulfide in Soil by Colourimetry										
Glass soil jar/Teflon lined cap										
2020 LGCS4	E401	03-Jun-2020	12-Jun-2020	14 days	8 days	✓	12-Jun-2020	5 days	0 days	✓
Inorganic Parameters : Acid Volatile Sulfide in Soil by Colourimetry										
Glass soil jar/Teflon lined cap										
2020 LGCS5	E401	03-Jun-2020	12-Jun-2020	14 days	8 days	✓	12-Jun-2020	5 days	0 days	✓
Inorganic Parameters : Acid Volatile Sulfide in Soil by Colourimetry										
Glass soil jar/Teflon lined cap										
2020 MGCS1	E401	02-Jun-2020	12-Jun-2020	14 days	9 days	✓	12-Jun-2020	4 days	0 days	✓
Inorganic Parameters : Acid Volatile Sulfide in Soil by Colourimetry										
Glass soil jar/Teflon lined cap										
2020 MGCS2	E401	02-Jun-2020	12-Jun-2020	14 days	9 days	✓	12-Jun-2020	4 days	0 days	✓

Matrix: **Soil/Solid**

Evaluation: × = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group / Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times Rec	Holding Times Actual	Eval	Analysis Date	Holding Times Rec	Holding Times Actual	Eval
Inorganic Parameters : Acid Volatile Sulfide in Soil by Colourimetry										
Glass soil jar/Teflon lined cap										
2020 MGCS3	E401	02-Jun-2020	12-Jun-2020	14 days	9 days	✓	12-Jun-2020	4 days	0 days	✓
Inorganic Parameters : Acid Volatile Sulfide in Soil by Colourimetry										
Glass soil jar/Teflon lined cap										
2020 MGCS4	E401	02-Jun-2020	12-Jun-2020	14 days	9 days	✓	12-Jun-2020	4 days	0 days	✓
Inorganic Parameters : Acid Volatile Sulfide in Soil by Colourimetry										
Glass soil jar/Teflon lined cap										
2020 MGCS5	E401	02-Jun-2020	12-Jun-2020	14 days	9 days	✓	12-Jun-2020	4 days	0 days	✓
Metals : Mercury in Soil/Solid by CVAAS										
Glass soil jar/Teflon lined cap										
2020 LGCS1	E510	03-Jun-2020	10-Jun-2020	28 days	6 days	✓	11-Jun-2020	21 days	0 days	✓
Metals : Mercury in Soil/Solid by CVAAS										
Glass soil jar/Teflon lined cap										
2020 LGCS2	E510	03-Jun-2020	10-Jun-2020	28 days	6 days	✓	11-Jun-2020	21 days	0 days	✓
Metals : Mercury in Soil/Solid by CVAAS										
Glass soil jar/Teflon lined cap										
2020 LGCS3	E510	03-Jun-2020	10-Jun-2020	28 days	6 days	✓	11-Jun-2020	21 days	0 days	✓
Metals : Mercury in Soil/Solid by CVAAS										
Glass soil jar/Teflon lined cap										
2020 LGCS4	E510	03-Jun-2020	10-Jun-2020	28 days	6 days	✓	11-Jun-2020	21 days	0 days	✓
Metals : Mercury in Soil/Solid by CVAAS										
Glass soil jar/Teflon lined cap										
2020 LGCS5	E510	03-Jun-2020	10-Jun-2020	28 days	6 days	✓	11-Jun-2020	21 days	0 days	✓
Metals : Mercury in Soil/Solid by CVAAS										
Glass soil jar/Teflon lined cap										
2020 MGCS1	E510	02-Jun-2020	10-Jun-2020	28 days	7 days	✓	11-Jun-2020	20 days	0 days	✓

Matrix: **Soil/Solid**

Evaluation: × = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group / Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times		Eval	Analysis Date	Holding Times		Eval
				Rec	Actual			Rec	Actual	
Metals : Mercury in Soil/Solid by CVAAS										
Glass soil jar/Teflon lined cap										
2020 MGCS2	E510	02-Jun-2020	10-Jun-2020	28 days	7 days	✓	11-Jun-2020	20 days	0 days	✓
Metals : Mercury in Soil/Solid by CVAAS										
Glass soil jar/Teflon lined cap										
2020 MGCS3	E510	02-Jun-2020	10-Jun-2020	28 days	7 days	✓	11-Jun-2020	20 days	0 days	✓
Metals : Mercury in Soil/Solid by CVAAS										
Glass soil jar/Teflon lined cap										
2020 MGCS4	E510	02-Jun-2020	10-Jun-2020	28 days	7 days	✓	11-Jun-2020	20 days	0 days	✓
Metals : Mercury in Soil/Solid by CVAAS										
Glass soil jar/Teflon lined cap										
2020 MGCS5	E510	02-Jun-2020	10-Jun-2020	28 days	7 days	✓	11-Jun-2020	20 days	0 days	✓
Metals : Metals in Soil/Solid by CRC ICPMS										
Glass soil jar/Teflon lined cap										
2020 LGCS1	E440	03-Jun-2020	10-Jun-2020	180 days	6 days	✓	10-Jun-2020	173 days	0 days	✓
Metals : Metals in Soil/Solid by CRC ICPMS										
Glass soil jar/Teflon lined cap										
2020 LGCS2	E440	03-Jun-2020	10-Jun-2020	180 days	6 days	✓	10-Jun-2020	173 days	0 days	✓
Metals : Metals in Soil/Solid by CRC ICPMS										
Glass soil jar/Teflon lined cap										
2020 LGCS3	E440	03-Jun-2020	10-Jun-2020	180 days	6 days	✓	10-Jun-2020	173 days	0 days	✓
Metals : Metals in Soil/Solid by CRC ICPMS										
Glass soil jar/Teflon lined cap										
2020 LGCS4	E440	03-Jun-2020	10-Jun-2020	180 days	6 days	✓	10-Jun-2020	173 days	0 days	✓
Metals : Metals in Soil/Solid by CRC ICPMS										
Glass soil jar/Teflon lined cap										
2020 LGCS5	E440	03-Jun-2020	10-Jun-2020	180 days	6 days	✓	10-Jun-2020	173 days	0 days	✓

Matrix: **Soil/Solid**

Evaluation: × = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group / Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times Rec	Holding Times Actual	Eval	Analysis Date	Holding Times Rec	Holding Times Actual	Eval
Metals : Metals in Soil/Solid by CRC ICPMS										
Glass soil jar/Teflon lined cap										
2020 MGCS1	E440	02-Jun-2020	10-Jun-2020	180 days	7 days	✓	10-Jun-2020	172 days	0 days	✓
Metals : Metals in Soil/Solid by CRC ICPMS										
Glass soil jar/Teflon lined cap										
2020 MGCS2	E440	02-Jun-2020	10-Jun-2020	180 days	7 days	✓	10-Jun-2020	172 days	0 days	✓
Metals : Metals in Soil/Solid by CRC ICPMS										
Glass soil jar/Teflon lined cap										
2020 MGCS3	E440	02-Jun-2020	10-Jun-2020	180 days	7 days	✓	10-Jun-2020	172 days	0 days	✓
Metals : Metals in Soil/Solid by CRC ICPMS										
Glass soil jar/Teflon lined cap										
2020 MGCS4	E440	02-Jun-2020	10-Jun-2020	180 days	7 days	✓	10-Jun-2020	172 days	0 days	✓
Metals : Metals in Soil/Solid by CRC ICPMS										
Glass soil jar/Teflon lined cap										
2020 MGCS5	E440	02-Jun-2020	10-Jun-2020	180 days	7 days	✓	10-Jun-2020	172 days	0 days	✓
Organic / Inorganic Carbon : Total Carbon by Combustion										
LDPE bag										
2020 LGCS1	E351	03-Jun-2020	----	----	----		11-Jun-2020	0 days	0 days	✓
Organic / Inorganic Carbon : Total Carbon by Combustion										
LDPE bag										
2020 LGCS2	E351	03-Jun-2020	----	----	----		11-Jun-2020	0 days	0 days	✓
Organic / Inorganic Carbon : Total Carbon by Combustion										
LDPE bag										
2020 LGCS3	E351	03-Jun-2020	----	----	----		11-Jun-2020	0 days	0 days	✓
Organic / Inorganic Carbon : Total Carbon by Combustion										
LDPE bag										
2020 LGCS4	E351	03-Jun-2020	----	----	----		11-Jun-2020	0 days	0 days	✓

Matrix: **Soil/Solid**

Evaluation: × = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group / Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times Rec	Holding Times Actual	Eval	Analysis Date	Holding Times Rec	Holding Times Actual	Eval
Organic / Inorganic Carbon : Total Carbon by Combustion										
LDPE bag 2020 LGCS5	E351	03-Jun-2020	----	----	----		11-Jun-2020	0 days	0 days	✓
Organic / Inorganic Carbon : Total Carbon by Combustion										
LDPE bag 2020 MGCS1	E351	02-Jun-2020	----	----	----		11-Jun-2020	0 days	0 days	✓
Organic / Inorganic Carbon : Total Carbon by Combustion										
LDPE bag 2020 MGCS2	E351	02-Jun-2020	----	----	----		11-Jun-2020	0 days	0 days	✓
Organic / Inorganic Carbon : Total Carbon by Combustion										
LDPE bag 2020 MGCS3	E351	02-Jun-2020	----	----	----		11-Jun-2020	0 days	0 days	✓
Organic / Inorganic Carbon : Total Carbon by Combustion										
LDPE bag 2020 MGCS4	E351	02-Jun-2020	----	----	----		11-Jun-2020	0 days	0 days	✓
Organic / Inorganic Carbon : Total Carbon by Combustion										
LDPE bag 2020 MGCS5	E351	02-Jun-2020	----	----	----		11-Jun-2020	0 days	0 days	✓
Organic / Inorganic Carbon : Total Inorganic Carbon by Acetic Acid pH Standard Curve										
LDPE bag 2020 LGCS1	E354	03-Jun-2020	----	----	----		11-Jun-2020	----	----	
Organic / Inorganic Carbon : Total Inorganic Carbon by Acetic Acid pH Standard Curve										
LDPE bag 2020 LGCS2	E354	03-Jun-2020	----	----	----		11-Jun-2020	----	----	
Organic / Inorganic Carbon : Total Inorganic Carbon by Acetic Acid pH Standard Curve										
LDPE bag 2020 LGCS3	E354	03-Jun-2020	----	----	----		11-Jun-2020	----	----	

Matrix: **Soil/Solid**

Evaluation: × = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group / Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times Rec	Holding Times Actual	Eval	Analysis Date	Holding Times Rec	Holding Times Actual	Eval
Organic / Inorganic Carbon : Total Inorganic Carbon by Acetic Acid pH Standard Curve										
LDPE bag 2020 LGCS4	E354	03-Jun-2020	----	----	----		11-Jun-2020	----	----	
Organic / Inorganic Carbon : Total Inorganic Carbon by Acetic Acid pH Standard Curve										
LDPE bag 2020 LGCS5	E354	03-Jun-2020	----	----	----		11-Jun-2020	----	----	
Organic / Inorganic Carbon : Total Inorganic Carbon by Acetic Acid pH Standard Curve										
LDPE bag 2020 MGCS1	E354	02-Jun-2020	----	----	----		11-Jun-2020	----	----	
Organic / Inorganic Carbon : Total Inorganic Carbon by Acetic Acid pH Standard Curve										
LDPE bag 2020 MGCS2	E354	02-Jun-2020	----	----	----		11-Jun-2020	----	----	
Organic / Inorganic Carbon : Total Inorganic Carbon by Acetic Acid pH Standard Curve										
LDPE bag 2020 MGCS3	E354	02-Jun-2020	----	----	----		11-Jun-2020	----	----	
Organic / Inorganic Carbon : Total Inorganic Carbon by Acetic Acid pH Standard Curve										
LDPE bag 2020 MGCS4	E354	02-Jun-2020	----	----	----		11-Jun-2020	----	----	
Organic / Inorganic Carbon : Total Inorganic Carbon by Acetic Acid pH Standard Curve										
LDPE bag 2020 MGCS5	E354	02-Jun-2020	----	----	----		11-Jun-2020	----	----	
Particle Size : Grain Size Report (Attachment) Pipet/Sieve Method										
LDPE bag 2020 LGCS1	E185A	03-Jun-2020	----	----	----		25-Jun-2020	----	----	
Particle Size : Grain Size Report (Attachment) Pipet/Sieve Method										
LDPE bag 2020 LGCS2	E185A	03-Jun-2020	----	----	----		25-Jun-2020	----	----	

Matrix: **Soil/Solid**

Evaluation: × = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group / Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times Rec	Holding Times Actual	Eval	Analysis Date	Holding Times Rec	Holding Times Actual	Eval
Particle Size : Grain Size Report (Attachment) Pipet/Sieve Method										
LDPE bag 2020 LGCS3	E185A	03-Jun-2020	----	----	----		25-Jun-2020	----	----	
Particle Size : Grain Size Report (Attachment) Pipet/Sieve Method										
LDPE bag 2020 LGCS4	E185A	03-Jun-2020	----	----	----		25-Jun-2020	----	----	
Particle Size : Grain Size Report (Attachment) Pipet/Sieve Method										
LDPE bag 2020 LGCS5	E185A	03-Jun-2020	----	----	----		25-Jun-2020	----	----	
Particle Size : Grain Size Report (Attachment) Pipet/Sieve Method										
LDPE bag 2020 MGCS1	E185A	02-Jun-2020	----	----	----		25-Jun-2020	----	----	
Particle Size : Grain Size Report (Attachment) Pipet/Sieve Method										
LDPE bag 2020 MGCS2	E185A	02-Jun-2020	----	----	----		25-Jun-2020	----	----	
Particle Size : Grain Size Report (Attachment) Pipet/Sieve Method										
LDPE bag 2020 MGCS3	E185A	02-Jun-2020	----	----	----		25-Jun-2020	----	----	
Particle Size : Grain Size Report (Attachment) Pipet/Sieve Method										
LDPE bag 2020 MGCS4	E185A	02-Jun-2020	----	----	----		25-Jun-2020	----	----	
Particle Size : Grain Size Report (Attachment) Pipet/Sieve Method										
LDPE bag 2020 MGCS5	E185A	02-Jun-2020	----	----	----		25-Jun-2020	----	----	
Physical Tests : Loss On Ignition (550°C)										
LDPE bag 2020 LGCS1	E205D	03-Jun-2020	----	----	----		11-Jun-2020	365 days	7 days	✓

Matrix: **Soil/Solid**

Evaluation: × = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group / Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times		Eval	Analysis Date	Holding Times		Eval
				Rec	Actual			Rec	Actual	
Physical Tests : Loss On Ignition (550°C)										
LDPE bag 2020 LGCS2	E205D	03-Jun-2020	----	----	----		11-Jun-2020	365 days	7 days	✓
Physical Tests : Loss On Ignition (550°C)										
LDPE bag 2020 LGCS3	E205D	03-Jun-2020	----	----	----		11-Jun-2020	365 days	7 days	✓
Physical Tests : Loss On Ignition (550°C)										
LDPE bag 2020 LGCS4	E205D	03-Jun-2020	----	----	----		11-Jun-2020	365 days	7 days	✓
Physical Tests : Loss On Ignition (550°C)										
LDPE bag 2020 LGCS5	E205D	03-Jun-2020	----	----	----		11-Jun-2020	365 days	7 days	✓
Physical Tests : Loss On Ignition (550°C)										
LDPE bag 2020 MGCS1	E205D	02-Jun-2020	----	----	----		11-Jun-2020	365 days	8 days	✓
Physical Tests : Loss On Ignition (550°C)										
LDPE bag 2020 MGCS2	E205D	02-Jun-2020	----	----	----		11-Jun-2020	365 days	8 days	✓
Physical Tests : Loss On Ignition (550°C)										
LDPE bag 2020 MGCS3	E205D	02-Jun-2020	----	----	----		11-Jun-2020	365 days	8 days	✓
Physical Tests : Loss On Ignition (550°C)										
LDPE bag 2020 MGCS4	E205D	02-Jun-2020	----	----	----		11-Jun-2020	365 days	8 days	✓
Physical Tests : Loss On Ignition (550°C)										
LDPE bag 2020 MGCS5	E205D	02-Jun-2020	----	----	----		11-Jun-2020	365 days	8 days	✓

Matrix: **Soil/Solid**

Evaluation: × = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group / Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times		Eval	Analysis Date	Holding Times		Eval
				Rec	Actual			Rec	Actual	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
2020 LGCS1	E144	03-Jun-2020	----	----	----		09-Jun-2020	14 days	5 days	✓
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
2020 LGCS2	E144	03-Jun-2020	----	----	----		09-Jun-2020	14 days	5 days	✓
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
2020 LGCS3	E144	03-Jun-2020	----	----	----		09-Jun-2020	14 days	5 days	✓
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
2020 LGCS4	E144	03-Jun-2020	----	----	----		09-Jun-2020	14 days	5 days	✓
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
2020 LGCS5	E144	03-Jun-2020	----	----	----		09-Jun-2020	14 days	5 days	✓
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
2020 MGCS1	E144	02-Jun-2020	----	----	----		09-Jun-2020	14 days	6 days	✓
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
2020 MGCS2	E144	02-Jun-2020	----	----	----		09-Jun-2020	14 days	6 days	✓
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
2020 MGCS3	E144	02-Jun-2020	----	----	----		09-Jun-2020	14 days	6 days	✓
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
2020 MGCS4	E144	02-Jun-2020	----	----	----		09-Jun-2020	14 days	6 days	✓

Matrix: **Soil/Solid**

Evaluation: × = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group / Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times Rec	Holding Times Actual	Eval	Analysis Date	Holding Times Rec	Holding Times Actual	Eval
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap 2020 MGCS5	E144	02-Jun-2020	----	----	----		09-Jun-2020	14 days	6 days	✓
Physical Tests : pH by Meter (1:2 Soil:Water Extraction)										
Glass soil jar/Teflon lined cap 2020 LGCS1	E108	03-Jun-2020	10-Jun-2020	30 days	6 days	✓	10-Jun-2020	23 days	0 days	✓
Physical Tests : pH by Meter (1:2 Soil:Water Extraction)										
Glass soil jar/Teflon lined cap 2020 LGCS2	E108	03-Jun-2020	10-Jun-2020	30 days	6 days	✓	10-Jun-2020	23 days	0 days	✓
Physical Tests : pH by Meter (1:2 Soil:Water Extraction)										
Glass soil jar/Teflon lined cap 2020 LGCS3	E108	03-Jun-2020	10-Jun-2020	30 days	6 days	✓	10-Jun-2020	23 days	0 days	✓
Physical Tests : pH by Meter (1:2 Soil:Water Extraction)										
Glass soil jar/Teflon lined cap 2020 LGCS4	E108	03-Jun-2020	10-Jun-2020	30 days	6 days	✓	10-Jun-2020	23 days	0 days	✓
Physical Tests : pH by Meter (1:2 Soil:Water Extraction)										
Glass soil jar/Teflon lined cap 2020 LGCS5	E108	03-Jun-2020	10-Jun-2020	30 days	6 days	✓	10-Jun-2020	23 days	0 days	✓
Physical Tests : pH by Meter (1:2 Soil:Water Extraction)										
Glass soil jar/Teflon lined cap 2020 MGCS1	E108	02-Jun-2020	10-Jun-2020	30 days	7 days	✓	10-Jun-2020	22 days	0 days	✓
Physical Tests : pH by Meter (1:2 Soil:Water Extraction)										
Glass soil jar/Teflon lined cap 2020 MGCS2	E108	02-Jun-2020	10-Jun-2020	30 days	7 days	✓	10-Jun-2020	22 days	0 days	✓
Physical Tests : pH by Meter (1:2 Soil:Water Extraction)										
Glass soil jar/Teflon lined cap 2020 MGCS3	E108	02-Jun-2020	10-Jun-2020	30 days	7 days	✓	10-Jun-2020	22 days	0 days	✓

Matrix: **Soil/Solid**

Evaluation: × = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group / Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times		Eval	Analysis Date	Holding Times		Eval
				Rec	Actual			Rec	Actual	
Physical Tests : pH by Meter (1:2 Soil:Water Extraction)										
Glass soil jar/Teflon lined cap										
2020 MGCS4	E108	02-Jun-2020	10-Jun-2020	30 days	7 days	✓	10-Jun-2020	22 days	0 days	✓
Physical Tests : pH by Meter (1:2 Soil:Water Extraction)										
Glass soil jar/Teflon lined cap										
2020 MGCS5	E108	02-Jun-2020	10-Jun-2020	30 days	7 days	✓	10-Jun-2020	22 days	0 days	✓

Legend & Qualifier Definitions

Rec. HT: ALS recommended hold time (see units).

Quality Control Parameter Frequency Compliance

The following report summarizes the frequency of laboratory QC samples analyzed within the analytical batches (QC lots) in which the submitted samples were processed. The actual frequency should be greater than or equal to the expected frequency.

Matrix: **Soil/Solid**

Evaluation: × = *QC frequency outside specification*; ✓ = *QC frequency within specification.*

Quality Control Sample Type			Count		Frequency (%)		
Analytical Methods	*Method*	*QC Lot #*	*QC*	*Regular*	*Actual*	*Expected*	*Evaluation*
Laboratory Duplicates (DUP)							
Acid Volatile Sulfide in Soil by Colourimetry	E401	48749	1	10	10.0	4.7	✓
Loss On Ignition (550°C)	E205D	48472	1	10	10.0	5.0	✓
Mercury in Soil/Solid by CVAAS	E510	47537	1	12	8.3	5.0	✓
Metals in Soil/Solid by CRC ICPMS	E440	47536	1	15	6.6	5.0	✓
Moisture Content by Gravimetry	E144	47542	1	17	5.8	5.0	✓
pH by Meter (1:2 Soil:Water Extraction)	E108	47541	1	13	7.6	5.0	✓
Total Carbon by Combustion	E351	48349	1	10	10.0	5.0	✓
Total Inorganic Carbon by Acetic Acid pH Standard Curve	E354	48351	1	10	10.0	5.0	✓
Laboratory Control Samples (LCS)							
Acid Volatile Sulfide in Soil by Colourimetry	E401	48749	1	10	10.0	4.7	✓
Loss On Ignition (550°C)	E205D	48472	1	10	10.0	5.0	✓
Mercury in Soil/Solid by CVAAS	E510	47537	2	12	16.6	10.0	✓
Metals in Soil/Solid by CRC ICPMS	E440	47536	2	15	13.3	10.0	✓
Moisture Content by Gravimetry	E144	47542	1	17	5.8	5.0	✓
pH by Meter (1:2 Soil:Water Extraction)	E108	47541	1	13	7.6	5.0	✓
Total Carbon by Combustion	E351	48349	2	10	20.0	10.0	✓
Total Inorganic Carbon by Acetic Acid pH Standard Curve	E354	48351	2	10	20.0	10.0	✓
Method Blanks (MB)							
Acid Volatile Sulfide in Soil by Colourimetry	E401	48749	1	10	10.0	4.7	✓
Loss On Ignition (550°C)	E205D	48472	1	10	10.0	5.0	✓
Mercury in Soil/Solid by CVAAS	E510	47537	1	12	8.3	5.0	✓
Metals in Soil/Solid by CRC ICPMS	E440	47536	1	15	6.6	5.0	✓
Moisture Content by Gravimetry	E144	47542	1	17	5.8	5.0	✓
Total Carbon by Combustion	E351	48349	1	10	10.0	5.0	✓
Total Inorganic Carbon by Acetic Acid pH Standard Curve	E354	48351	1	10	10.0	5.0	✓

Methodology References and Summaries

The analytical methods used by ALS are developed using internationally recognized reference methods (where available), such as those published by US EPA, APHA Standard Methods, ASTM, ISO, Environment Canada, BC MOE, and Ontario MOE. Reference methods may incorporate modifications to improve performance (indicated by "mod").

Analytical Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
pH by Meter (1:2 Soil:Water Extraction)	E108 Vancouver - Environmental	Soil/Solid	BC Lab Manual	pH is determined by potentiometric measurement with a pH electrode at ambient laboratory temperature (normally 20 ± 5°C), and is carried out in accordance with procedures described in the BC Lab Manual (prescriptive method). The procedure involves mixing the dried (at <60 ºC) and sieved (10mesh/2mm) sample with ultra pure water at a 1:2 ratio of sediment to water. The pH is then measured by a standard pH probe.
Moisture Content by Gravimetry	E144 Vancouver - Environmental	Soil/Solid	CCME PHC in Soil - Tier 1	Moisture is measured gravimetrically by drying the sample at 105°C for a minimum of six hours or to constant weight. Moisture content is calculated as the weight loss (due to water) divided by the wet weight of the sample, expressed as a percentage.
Grain Size Report (Attachment) Pipet/Sieve Method	E185A Saskatoon - Environmental	Soil/Solid	SSIR-51 Method 3.2.1	A grain size curve is a graphical representation of the particle sizing of a sample representing the percent passing against the effective particle size.
Loss On Ignition (550°C)	E205D Saskatoon - Environmental	Soil/Solid	CSSS (2008) 28.3 (mod)	Loss On Ignition (LOI) is determined by drying a portion of an air dried and ground sample at 105°C overnight, then igniting at 550°C for 16-20 hours. The weight loss after ignition is reported as % loss on ignition. LOI is reported on a dry weight basis. LOI at 550°C can be used as an estimation of Organic Matter (CSSS 2008).
Total Carbon by Combustion	E351 Saskatoon - Environmental	Soil/Solid	CSSS (2008) 21.2 (mod)	Total Carbon is determined by the high temperature combustion method with measurement by an infrared detector.
Total Inorganic Carbon by Acetic Acid pH Standard Curve	E354 Saskatoon - Environmental	Soil/Solid	CSSS (2008) 20.2	Total Inorganic Carbon is determined by acetic acid pH standard curve, where a known quantity of acetic acid is consumed by reaction with carbonates in the soil. The pH of the resulting solution is measured and compared against a standard curve relating pH to weight of carbonate.
Acid Volatile Sulfide in Soil by Colourimetry	E401 Waterloo - Environmental	Soil/Solid	APHA 4500S2J	This analysis is carried out in accordance with the method described in APHA 4500 S2-J. After extraction the Acid Volatile Sulphide is determined colourimetrically.
Metals in Soil/Solid by CRC ICPMS	E440 Vancouver - Environmental	Soil/Solid	EPA 6020B (mod)	Samples are dried, then sieved through a 2 mm sieve, and digested with HNO3 and HCl. This method is intended to liberate metals that may be environmentally available. Silicate minerals are not solubilized. Dependent on sample matrix, some metals may be only partially recovered, including Al, Ba, Be, Cr, Sr, Ti, Tl, V, W, and Zr. Volatile forms of sulfur (including sulfide) may not be captured, as they may be lost during sampling, storage, or digestion. Analysis is by Collision/Reaction Cell ICPMS.
Mercury in Soil/Solid by CVAAS	E510 Vancouver - Environmental	Soil/Solid	EPA 200.2/1631 Appendix (mod)	Samples are dried, then sieved through a 2 mm sieve, and digested with HNO3 and HCl, followed by CVAAS analysis.

Analytical Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
Total Organic Carbon (Calculated) in soil	EC356 Saskatoon - Environmental	Soil/Solid	CSSS (2008) 21.2	Total Organic Carbon (TOC) is calculated by the difference between total carbon (TC) and total inorganic carbon (TIC).

Preparation Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
Leach 1:2 Soil:Water for pH	EP108 Vancouver - Environmental	Soil/Solid	BC WLAP METHOD: PH, ELECTROMETRIC, SOIL	The procedure involves mixing the dried (at <60°C) and sieved (No. 10 / 2mm) sample with deionized/distilled water at a 1:2 ratio of sediment to water.
Distillation for Acid Volatile Sulfide in Soil	EP400 Vancouver - Environmental	Soil/Solid	EPA 821/R-91-100 (mod)	Acid Volatile Sulfide is determined by colourimetric measurement on a sediment sample that has been treated with hydrochloric acid within a purge and trap system, where the evolved hydrogen sulfide gas is carried into a basic solution by argon gas for analysis.
Preparation of Acid Volatile Sulfide in Soil	EP401 Waterloo - Environmental	Soil/Solid	APHA 4500S2J	This analysis is carried out in accordance with the method described in APHA 4500 S2-J. Hydrochloric acid is added to sediment samples within a purge and trap system. The evolved hydrogen sulphide (H2S) is carried into a basic solution by inert gas.
Digestion for Metals and Mercury	EP440 Vancouver - Environmental	Soil/Solid	EPA 200.2 (mod)	Samples are dried, then sieved through a 2 mm sieve, and digested with HNO3 and HCl. This method is intended to liberate metals that may be environmentally available.
Dry and Grind	EPP442 Saskatoon - Environmental	Soil/Solid	Soil Sampling and Methods of Analysis, Carter 2008	After removal of any coarse fragments and reservation of wet subsamples a portion of homogenized sample is set in a tray and dried at less than 60 C until dry. The sample is then particle size reduced with an automated crusher or mortar and pestle, typically to <2 mm. Further size reduction may be needed for particular tests.

Chain of Custody (COC) / Analytical Request Form

ALS Environmental

Canada Toll Free: 1 800 668 9878

Affix ALS barcode label here
(lab use only)

COC Number: 15 -

Page 1 of 1

Report To		Report Format / Distribution		Select Service Level Below (Rush Turnaround Time (TAT) is not available for all tests)
Company:	ADF&G Habitat Section	Invoice Distribution	☑ PDF ☑ EXCEL ☑ EDD (DIGITAL)	R ☑ Regular (Standard TAT if received by 3 pm - business days)
Contact:	Dylan Krull	Quality Control (QC) Report with Report	yes	P ☐ Priority (2-4 bus. days if received by 3pm) 50% surcharge - contact ALS to confirm TAT
Address:	PO Box 110024 Juneau AK 99811	☐ Criteria on Report - provide details below if box checked		E ☐ Emergency (1-2 bus. days if received by 3pm) 100% surcharge - contact ALS to confirm TAT
		Select Distribution:	☑ EMAIL ☐ MAIL ☐ FAX	E2 ☐ Same day or weekend emergency - contact ALS to confirm TAT and surcharge
Phone:	907-465-6160	Email 1 or Fax	dylan.krull@alaska.gov	Specify Date Required for E2,E or P:
		Email 2	allegra@constantinemetals.com	

Invoice To	Aris Morfopoulos	Invoice Distribution	
	Suite 320, 800 W. Pender St. Vanouve	Select Invoice Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Company:	Constantine Mining LLC	Email 1 or Fax	aris@constantinemetals.com
Contact:	Aris@constantinemetals.com	Email 2	allegra@constantinemetals.com

Project Information		Oil and Gas Required Fields (client use)	
ALS Quote #:	Q62329	Approver ID:	Cost Center:
Job #:	Stream Sediments	GL Account:	Routing Code:
PO / AFE:		Activity Code:	
LSD:		Location:	

ALS Lab Work Order # (lab use only)

ALS Contact: Carla Fuginski **Sampler:** Dylan Krull

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

AS PER QUOTE Q2329

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Number of Containers
	2020 LGCS1	3/6/20	1000	Soil	3
	2020 LGCS2	↓		Soil	3
	2020 LGCS3			Soil	3
	2020 LGCS4			Soil	3
	2020 LGCS5			Soil	3
	2020 MGCS1	2/6/20	1400	Soil	3
	2020 MGCS2	↓		Soil	3
	2020 MGCS3			Soil	3
	2020 MGCS4			Soil	3
	2020 MGCS5	↓		Soil	3

Environmental Division
Vancouver
Work Order Reference
VA20A7841

Telephone : +1 604 253 4188

Drinking Water (DW) Samples [1] (client use)	Special Instructions / Specify Criteria to add on report (client Use)
Are samples taken from a Regulated DW System?	Please select criteria from drop-down list
Are samples for human drinking water use?	Please select criteria from drop-down list

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen	☐		SIF Observations	Yes ☐	No ☐
Ice packs	Yes ☑	No ☐	Custody seal intact	Yes ☐	No ☐
Cooling Initiated	☐				

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
			14	15	

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)			
Released by:	Date:	Time:	Received by:	Date:	Time:	Received by:	Date:		Time:
	6/3/20	1600				JL	Jun 5, 20		15:20

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from **Regulated Drinking Water (DW) System** please submit using an **Authorized DW COC form**.